Boundary-crossing learning in agricultural learning systems: formative interventions for water and seed provision in southern Africa

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ABSTRACT

This research was conducted in the Amathole rural district of the Eastern Cape Province of South Africa, and in Zvishavane and Zhombe rural districts of the Midlands Province of Zimbabwe over a period of four years. In the first two years of this period I was involved in co-engaged boundary-crossing expansive learning processes with research participants from agricultural education (agricultural college lecturers, principals and university lecturers), extension services (extension officers, advisors and workers), small-scale farmers and a local economic development (LED) agency as agricultural learning activity systems. The latter was applicable only to the South African nested case while the rest applied to both country nested cases. The study focusses on the boundary-crossing learning of sustainable agricultural water relevant for small-scale farming contexts under rain-fed and climate constrained conditions with specific attention to rainwater harvesting and conservation and climate-adaptive seed. The study employed cultural-historical activity theory (CHAT) and developmental work research methodology developed by Yrjö Engeström and his colleagues at the Centre for Researching Activity Development and Learning (CRADLE) at the University of Helsinki in Finland.

The study was guided by three objectives. The first objective was to find out how the different groups represented across the activity systems listed above learn together to mediate and communicate sustainable agricultural water and seed saving. To address this objective I conducted focus groups and interviews with key informants, made observations and analysed documents. The second objective was to explore and document the socio-ecological histories of rainwater harvesting and conservation, locally-adaptive seed systems and associated value chains, and socio-cultural histories of agricultural learning systems in the context of small-scale farming using historical and ethnographic research techniques. The third objective was to understand how learning, curriculum innovation and mediation tools for agricultural extension education and farmer training that can expand learning of rainwater harvesting and conservation sustainable practices for improved local agricultural water and climate-adaptive non-formal seed systems in agricultural education and small-scale farmer activity systems could be co-generated. This third objective constituted the boundary-crossing expansive learning that emerged from change laboratory workshops carefully designed to explore the common water for food object across the different but related activity systems.

The study reveals historically-persisting tensions and contradictions in the work of agricultural college lecturers, small-scale farmers and extension workers that limit their ability to work together relationally leaving them operating in isolated ‘silos’. The industrially-driven agricultural college curriculum promoting conventional irrigated agriculture conflicted with the college’s objective of

producing extension workers who will work with resource-poor small-scale farmers in rain-fed farming systems. This conflict was aggravated by the work of extension workers who had little to no knowledge regarding how to support small-scale farmers facing persistent drought and consequent crop failure due to poor and erratic rainfall. At the same time extension services promoting genetically modified (GMO) seed in South Africa were in conflict with some small-scale farmers' demands for seed that was adapted to their changing climate and their ability to operate independently with access to and ownership of land. This study shows that the work of agricultural colleges and extension services often defeats its intended structural objectives due to historically-constituted power relations around knowledge.

This study has demonstrated the effectiveness of co-generative formative interventions in boundary-crossing scenarios in learning network contexts for expansion of activity in farming communities, agricultural colleges and extension services, with emphasis of transformed activity towards engaging a collective object of rainwater harvesting and conservation for more sustainable agriculture and poverty alleviation. The study shows that diverse combinations of change practice courses, change laboratories, demonstration sites and media engagements as mediation processes in the context of learning networks strengthened the possibility for boundary-crossing expansive learning across activity systems of agricultural college lecturers, smallholder farmers, extension workers and local economic development agency facilitators. Three of the five mediation processes emerged out of the formative intervention processes in both the South African and Zimbabwean case studies while two were not realised in the Zimbabwean case study, namely the change practice course and media engagements, due to different formative intervention conditions, inadequate time and resources.

Boundary-crossing was enabled by a variety of actions including understanding and identifying with the context of the other (i.e. developing empathy) as a result of change laboratory workshops that also ensured confrontation with relational contradictions. The study concludes that it is possible for historically-constituted contradictions around water for food to be resolved when participants from different agricultural learning systems co-engage as equals in boundary-crossing change laboratory fora mediated by appropriate tools and processes. The study contributes to innovation in agricultural learning systems in southern Africa, in particular to means of engaging across boundaries of previously largely disconnected activity systems in ways that benefit smallholder farmers who have previously been marginalised from mainstream agricultural learning systems.

DEDICATION

I am grateful to my Almighty Heavenly Father for making it possible for me to do this work and complete this PhD thesis. I therefore dedicate this thesis to Him and may all the glory be bestowed to Him through Christ.

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TABLE OF CONTENTS

Abstract i
Dedication iii
Acknowledgements iii
List of Tables xv
List of Figures xvii
Abbreviations and Acronyms xxv

CHAPTER 1
LEARNING ACROSS BOUNDARIES 1
1.1 INTRODUCTION 1
1.2 ORIENTATING EXPERIENCES MOTIVATING MY RESEARCH INTEREST 2
1.2.1 Learning to flourish in the marginalised rural village under colonial rule 2
1.2.2 Learning to work with cattle and crops: Herd boys and plough handlers 3
1.2.3 Master Farmers, grandmothers and youths: Embodied cultural choices and sense-making or specialisation vs emergent diversity 4
1.2.4 Face to face with water problems and hope in innovative solutions 5
1.2.5 A disturbing moral question 6
1.3 THE RESEARCH INTEREST AND CURIOSITY 7
1.4 RESEARCH OBJECTIVES AND QUESTIONS 9
1.5 STUDY SITES AND NESTED CASE STUDY DESIGN 11
1.5.1 Context of study site in South Africa: Study site 1 12
1.5.1.1 Fort Cox College of Agriculture and Forestry as a community learning centre 18
1.5.1.2 eDikeni Water User Association (WUA) 19
1.5.1.3 Keiskammahoek rural town and villages 20
1.5.1.4 Mqayise village, Matole Basin 20
1.5.1.5 General socio-ecological characteristics of the South African study site 21
1.5.2 Context of study sites in Zimbabwe: Study site 2 22
1.5.2.1 The Department of Agricultural Education and Farmer Training, Zimbabwe: Mlezu and Rio Tinto Agricultural Colleges 25
1.5.2.2 Mapanzure and Mazvihwa communal lands, Zvishavane (Runde) Rural District, Zimbabwe 26
1.6 CONCEPTUALISING THE AGRICULTURAL LEARNING SYSTEM AS ACTIVITY SYSTEMS: LEARNING AND AGENCY ACROSS THEM 28
1.7 WHY BOUNDARY-CROSSING LEARNING IN AGRICULTURAL LEARNING ACTIVITY SYSTEMS? 29
1.8 KEY CONCEPTS CONNECTED TO AND ROOTED IN LEARNING ACROSS BOUNDARIES 31
1.8.1 Activity, activity system and mediated action 31
1.8.2 Expansive learning 32
1.8.3 Boundary-crossing 32
1.8.3.1 Boundary objects 32
1.8.4 Boundaries and borders 33
1.8.5 Boundary-crossing learning 34
1.8.6 Dialectics 35

1.8.6.1 Absenting absence as a dialectic *35*
1.8.7 Culture(s) 36
1.8.8 Small-scale farming 36
1.8.9 Sustainability 36
1.8.10 Agency 37
1.8.11 Reciprocity 38
1.8.12 Empathy 38
1.8.13 Praxis 38
1.8.14 Reflexivity 40
1.9 OUTLINE OF THE THESIS 40
1.10 CONCLUSION 44

CHAPTER 2
CULTURES OF AGRICULTURE, WATER AND AGRICULTURAL LEARNING SYSTEMS IN SOUTHERN AFRICA 45
2.1 INTRODUCTION 45
2.2 HISTORY OF AGRI-CULTURE IN AFRICA AND SOUTHERN AFRICA 46
2.2.1 A history of smallholder family-based and communal farming and water in Africa with a focus on southern Africa 46
2.2.2 A brief history of agriculture and water for food in the South African case 49
2.2.2.1 Pre-colonial agricultural history *49*
2.2.2.2 Colonial impact on the culture of agriculture in South Africa *50*
2.2.2.3 Impact of climate variability and change on the culture of small-scale agriculture in South Africa *51*
2.2.3 A brief history of agriculture and water for food in Zimbabwe 51
2.3 POLICIES 55
2.3.1 SADC protocols and agreements on agriculture and water development 56
2.3.1.1 Agricultural policy and seed systems in SADC: Vigorous GMO debate *58*
2.3.1.2 Connecting policy with practice for sustainable smallholder farmer development in SADC *59*
2.3.2 National Development, Agriculture and Water Policies in South Africa 61
2.3.2.1 Agricultural policy in South Africa *62*
2.3.2.2 The South African Water Act and agriculture *65*
2.3.2.3 Water research policy and legislation in South Africa *66*
2.3.2.4 South Africa's seed and food security policy and its impact on small-scale farmers *67*
2.3.3 National Development, Agriculture and Water Policies in Zimbabwe 69
2.4 CULTURES OF PRAXIS OF RAIN-FED SMALL-SCALE FARMING AND AGRICULTURAL WATER 73
2.4.1 Cultures of small-scale (or smallholder) farming praxis 74
2.4.2 Cultures of agricultural water praxis: Rainwater harvesting and conservation and irrigation 77
2.4.3 Cultures of praxis in locally-adaptive seed crop production, seed saving and exchange in southern Africa 82
2.4.3.1 Cultures of praxis in locally-adaptive seed crop production, seed saving and exchange in South Africa *83*

2.4.3.2 Culture of GMO praxis in South African agriculture and smallholder food production ... 84
2.4.3.3 Cultures of praxis in locally-adaptive seed crop production, seed saving and exchange in Zimbabwe ... 85
2.4.4 Cultures of agricultural education and farmer training praxis: Silenced and privileged voices ... 88
2.4.4.1 Historicised culture of agricultural education and training (AET) in South Africa 89
2.4.4.2 Contemporary AET praxis in South Africa and the persistence of legacy ... 91
2.4.4.3 Culture of agricultural education and training praxis in Zimbabwe ... 96
2.4.4.4 The response of Zimbabwean Agricultural Education Colleges to Environmental Education ... 98
2.4.4.5 Articulation of agricultural education in the schools with agricultural colleges ... 99
2.4.5 Cultures of agricultural extension praxis ... 100
2.4.5.1 Culture of extension praxis in South Africa ... 100
2.4.6 Cultures of agricultural learning systems in tension ... 102
2.5 IMPACTS OF CHANGING TECHNOLOGY, ECONOMIC, SOCIAL AND ENVIRONMENTAL LANDSCAPES ON THE CULTURE OF AGRICULTURAL PRAXIS ... 102
2.5.1 Impacts of changing technology on the culture of agriculture ... 103
2.5.2 Impacts of globalising economic models on the cultures of agriculture ... 103
2.6 TOWARDS SUSTAINABILITY IN AGRICULTURAL LEARNING SYSTEMS ... 104
2.6.1 Transformational changes across agricultural education, extension and research and their relational processes: Towards collective learning ... 105
2.6.1.1 Farmer field schools ... 106
2.7 EMERGENCE OF SUSTAINABILITY PRACTICES IN AGRICULTURAL LEARNING SYSTEMS ... 107
2.8 ENGAGEMENT WITH LEARNING IN AND ACROSS BOUNDARIES (BOUNDARY-CROSSING) ... 108
2.9 CONCLUSION ... 108

CHAPTER 3
GENERATIVE THEORY AND METHODOLOGY FOR BOUNDARY-CROSSING EXPANSIVE LEARNING RESEARCH ... 110
3.1 INTRODUCTION ... 110
3.2 INTRODUCING CULTURAL-HISTORICAL ACTIVITY THEORY (CHAT) ... 111
3.2.1 Elaborating CHAT: Basic principles ... 112
3.2.2 Why CHAT? ... 113
3.2.2.1 Activity Theory and Cultural-Historical Activity Theory tradition: Origins and historical development ... 114
3.2.2.2 Activity theory: A reflection on its pedestals of Marxist thought ... 115
3.2.2.3 Development of the idea of mediated action and activity theory ... 116
3.2.2.4 Elaboration of concepts of activity systems ... 119
3.2.2.5 Second generation activity theory ... 120
3.2.2.6 Three analytical levels of activity theory ... 121
3.2.3 Identifying, conceptualising, and theorising contradictions and their manifestations ... 122

3.2.3.1 Manifestations of contradictions in 'dilemmas' *123*
3.2.3.2 'Conflicts' as manifestations of contradictions *124*
3.2.3.3 'Critical Conflicts' as manifestations of contradictions *124*
3.2.3.4 'Double-binds' as manifestations of contradictions *124*
3.2.3.5 The ubiquitous and latent nature of primary contradictions in capitalist commodities: Use versus exchange value and a possible reinterpretation *125*
3.2.3.6 Secondary contradictions *125*
3.2.3.7 Tertiary contradictions *126*
3.2.3.8 Quaternary contradictions *127*
3.2.3.9 Third generation activity theory and boundary-crossing in learning networks ... *127*
3.2.3.10 Application of third generation CHAT to boundary-crossing learning in networked agricultural learning systems *129*
3.3 THEORY AND MECHANISMS OF EXPANSIVE BOUNDARY-CROSSING LEARNING 132
3.3.1 Potential dialogical learning mechanisms at and across boundaries 132
3.3.1.1 'Identification' as learning mechanism in boundary-crossing *132*
3.3.1.2 'Coordination' as learning mechanism in boundary-crossing *133*
3.3.1.3 'Reflection' as learning mechanism in boundary-crossing *133*
3.3.1.4 'Transformation' as a learning mechanism in boundary-crossing *133*
3.3.1.5 The potential role of emotion in enabling or constraining boundary-crossing learning *136*
3.3.2 Expansive learning and transformative change across boundaries 136
3.4 DEVELOPMENTAL WORK RESEARCH (DWR) METHODOLOGY – PRECURSOR TO CHANGE LABORATORY WORKSHOPS 136
3.4.1 Connecting methodology, theory and the study of boundary-crossing expansive learning as generative of sustainable farming innovations 137
3.4.2 Self-reflexivity in carrying out formative interventionist research 138
3.4.3 Brief history and origins of developmental work research methodology 140
3.4.4 Principles of developmental work research that I drew on 141
3.4.4.1 Layers of transformative change *141*
3.4.4.2 'Knotworking' *143*
3.4.5 Obtaining research access, and mediating data generation tools and processes 143
3.5 DATA GENERATION METHODS 144
3.5.1 Document and artefact analysis 146
3.5.2 Field and activity participation, ethnography and observation 148
3.5.3 Group interviews and focus groups 149
3.5.4 In-depth key informant interviews 150
3.5.5 Categorisation of data generated from the activity systems 150
3.5.6 Observation and following the object in Change laboratory workshops (CLWs) 152
3.5.6.1 Description of change laboratory settings *154*
3.5.7 Expansive learning cycle 155
3.5.8 Boundary-crossing Change Laboratories: A tool for transforming co-engaged collaborative learning and coordinated work in learning networks 157
3.5.9 Double stimulation 157

3.5.10 The anatomy, nature and importance of the 'germ cell' in formative intervention 161
3.6 DATA PROCESSING AND ANALYSIS 161
3.6.1 Transcription and member checking 161
3.6.2 Data analysis 162
3.6.2.1 Identification and analysis of contradictions in work through activity systems ... 165
3.6.2.2 Use of historical data to identify contradictions 166
3.6.2.3 Analysis of changed practices and the ZPD 167
3.6.2.4 Explaining transformative change with the notion of 'Learning leads development' in the ZPD 169
3.7 CRITICAL REALISM AND DIALECTICAL CRITICAL REALISM: EXPLAINING CHANGE 171
3.7.1 Introducing critical realism 171
3.7.2 Understanding the foundations and building blocks of critical realism 171
3.7.3 Why Critical Realism? 172
3.7.4 Using the idea of a stratified ontology: Real, actual and empirical 174
3.7.5 Towards a deep ontology of learning 175
3.7.6 Principles and concepts of critical realism in relation to CHAT: Applications 176
3.7.7 Use of Dialectical Critical Realism's emancipatory and transformative nature 176
3.7.7.1 Power relations as generative mechanisms: Goods or evils 177
3.7.7.2 Absences and absenting absences as transformative change 178
3.7.8 Generative Mechanisms 178
3.8 CONCLUSION 179

CHAPTER 4
SURFACING CONTRADICTIONS FROM THE SOUTH AFRICAN NESTED CASE STUDY 181
4.1 INTRODUCTION 181
4.2 UNDERSTANDING AND CONCEPTUALISING ACTIVITY SYSTEMS IN THE SOUTH AFRICAN NESTED CASE STUDY 182
4.2.1 The small-scale farming activity system and its internal contradictions 183
4.2.1.1 Case study 1 South Africa: Koloni Village 185
4.2.1.2 Case study 2 South Africa: Lloyd Village Cooperative garden producers' activity system 193
4.2.1.3 Case study 3 South Africa: Matole Basin small-scale farming activity system 199
4.2.2 The Agricultural Extension activity system and its internal contradictions 211
4.2.3 The agricultural education activity system and its internal contradictions 221
4.3 CONTRADICTIONS IN SUSTAINABILITY PERSPECTIVES INDICATE VALUE OF ASPIRATIONS AND AGENCY IN WATER AND SEED FOR FOOD; INFLUENCING CONTRADICTIONS IN THE ACTIVITY SYSTEMS 230
4.3.1 Sustainable water and seed for food needs to satisfy domestic food needs and be reflected in college curricula and extension praxis: Social pillar 231
4.3.2 Representations of the Economic pillar of sustainability in water for food 237
4.3.3 Representations of the Environmental pillar of sustainability in water for food 240
4.4 SUMMARY 242
4.4.1 Summary of contradictions 242
4.5 CONCLUSION 248

CHAPTER 5
SURFACING CONTRADICTIONS FROM THE ZIMBABWEAN NESTED CASE STUDY 249
5.1 INTRODUCTION 249
5.2 DEFINING THE 'NEED STATE': CULTURE IN CONTEXT 250
5.2.1 Small-scale farmers as progenitors of the need state in agricultural learning systems 250
5.2.2 The need state as a problematic boundary across agricultural learning systems 252
5.3 THE ZIMBABWEAN SMALL-SCALE FARMING ACTIVITY SYSTEM AND CONTRADICTIONS IN THE FARMERS' WORK 253
5.3.1 Small-scale farmer typologies 254
5.3.2 Cultural history of collective work engagement and learning and boundaries in small-scale farming 255
5.3.3 Description of the Zimbabwe small-scale farmer innovation activity system 256
5.3.3.1 Elements in the small-scale farmer innovation activity system 258
5.3.4.1 Primary contradictions stemming from their discursive and concrete manifestations in the small-scale farmer-innovation activity system 267
5.4 THE ZIMBABWEAN AGRICULTURAL EDUCATION ACTIVITY SYSTEM AND EMERGING CONTRADICTIONS 274
5.4.1 Contradictions emerging from the Zimbabwean agricultural education and farmer training activity system 277
5.4.1.1 Contradictions in agricultural water priorities 278
5.4.1.2 Contradictions linking seed inputs with agricultural water 279

CHAPTER 6
BOUNDARY-CROSSING EXPANSIVE LEARNING IN THE SOUTH AFRICAN CASE STUDY 287
6.1 INTRODUCTION 287
6.2 MEDIATION OF BOUNDARY-CROSSING CHANGE LABORATORY WORKSHOPS THROUGH VARIOUS INTERCONNECTED PROCESSES 288
6.2.1 Background to the WRC Amanzi for Food project: relevance to this study 288
6.2.2 Mediation of BCCLWs through a course-activated learning network 290
6.2.3 Mediating site-specific boundary-crossing change laboratory workshops 293
6.3 CONFRONTING AND TRANSGRESSING BOUNDARIES DRAWN BY QUATERNARY AND TERTIARY CONTRADICTIONS IN THE IBLN 293
6.3.1 Confronting and crossing boundaries disrupting co-engagement of agricultural learning activity systems in the agricultural water activity 294
6.3.1.1 Recognising the problem: Questioning current problems in collaborative and relational work 295
6.3.1.2 Analysis of relational development of agricultural water and locally-adaptive seed 295
6.3.1.3 Expanding the community: How the learning network map was co-constructed and interpreted 299
6.3.1.4 Modelling solutions: Introducing the activity triangle as a second stimulus in the IBLN 303
6.3.1.5 Summary of evidences of boundary-crossing learning in the IBLN water activity 304
6.3.2 Boundary-crossing issues in the locally adaptive seed activity 305

6.3.2.1 Introducing traditional OPV seed maize as a second stimulus in the IBLN 305

6.3.2.2 Summary of evidences of boundary-crossing learning in the IBLN seed activity 318

6.4 BOUNDARY-CROSSING ISSUES IN THE AGRICULTURAL EDUCATORS' ACTIVITY SYSTEM 319

6.4.1 Analysis of agricultural water as a boundary issue in the curriculum 320

6.4.2 Modelling and examining curriculum solutions across boundaries: Fort Cox College 326

6.4.3 Implementation of curriculum innovation solutions across boundaries: Fort Cox College 327

6.4.3.1 Agricultural college lecturers and management 'identified with' smallholder farmers – lessons from Keiskammahoek productive demonstration plot 328

6.4.3.2 Agricultural college lecturers collaborated to establish productive RWH&C demonstration plots in the agricultural college farm 331

6.4.3.3 Agricultural college lecturers coordinated to integrate RWH&C in pedagogy ... 333

6.4.4 Reflection on the implementation of boundary-crossing curriculum solutions and summary of evidences for boundary-crossing learning 342

6.5 BOUNDARY-CROSSING ISSUES IN THE SMALL-SCALE FARMER INNOVATOR'S ACTIVITY SYSTEM: MATOLE BASIN 347

6.5.1 Genesis and pursuit of generative developmental learning 'tentacles' 347

6.5.2 Boundary learning interactions mediated using a productive demonstration site at Lloyd village garden as a second stimulus 349

6.5.2.1 Interacting activity systems and boundary learning interactions: Matole Basin farmer innovator with partners at Lloyd Village garden 350

6.5.3 RWH&C productive demonstration plots emerging as sites of intermediary action ... 351

6.5.3.1 Examining and implementation of new models of sustainable agricultural water practices at individual level in Matole Basin: glitches and triumphs 352

6.5.4 Catalytic boundary-crossing in the IBLN exemplified by Matole basin farmers acting with Fort Cox College and key associates 354

6.5.4.1 Description of interactions and explanation of expansive transitions 355

6.5.4.2 Tertiary contradictions and formative intervention in networked activity systems in Matole Basin 357

6.5.4.3 Integration of youth farmers through empathetic leadership, mentorship and agency of a mature farmer and former professional within IBLN 360

6.5.4.4 Continuous joint work at the boundary as 'transformation' in advanced boundary-crossing co-engaged activity 367

6.5.5 Summary of boundary-crossing learning evidences and conclusion to Matole Basin nested case 368

6.6 SUMMARY OF BOUNDARY-CROSSING EXPANSIVE LEARNING ISSUES, MECHANISMS AND AGENTIVE TRAILS IN THE IBLN 369

6.7 CONCLUSION 371

CHAPTER 7
BOUNDARY-CROSSING EXPANSIVE LEARNING IN THE ZIMBABWEAN CASE STUDY 372

7.1 INTRODUCTION 372

7.2 PERCEPTIONS OF SUSTAINABILITY OF SUSTAINABLE AGRICULTURAL WATER AND JOINT PROBLEMS FACED BY THE LEARNING NETWORK 373
7.2.1 Sustainability as environmental integrity of agro-ecological systems 373
7.2.2 Sustainability as social and cultural practices of interaction and agricultural curricula 374
7.2.3 Sustainability as economic viability of agricultural practice 375
7.3 BCCLWs IN A SUSTAINABLE AGRICULTURAL WATER PROVISIONING LEARNING NETWORK 375
7.3.1 Organisation through a learning network 375
7.3.2 Historicity of agricultural water and locally-adaptive seed systems in Zimbabwean agricultural learning activity systems 376
7.3.3 Boundary-crossing change laboratory workshop, session #1 in Zvishavane: 15 January 2015 376
7.3.3.1 Explanation of quaternary contradictions across the interacting activity systems 385
7.3.3.2 Constructing an activity triangle as a second stimulus for boundary learning 390
7.3.4 Boundary-crossing change laboratory workshops 2 and 3 in Zvishavane: 12 February 2015 and 23 April 2015 393
7.3.5 Boundary learning and boundary-crossing accumulating from the learning network 399
7.3.5.1 Boundary learning as collective co-engaged learning through the ZPD 400
7.3.5.2 Boundary-crossing mechanisms detected 401
7.4 BOUNDARY-CROSSING LEARNING AT MLEZU AGRICULTURAL COLLEGE THROUGH BCCLWs AND INTRAVENTIONS 402
7.4.1 Boundary-crossing learning look-and-learn visit to Farmer innovator #3's homestead by Mlezu team: 23 April 2015 405
7.4.2 Implementation of rainwater harvesting at Mlezu Agricultural College 406
7.4.3 Historicity of agricultural water at Mlezu Agricultural College 408
7.4.4 Opportunities for further expansive learning 409
7.5 BOUNDARY-CROSSING LEARNING AT RIO TINTO AGRICULTURAL COLLEGE: BCCLWs AND INTRAVENTIONS 409
7.5.1 Boundary-crossing change laboratory workshops at Rio Tinto College of Agriculture 409
7.5.1.1 Historicity of sustainable agricultural water at Rio Tinto College of Agriculture 412
7.5.1.2 Summary of contradictions emerging from the Zhombe learning network around Rio Tinto College of Agriculture 413
7.5.1.3 Mediating co-engaged learning beyond contradictions towards new models 414
7.5.2 Implementation of agricultural water solutions and continuous joint work at Rio Tinto College of Agriculture 416
7.5.3 Boundary-crossing learning look-and-learn visits and small grains preliminary 'intraventions' 417
7.6 SUMMARY OF BOUNDARY-CROSSING ACTIONS AND MECHANISMS 417
7.7 ANALYSIS OF CHANGED PRACTICES AS A JOURNEY THROUGH THE ZPD IN THE ZIMBABWEAN LEARNING NETWORK CASE STUDY 420
7.7.1 Changes in relational learning practices and agency 420
7.7.2 Catalytic reciprocal changes in college curricula and farmers' market opportunities 421
7.7.3 Change in reflexive learning practices 421

7.8 SUMMARY OF TRANSFORMATIVE AGENCY EXPRESSIONS AND TRAILS IN THE ZIMBABWEAN LEARNING NETWORK CASE STUDY 422
7.9 UNFINISHED BUSINESS, OPPORTUNITIES AND RECOMMENDATION 423
7.10 CONCLUSION 423

CHAPTER 8 SYNTHESIS: STRENGTHENING POSSIBILITIES FOR MEDIATED BOUNDARY-CROSSING LEARNING 425
8.1 INTRODUCTION 425
8.2 DIVERSE COMBINATIONS OF FORMATIVE INTERVENTIONS STRENGTHENED THE POSSIBILITY FOR BOUNDARY-CROSSING ACROSS AGRICULTURAL LEARNING ACTIVITY SYSTEMS 426
8.2.1 New learning networks formed in both the South African and Zimbabwean case studies provided generative boundary-crossing fora 426
8.2.2 Public extension function was improved by co-engaged learning within a learning network as collective extension transcending scripted boundaries 441
8.3 SUMMARY OF BOUNDARY-CROSSING EXPANSIVE LEARNING PROCESSES 443
8.4 RECOMMENDATIONS 445
8.4.1 Recommendation 1: That *agricultural actors make concerted efforts to cultivate and nurture learning networks* that enable co-engagement and learning of sustainable agricultural water and locally-adaptive seed 445
8.4.2 Recommendation 2: That agricultural colleges (or ATIs) and their associates co-learn and empathise with farmer contexts, placing farmers at the centre of knowledge generation and flow to improve curriculum relevance 446
8.4.3 Recommendation 3: That agricultural extension workers work with farmers to develop contextually-relevant productive demonstration sites for collective extension and learning within learning network contexts 447
8.4.4 Recommendation 4: Further research in the South African case study 447
8.4.5 Recommendation 5: Further research in the Zimbabwean case study 449
8.4.6 Recommendation 6: Further research in southern Africa and beyond 449
8.5 PROPOSED TOOLS FOR BOUNDARY-CROSSING EXPANSIVE LEARNING 450
8.5.1 Tools for organising learning networks for boundary-crossing learning 451
8.5.2 Recommended tools for facilitating boundary-crossing learning and agency 451
8.6 CONCLUSION 453

REFERENCES 456

APPENDICES 498
Appendix 1: Research Access letter 501
Appendix 2.1: Research Access to the Nkonkobe Economic Development Agency (NEDA) and its stakeholders in the Nkonkobe Smallholder Farmer Development Programme 502
Appendix 2.2: Research Access to Agricultural Extension (under Department of Rural Development and Agrarian Reform) in Eastern Cape Province 503
Appendix 2.3: Research Access to Fort Cox College of Agriculture and Forestry 504
Appendix 3.1: Informed Consent – Samples for South African Case study 505
Appendix 3.2A: Research Access to Runde Rural District Council area in Zimbabwe 506
Appendix 3.2B: Research Access to Zimbabwean Agricultural Colleges 508
Appendix 3.3A: List of my Field Engagements in the South African Case Study 509
Appendix 3.3B: List of my Field Engagements in the Zimbabwean Case Study 510
Appendix 3.4A: Extract of Soil and Water Conservation Course from Fort Cox College Prospectus, 2015 511
Appendix 3.4B: Sample of Curriculum Documents from the Zimbabwean Agricultural Education and Farmer Training Activity System (Extract of Agricultural Engineering Syllabus) 512

Appendix 3.5A: Change Laboratory Workshop Training at CRADLE, University of Helsinki... 523
Appendix 3.5B: Change Laboratory Workshop Training at University of Helsinki: Field Proposals... 525
Appendix 3.6A: Initial Categorisation of Data from the South African and Zimbabwean Nested Case Studies... 529
Appendix 3.6B: Quantification of Data – Interviews in the South African Case Study... 532
Appendix 3.6C: Quantification of Data – Interviews in the Zimbabwean Case Study... 534
Appendix 4.1: Extract of Book Chapter by Author analysing Contradictions in Agricultural Water among Smallholder Farmers in South Africa... 536
Appendix 4.2: A Detailed Case Description of Fort Cox College... 540
Appendix 5: Extract of Book Chapter by Author Analysing Contradictions in Agricultural Water among Smallholder Farmers in Zimbabwe... 541
Appendix 6.1: Sample of Amanzi for Food Training of Trainers Course Modules... 542
Appendix 6.2: List of Agricultural Colleges and selected FET Colleges in South Africa... 543
Appendix 6.3: Sources of Data for Boundary Learning and Boundary-Crossing Issues in the South African Case Study... 545
Appendix 6.4: Samples of Learning Network Communications From Various Media... 549
Appendix 6.4A: Sample Minutes of Imvotho Bubomi Learning Network Meetings (DIBSAM) 549
Appendix 6.4B: Sample of Imvotho Bubomi Learning Network WhatsApp Chat History (DIBSAW) from 23 November 2016 to 31 March 2017... 554
Appendix 6.4C: Samples of Community Radio Show Scripts (DIBSAR) and Studio Presentation Summaries (DIBSARS)... 565
Appendix 6.4D: Sample Transcripts of IBLN Boundary Crossing workshops... 569
Appendix 6.5: Cluster of Themes emerging from the data... 583
Appendix 6.6: Curriculum Analysis Tool used in BCCLWs and applied in Assignment 1 with Analytical Content... 584
Appendix 6.7A: Memorandum of Understanding (MoU) entered into between Fort Cox College and Rhodes University on “Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food” (pages 1-3, and 5)... 586
Appendix 6.7B: Extract of Monitoring and Evaluation Plan of MoU between Fort Cox College and Rhodes University on “Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food”... 588
Appendix 6.8: Transcript of MoU Monitoring and Evaluation Planning Meeting (FCCMESA1) 8 June 2016... 590
Appendix 6.9: Nkonkobe Farmer’s Association Agricultural Show Programme, June 10, 2015. 593
Appendix 6.10: Curriculum Innovation and Development Outcomes in the Fort Cox Agricultural College... 597
Appendix 6.11: Matrix for the Empirical Analysis of Boundary-Crossing Expansive Learning.. 607
Appendix 6.12: Summary Of Boundary Crossing Issues, Mechanisms and Agentive Trails in the IBLN (incorporating and expanding Tables 6.3 and 6.8)... 608
Appendix 7.1: List of Agricultural Colleges and Selected Vocational Training Colleges in Zimbabwe... 610
Appendix 7.2: Data Sources for Boundary-Crossing Expansive Learning Zimbabwean Case Study... 612
Appendix 7.3: Sample Transcript of Zimbabwean Learning Network Boundary Crossing Workshops... 613
Appendix 7.4: Curriculum Analysis Tool used in BCCLWs and applied in Curriculum Documents with Analytical Content... 615
Appendix 7.5: Curriculum Innovation and Development Outcomes in the Mlezu and Rio Tinto Agricultural Colleges... 617
Appendix 8.1: Proposed Curriculum Analysis tool for Sustainable Agricultural Water and Locally Adaptive Seed - based on Tested Tools (see Appendix 6.6)... 619

LIST OF TABLES

Table 3.1: Template for analysing boundary-crossing and learning mechanisms 136

Table 3.2: Index coding of research participants 146

Table 3.3: Index coding of audio, video and transcript files 147

Table 3.4: Summary of documents and artefacts found and analysed 148

Table 3.5a: Primary document analysis tool 149

Table 3.5b: Curriculum documents analysis tool 149

Table 3.6: Initial categorisation of data from the two country nested cases 152

Table 3.7: A sample of second stimuli employed for brokering in moments of dissonance in boundary-crossing change laboratory workshop (BCCLW) sessions 160

Table 3.8: Sannino's Vygotskian model of double stimulation 161

Table 3.9: Phases of data analysis in this study 164

Table 3.10: Levels of contradictions and corresponding learning actions (adapted from Foot & Groleau in Foot, 2014) 170

Table 3.11: Type of Agency Expression based on Engeström (2011) and Haapasaari (2012) 175

Table 3.12: The domains of the real, the actual and the empirical 174

Table 4.3: Summary of categorised manifestations of primary and secondary contradictions following the object of agricultural water cross-referenced across different activity systems 245-248

Table 4.4: Summary of categorised manifestations of primary and secondary contradictions following the object of locally adaptive seed across different activity systems 248

Table 4.5: Summary of categorised manifestations of tertiary contradictions following the object of water for food between the central activity and a culturally more advanced activity 249

Table 4.6: Summary of categorised manifestations of quaternary contradictions following the object of water for food across different activity systems 250

Table 5.2: Contradictions in seed systems in Crop Production syllabus: curriculum analysis 281

Table 5.3: Deep ontological questions for critical realist analysis 282

Table 5.4: Representation of agricultural water in key agricultural college curriculum documents 284

Table 5.5: Summary of categorised primary and secondary contradictions following the object of agricultural water cross-referenced across different activity systems 287

Table 5.6: Summary of categorised primary and secondary contradictions following the object of locally-adaptive seed systems cross-referenced across different activity systems 288

Table 6.1: List of boundary-crossing change laboratory workshops held within the IBLN 293-294

Table 6.2: Research participants' initial co-construction of their learning network 304-305

Table 6.3: Emerging boundary-crossing issues, mechanisms and agentive trails in the IBLN 319-320

Table 6.4: Engagement of agricultural educators in BCCLWs and other boundary activities 321

Table 6.5: Curriculum Analysis Tool for assessing RWH&C content and practice 321

Table 6.6: Summary of the actual-empirical analysis 326-328

Table 6.7: Application of a series of second stimulus tools and learning outcomes 342

Table 6.8: Summary of boundary-crossing issues, mechanisms and agentive trails in the Agricultural college educators' activity system 347-348

Table 6.9: Historicity of collective learning of agricultural water and seed in Matole Basin 360-361

Table 7.1: Scope and sequence chart of BCCLWs in the Zimbabwean case study 377-378

Table 7.2: Summary of contradictions depicted in Figure 7.4 384

Table 7.3: Emergence of a germ cell for sustainable agricultural water provisioning activity 389

Table 7.4: Action areas for model solutions and their prioritisation 396-397

Table 7.5: Boundary-crossing mechanisms (*) detected in the Zimbabwean learning network 402

Table 7.6: Historicity of agricultural water at Mlezu Agricultural College 409

Table 8.1: Explaining co-engaged learning of sustainable agricultural water through the ZPD 429

Table 8.2: Youth participation in the learning network of the South African case study 438

LIST OF FIGURES

Figure 1.1: Provincial map of South Africa showing neighbouring countries and Study Site 1 13

Figure 1.2: Abandoned fields showing succession by secondary vegetation in Nkobonkobo Village, Alice, Nkonkobe Local Municipality 15

Figure 1.3: Initial (access stage) conceptualisation of a College-centred Learning Network map (April 2014) 16

Figure 1.4: Triangles within a circle: Each activity system case nested within the expansive course-activated learning network in the South African nested case. 17

Figure 1.5: Map of the South African case study site focusing on Amathole District Municipality, with the two Local Municipalities of Raymond Mhlaba and Amahlati and environs of interest. 18

Figure 1.6: Area of operation of eDikeni Water Users Association 19

Figure 1.7: Sectoral production structure of the Amathole District Municipality (ADM) economy, 2010 21

Figure 1.8: Location of study sites in the Zimbabwean case study from the provincial to the district and local contexts 23

Figure 1.9: Triangles within a circle: each case nested within the expansive learning network in the Zimbabwean nested case 25

Figure 1.10: Organisational structure of agricultural colleges within Zimbabwe's Department of Agricultural Education and Farmer Training 26

Figure 1.11: Conceptualisation of a National Agricultural Innovation System 30

Figure 2.1: Components of a generic two-wheel tractor (2WT)-based technology business model for small-scale farming 82

Figure 2.2: The cycle of poverty and vulnerability and possible seed interventions 88

Figure 2.3: Agricultural knowledge triangle with farmer at the centre 96

Figure 3.1: Vygotsky's original formulation of mediated action 118

Figure 3.2: Second-generation activity theory 121

Figure 3.3: Three levels of activity 122

Figure 3.4: Metaphoric onion methodological tool for analysing contradictions and their manifestations 124

Figure 3.5: Secondary contradictions illustrated between subject and rules and object and instruments 127

Figure 3.6: The four levels of contradictions in activity systems 128

Figure 3.7: Third generation activity: Two interacting activity systems as minimal unit of analysis and a potentially shared [boundary] object 129

Figure 3.8: Cycle of developmental work research 143

Figure 3.9: Left top and bottom: Extracts from pp. 11 and 13 of Module 3 Text of Amanzi for Food Training of Trainers' Course showing the way that the course supported change laboratories and expansive learning; Right top and bottom: Extract from Module 4 Text, p. 12 154

Figure 3.10: Prototypic layout and instruments of the Change laboratory space 156

Figure 3.11: The ideal-typical expansive cycle learning actions 157

Figure 3.12: The hypothesised zone of proximal development for work in extension workplaces or spaces (adapted by author from Engeström, Brown, Christopher & Gregory, 1997, p.370) 168

Figure 3.13: ZPD as a generality of dimensions of potential developmental steps 171

Figure 3.14: A laminated learning system showing connections between components of an activity system 176

Figure 4.1: Structural organisation of the Nkonkobe Farmers Association from commodity groups at village and area levels to the local municipality level 184

Figure 4.2: Small-scale farmer activity system for water in the South African case study 185

Figure 4.3: Historicity of the water object in Koloni Village 188-189

Figure 4.4: Left: Fence of cropland plot frequently destroyed by straying livestock; Right: Temporary cattle-holding pen for impounding problem cattle 194

Figure 4.5: Photograph of typical abandoned crop fields in Lloyd Village, Alice showing invasive succession by secondary vegetation 195

Figure 4.6: Diagrammatic representation of the fundamental inner contradiction in the object of water for food at Lloyd Village garden cooperative 198

Figure 4.7: Top left: Vegetables wilting in Lloyd Village garden; Top right and bottom: Bare soils in vegetable beds and paths 199

Figure 4.8: Researcher's first interview with one farmer innovator (Mrs Peter), May 13, 2015 at Mqayise village, Matole Basin 201

Figure 4.9: 'Current state': Agricultural water innovations before the formative intervention at Matole Basin farmer innovators gardens (left: mounted drip irrigation system, centre: cardboard paper mulching, right: organic mulching) 202

Figure 4.10: Matole basin small-scale farmer activity system 202

Figure 4.11: Historicity of water for food, locally adaptive seed and collective learning culture in the Matole Basin farmers' activity system 204

Figure 4.12: Manifestations of internal contradictions in the Matole basin small-scale farmer innovator activity system 205

Figure 4.13: Tractor-ploughed, rain fed field of eDikeni WUA member in Alice showing no rainwater harvesting and conservation structures 211

Figure 4.14: In-field RHW&C carried out by a farmer in Khayalethu village trained by the ARC; Right: Some production in the amadanyana 212

Figure 4.15: Agricultural Extension Officers' activity system in the South African case study 213

Figure 4.16: A simplified strengths/opportunities and weaknesses/threats analysis of alternative water for food options available to extension officers and farmers in the study area 218

Figure 4.17: Tertiary contradiction between the dominant form of the agricultural extension officers' activity system and a culturally more advanced form of the same activity system 220

Figure 4.18: Agricultural college educators' activity system in the South African case study 223

Figure 4.19: Extract from an agricultural college SWC course 225

Figure 4.20: Historicity of agricultural water in the Agricultural College Educators' activity system 227

Figure 4.21: Top Left: In-field RWH&C at Fort Cox College established with ARC support; Top Right: Runoff potential (photo by author on 2 December 2014); Bottom: Infield RWH&C demonstration plot supported by ARC, producing peppadew (12 August 2014) 228

Figure 4.22: Tertiary contradiction in the agricultural educators activity system 230

Figure 4.23: New boundary-crossing marketing relations reported in the IBLN 239

Figure 4.24: Busy marketing corner of organic vegetables, herbs and ointments from a farmer innovator's productive demontration plot 240

Figure 5.1: An agro-forestry system combining fruit trees (banana, mango, peach, papaya) and crops in rotation with vegetables in a farmer innovator's dryland fields, in agro-ecological region 4 (note RWH deep contour full of water) 258

Figure 5.2: Typical mono-cropping system of maize at two of the Zimbabwean agricultural colleges showing moisture stress resulting from dysfunctional irrigation systems 259

Figure 5.3: Zimbabwe small-scale farmer-innovators activity system at beginning of research 261

Figure 5.4: Historicity of the objects of agriculture water, seed-based value chains and collective learning in the small-scale farmer-innovator activity system 263-264

Figure 5.5a: Manure-enriched raised beds clearing vegetable root zone from water logged profile in a RWH&C system 266

Figure 5.5b: Farmer innovator showing shifting soil water level, high in the early morning and lowest around midday 267

Figure 5.5c: A thriving mono-crop system of sweet-potatoes grown on traditional raised mounds (note the moist water harvesting contours between the beds) 268

Figure 5.5d: Left: Deep contour rainwater harvesting innovation, showing depth at waist level - about 1m high; Right: Water management valve controlling water movements from one contour to another 268

Figure 5.6: Manifestations of primary contradictions in the small-scale farmer-innovator activity system 269

Figure 5.7: An illustration of the manifestations of primary and secondary contradictions in the small-scale farmer-innovator activity system 271

Figure 5.8: Zimbabwe typical small-scale farmer activity system 275

Figure 5.9: Zimbabwe agricultural education and farmer training department official activity system (Rule-producing activity for agricultural colleges) 277

Figure 5.10: Historicity of agricultural water in the Zimbabwean AET activity system 278-279

Figure 5.11: Typical leaking and derelict irrigation pipes with makeshift maintenance and disrepair in the Zimbabwean agricultural colleges during economic recession (August 2016) 281

Figure 5.12: Zimbabwe agricultural college lecturer activity system 282

Figure 5.13: Primary contradictions in the agricultural college lecturer activity system 285

Figure 6.1: RWH&C sample materials of books provided by the WRC for "dissemination" 291

Figure 6.2: Four interacting activity systems (smallholder farmer, agricultural college lecturer, local economic development [LED] agriculture specialist and extension officer) in the IBLN 296

Figure 6.3 Illustration of the need state(s) as ZADs and the emergent unchartered course of boundary learning towards ZPDs 304

Figure 6.4: A more advanced learning network map showing complex linkages between various organisations and entities constructed during BCCLW6 300

Figure 6.5: Top and bottom left: Activity triangles developed by action groups at BCCLW4; Bottom right: Fort Cox College site team modelling solution using activity triangle 306

Figure 6.6: Top from left: a ‘seed guardian’ farmer; centre: workshop chairperson exhibiting seed saving artefacts (seeds, regalia, posters) and right: participating farmers raising their hands. Bottom: various OPV seeds used as a second stimulus 309

Figure 6.7a: Scores of pairwise rankings to assess priorities for soil fertility (left and top right) and seed preferences (bottom right) 316

Figure 6.7b: Documentation of new tools and models in the Matole Basin BCCLW 318

Figure 6.8: Outcomes of curriculum analysis task at University of Mpumalanga showing curriculum gaps [top and bottom right] and aspirations [all three charts], July 3, 2015 324

Figure 6.9: Stepwise development of boundary-crossing agency in the curriculum innovation pathway at Fort Cox Agricultural College 330

Figure 6.10: Left: Deliberation on site selection and agricultural water solution at Keiskammahoek (February 26, 2015), right: Implementing infield RWH demonstration plot (March 10, 2015) 332

Figure 6.11: Top left: Agriculture lecturer showing natural catchment for pond; top right: TLB digging farm pond; bottom left, centre: students constructing tank base (July 2015); bottom right: students filling up raised tank (September 4, 2015) 334

Figure 6.12: An SWC class integrating RWH&C using WRC’s WHC materials: implementing a curriculum innovation model 335

Figure 6.13: Changes in agricultural water content in the Introduction to Agricultural Engineering course from exclusive irrigation in 2014 (top left) to incorporation of RWH&C in 2016 (top right, middle left and right and bottom) 333

Figure 6.14: Focus group interview session with two Fort Cox College students 339

Figure 6.15: Two sets of one of the WRC RWH&C books (a) showing evidence of incorporation in the Fort Cox College Library (b-d), and signs of borrowing/use 340

Figure 6.16: Extract of MoU monitoring and evaluation plan used in the refection process 346

Figure 6.17: Lecturers, students and farmers preparing a RWH&C demonstration planting site near lecturer rooms (top left); preparing compost (top right); experimentation with RWH&C conveyance led by Professor Rob O’Donoghue (bottom left and right) (August 1, 2016) 346

Figure 6.18: Growth of the IBLN in Matole Basin 351

Figure 6.19: Quaternary contradictions from interactions between the Matole Basin farmer innovator, a permaculture motivator, Lloyd village farmers, Fort Cox College lecturer’s activity systems with the emerging IBLN collective activity system 353

Figure 6.20: Experimentation with new RWH&C model during a BCCLW at Lloyd Village garden, led by a permaculture expert (Omelela), March 30, 2016 354

Figure 6.21: Foreground: Mulching on new raised circular beds in homestead garden by FSA10 after a BCCLW demonstration session; Background: Emerging farm pond 355

Figure 6.22: A two cubic metre farm pond at the garden of the farmer innovator in Matole Basin dug in April 2016 as a holding reservoir by the garden edge next to a pathway 355

Figure 6.23: State of interaction at beginning of formative intervention 357

Figure 6.24: Contradictions from interacting activity systems in the Matole Basin BCCLW 359

Figure 6.25: Top: Interactions between youths, a mentor and IBLN members before and after formative intervention (after Engeström, 2008a); bottom: RWH&C beds in ZAMBS garden (left); OPV maize sample harvest by Matole youths (centre); FSA10's millet seed crop (right) 365

Figure 6.26: Transformative innovation pathway: historical stepping-up to RWH&C models and intergenerational co-engaged relational learning between youths and a caring mentor 368

Figure 6.27: Top: Ilima activities at farmer's garden: Fort Cox College lecturer, students, farmers and an NGO Officer making an A-frame (left); preparing new productive demonstration plot (right); bottom: Tunnel garden developed by agriculture students, lecturer and farmer innovator 370

Figure 6.28: Transformative agency trail followed by extension workers in collective learning in the IBLN 372

Figure 6.29: Agricultural college educators' transgressive curriculum innovation pathway in the South African case study 372

Figure 7.1: Participants at the first Zimbabwean learning network boundary-crossing change laboratory workshop 379

Figure 7.2: Extracts from e-mail communications with Murowa Diamond Mine (Community Liaison Officer, e-mail communications, January 9-12, 2015) 379-381

Figure 7.3: Workshop objectives 381

Figure 7.4: Constellation of secondary contradictions in agricultural water in the Zimbabwean learning network 384

Figure 7.5: Quaternary contradictions across interacting activity systems in the Zimbabwean learning network 386

Figure 7.6: Illustrative activity system diagram used in the first BCCLW as second stimulus 392

Figure 7.7: Top left and right: some workshop participants walking in the rain witnessing water harvesting; bottom left and right: deep contours filling up and full of water respectively 393

Figure 7.8: Expansive learning cycle after the first Zimbabwe case learning network BCCLW 394

Figure 7.9: Left: List and prioritisation (with stars) of model solutions in BCCLW 3; right: Model solutions tested for implementation in different sites (April 23, 2015) 395

Figure 7.10: Some of the participants at Zimbabwe learnng network BCCLW #3 (Mlezu Agricultural College principal, farmer, farmer innovator, extension officer from Mlezu area, farmer from Mlezu area, lecturer from Mlezu Agricultural College) 396

Figure 7.11: Trail of developmental actions leading to expansion of the object towards market capture for climate-adapted seed grain produce in the Zimbabwean case study 399

Figure 7.12: Zone of Proximal Development for the collective of learning network members in the Zimbabwean case study 401

Figure 7.13: Left: Prematurely wilting maize crop in an agricultural college farm; Right: ageing, leaking irrigation infrastructure – typical of agricultural college systems in Zimbabwe 404

Figure 7.14: Zimbabwe Primary School Agriculture Textbook with RWH&C topics (Sithole, & Jeketera, 2013) that were shared with change laboratory workshop participants as a learning stimulus 405

Figure 7.15: Left: Team from Mlezu (lecturers, farmer and extension worker); right: Rainwater harvesting tied ridges between raised beds bearing green beans surrounded by a tomato crop and banana planation 406

Figure 7.16: Rainwater harvesting deep contours with water holding demarcations and rainwater harvesting surface tied ridges 406

Figure 7.17: Farmer in rural Zvishavane explaining his water harvesting system to a farmer, agricultural college lecturer and extension officer from Mlezu Agricultural College and Kwekwe rural after BCCLW1 they had all attended 407

Figure 7:18 Email planning for Mlezu Agricultural College implementation 407

Figure 7.19: Rainwater harvesting deep contour implemented in the college farm at Mlezu Agricultural College, with herbage accumulation around it 408

Figure 7.20: Left: First BCCLW chaired by College Principal (screenshot @ 10min 55sec); Right: Some of the paricipants 411

Figure 7.21: Left (A): Arrangement of interactive board at Rio Tinto BCCLW; right (B): Workshop archive; (C) newspaper article on small grains (August 12, 2016) 412

Figure 7.22: Mapping of agricultural water history and water issues in the curriculum at Rio Tinto Agricultural College boundary-crossing change laboratory workshops 413

Figure 7.23: Irrigation water tap supplying a vegetable plot and a canal for flood irrigation 414

Figure 7.24: Top: Group work during third BCCLW at Zhombe learning network; Bottom left: Proposed model solutions; bottom right: Prioritised model solutions 416

Figure 7.25: Deep contour constructed at Rio Tinto Agricultural College with student involvement – work in progress 417

Figure 7.26: Multi-dimensional ZPD showing developmental changes in practices in the Zimbabwean learning network (adapted from Zaretskii, 2016) 421

Figure 8.1: Analysis of generative mechanisms for boundary-crossing expansive learning of sustainable agricultural water 436

Figure 8.2: Learning network maps showing expansion of relationality and relational agency from 2014 (left) to 2017 (right) due to formative intervention 441

Figure 8.3: Summary of boundary-crossing expansive learning mechanisms from study 445

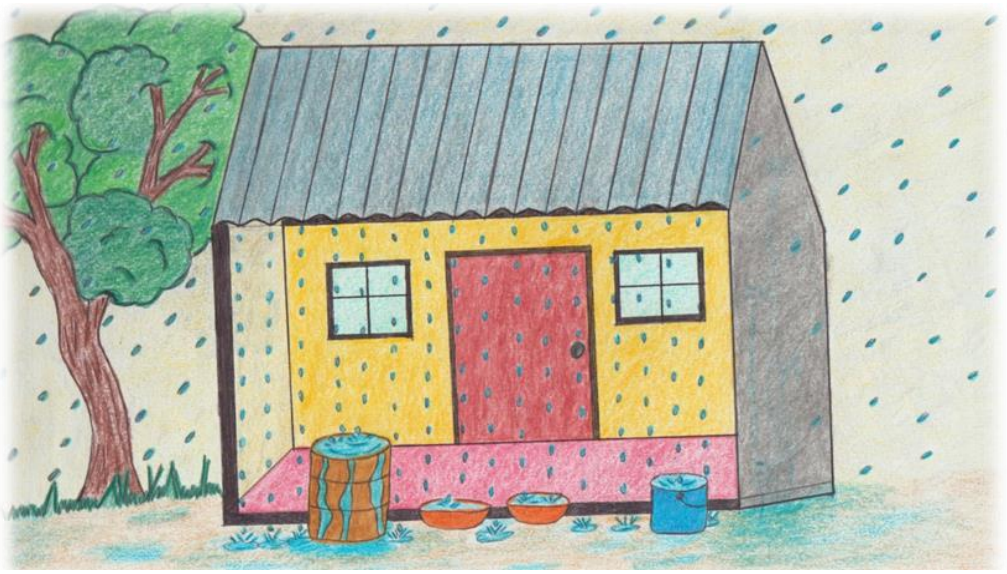
Figure 8.4: Link between the problem situation and formative boundary-crossing interventions 446

Figure 8.5: Sample of MoU monitoring and evaluation tool used jointly by Fort Cox Agricultural College and Rhodes University 453

ABBREVIATIONS AND ACRONYMS

ADM	Amathole District Municipality
AET	Agricultural Education and Training
AGRITEX	Department of Agricultural Technical and Extension Services (Zimbabwe)
ARC	Agricultural Research Council
BCCLWs	Boundary-Crossing Change Laboratory Workshops
BSAC	British South Africa Company
CBL	Competency Based Learning
COLA	Community of Learning and Action
DAEFT	Department of Agricultural Education and Farmer Training (Zimbabwe)
DRDAR	Department of Rural Development and Agrarian Reform (Eastern Cape Province of South Africa)
ELRC	Environmental Learning Research Centre (Rhodes University)
FAO	Food and Agriculture Organisation
FET	Further Education and Training
GM(O)	Genetically modified (organism)
LED	Local Economic Development
MEC	Member of the Executive Committee
MoU	Memorandum of Understanding
NEDA	Nkonkobe Economic Development Agency (now Raymond Mhlaba Development Agency, RMDA)
NGO	Non-governmental Organisation
OPV	Open-pollinated variety
RWH&C	Rainwater harvesting and conservation
TACATI	Transformation of Agricultural Colleges to Agricultural Training Institutes
WRC	Water Research Commission
WUA	Water User Association

CHAPTER 1
LEARNING ACROSS BOUNDARIES



"Mvura ngainaye, tidye makavhu…" [Shona song: 'May the rain fall, so that we may enjoy pumpkins']

1.1 INTRODUCTION

This is a formative interventionist[1] case study on water for food education across key agricultural learning activity systems working together within learning networks in South Africa and Zimbabwe. A case study is an inquiry into a specific example selected because its individual case properties are important. The activity systems of interest to this study were marginalised rural farmers, agricultural educators in colleges and universities, extension advisors (workers, technicians and officers), and agricultural and environmental specialists in local municipality development agencies. The research focused on the educational and development intervention processes used in water for food education across these activity systems through sustainability and social justice lenses. The latter are provided for by South Africa's National Development Plan (South Africa. Department of the Presidency [DP], 2012) and Zimbabwe's Agenda for Sustainable Socio-Economic Transformation, Zim Asset (Zimbabwe, 2013b) and enshrined in their respective constitutions (South Africa, 1996; Zimbabwe, 2013a). The aim of the study was to explore water for food knowledge flows and practices and to co-generate knowledge on how agricultural learning activity systems can learn better together and from each other across boundaries to improve water for food praxis. This chapter lays the foundation of the

[1] These are transformative experiments "in which new concepts and principles of carrying out an activity are created" (Virkkunen & Newnham, 2015, p. 1) rather than pursuing a predetermined objective (see Chapter 3).

study by outlining the motivation, presenting the research interest and questions, and mapping the contextual and conceptual frameworks.

1.2 ORIENTATING EXPERIENCES MOTIVATING MY RESEARCH INTEREST

My main challenge in writing this thesis was to balance the contradiction in the object of writing; endeavouring to make sense to the common person, but also to be convincing to the academy. I found Aristotle's advice useful "to write well, express yourself like the common people, but think like a wise man" (quoted from Yeats, 1997, p. 8). I thus start out with an orientation of my common experience with the common people to whom I owe priceless practical wisdom. The research context inevitably begins with my own personal interest and experiences in small-scale farming in rural Zimbabwe during the colonial period before 1980 when the independence era began. I grew up seeing and experiencing the satisfaction and sufficiency of own food production in the family, and the humbling problem of people moving through households asking for food (*kushuzha*) due to various reasons ranging from poverty to crop failures. The purchasing of food in the village home was restricted to necessary items which were neither available nor accessible to the household or were only available from the grocery shops. These included cooking oil, salt, tea and sugar. Of course there were substitutes for these too; for example, cooking oil could be replaced with animal fat after the rare slaughter, and brown sugar was sometimes melted to act as a base for a hot beverage replacing tea leaves. Whenever it rained, vessels would be deployed under the roof edges to collect rainwater (*kuchingidzira*, in Shona). It appears there was always a plan within the cultural practices of self-reliance. As an urban dweller in adult life, I continue to experience the contradictions of water security, the value, space and time for own food production both in the urban and rural settings and the risk and conveniences of buying and consuming industrially produced commercial foods.

1.2.1 Learning to flourish in the marginalised rural village under colonial rule

The possibility of successful small-scale farming was inspired by five years of living continuously and working together with successful small-scale farmers. This was followed by another 10 years of living with such farmers during seasonal periods of cultivation, harvesting and fallow which coincided with three monthly school holidays each year. Living in the village in the age of urbanisation was a contradictory exercise. It was very demanding physically, yet very productive and enriching in terms of practical skills and values-learning experiences. The later holiday translocations from urban to rural life were different. Although quite regular, they felt like pilgrimages to inspiration and hope in self-reliance, and certainly provided a bridge across the boundaries of opposing places and spaces. They were dominated by work in the fields. Sometimes they felt like necessary but periodic back-breaking and exhausting labour intensive exercises. Fieldwork was fortunately usually rewarded with satisfying *maheu* (traditional non-alcoholic beverage) and good harvests most of the time. So while this life was

not easy, it was fulfilling and healthy. Above all, the rural-urban boundary transitions ensured a vital connection between the vagaries of urban life and disenfranchisement in a colonial state and a sense of place, belonging and ownership in the rural area despite the civil war risks. It also ensured a steady supply of healthy and safe food from family in the village to those dwelling in towns and cities.

My perception of success was shaped by the ability of small-scale farming to feed the farmer's family, and was capped by capability to produce and sell excess (usually maize) crop yield to the Grain Marketing Board and save enough for the family. My grandparents' household was fed entirely from produce coming from the family's fields (*minda*) except for a few processed products such as sugar, salt and the indulgence of soft drinks. There were basically two types of fields – grandfather's relatively bigger fields made up of three homestead plots (*makandiwa*), plus one leased from a neighbour and a very large fourth one at the foot of a nearby mountain (Mount Bera) some ten kilometres away. Such production ensured a steady supply of food. This scenario also attracted the guerrilla fighters (officially called 'terrorists' at that time by the colonial government) and the colonial 'security forces' to visit occasionally, fortunately at different times.

1.2.2 Learning to work with cattle and crops: Herd boys and plough handlers

Our fields were always tilled using draught power provided by the family's cattle herd. Without cattle, there would have been a need to borrow or 'rent' draught power. This did happen sometimes when the draught power (*chipani*) was incomplete due to stock losses. As young boys and girls we were expected to graduate from leading the cattle from the front to handling the plough from the rear as part of ploughing activities. The boys, and sometimes girls, were still expected to take the cattle to the grazing areas (*mafuro*) for the rest of the day till dusk after the field activities. The cattle were also important for providing manure (*mufudze*), which we shovelled from the cattle pens (*matanga*) in the winter season and spread on the fields during winter to spring ploughing (*kuvundukura*). Cattle deaths usually occurred during drought periods, which seemed to get more intense with each succeeding decade but was at its peak during the intense drought of 1991/92. During the liberation war period (significantly, others saw it as a terrorist war[2]) before 1980 (the year of formal independence in Zimbabwe), cattle would be migrated to farms several kilometres away for pasture. This included the Mufiri tribal trust lands some 25 km away from our home where natural pasture was exchanged for a small fee. One of these farms belonged to the Stockil family – a white, farming, Christian family – (*kwa Stokeri*) that maintained good relations with local black farmers. This farm was eventually bought by the independence government after 1980, divided up and redistributed during the first resettlement exercises (*minda mirefu*).

[2] The language and discourse of war and conflict reflects biases, positions and sides. I leave this discussion for another time and place. However, in my reflexivity in this thesis, language as a mediating tool is interrogated.

1.2.3 Master Farmers, grandmothers and youths: Embodied cultural choices and sense-making or specialisation vs emergent diversity

Our grandfather having been a teacher and a 'Master Farmer', and married to a practising midwife, had the resource capability to lease a plot from a privileged beneficiary in an irrigation scheme at Denge growth point some 20 kilometres from home for many years (this did not last long after the extended drought years hit hard). These capabilities were acquired from divine providence, hard work and early support provided by Dutch Reformed Church priests at a mission station. The men of the cloth provided an otherwise deprived young man with a valuable education through schooling that was interspersed with labour for fees and food instead of holidays. Irrigation made it possible for the family to produce more maize for selling to the market which translated to more income and other capabilities. To be able to earn Master Farmer certification my grandfather had to satisfy a number of criteria including learning to do mixed farming, to use the plough, and to prepare contours in the prescribed way among others. He and other Master Farmers basically had to unlearn traditional ways of farming as inferior inconveniences and learn the linear mono-culture conventions of the agricultural revolution as they were seen to be superior and more civilised.

Then there were grandmother's two smaller fields each about a kilometre from home, which were less easy to work in because of the 'clutter' and mix of crops in them. We quickly learnt that these fields surprisingly produced the tastiest, diverse and most sought-after foods. These included brown rice (*mupunga*) from the dambo patch (*doro*), cow peas and their vegetable leaves (*nyemba* and *munyemba*), pumpkins (*mapudzi, manhanga*) and traditional open-pollinated maize among others. This field was managed by our great-grandmother (*vaKuzviringa*) when grandmother was busy with maternity inmates. The other field was difficult to work for the uninitiated in the sense that it required precision weeding and soil mounding (*kufukira*). These cultural practices were designed to support and activate production of the groundnuts (e.g. *kanyimo kachena keziso dema;* the white groundnut with a black eye/spot) which were usually grown there, without cutting the plants or exposing the productive roots. Seeds were not a problem for grandmother as she always saved some of her harvests (*kuuchika*), specially drying and preserving maize over the smoky fireplace in the kitchen, hanging sorghum and sweet reed bushels in cool, dry places. I also witnessed many times how she exchanged seeds with acquaintances. This became part of my culture too.

My grandfather always kept an annual calendar of moon phases which together with other tools enabled him to predict when to prepare the land and when to plant in anticipation of rains. These predictions were usually fairly accurate for his needs. Despite the adverse climatic conditions in many seasons, production and storage in the good years enabled food to be available most of the time. Even

we children had learnt that it would be raining at Christmas. However, after 1991 the rains progressively became more erratic and droughts became more frequent to the extent of causing more frequent crop failure and hunger in the villages, cessation or reduction of local river flows and depletion of livestock heads. These developments have aroused my curiosity on what else is possible regarding crop farming in these relatively new contexts of risk where people do not migrate from their complex and degraded socio-ecological systems to resettle elsewhere. Extra land is simply not always available to all even with Government resettlement programmes opening larger arable lands to black farmers (*minda mirefu*) after independence and the more recent accelerated and often deemed violent land re-distribution programme (*hondo yeminda / jambanja*).

As growing grandchildren we participated in all practical farming activities and learnt by doing. Through working at the side of adults, following instructions, observation and sometimes questioning we got to make meaning of what we were doing. However, the sense-making process was hardwired in the culture of the practice from one generation to the next and our desire to do what the adults were able to do in the fields. Collecting rainwater flowing off the roof became a sensible common-sense practice which was expected even of youths when the adults were away. However, I experienced the strong 'agri-cultural' boundaries between urban life and rural life. Higher education and the field of work somewhat disconnected and re-connected me in different ways from the rural farming context, but the teaching of Science and the study of Holy Scripture reminded me of the struggles and opportunities back home.

1.2.4 Face to face with water problems and hope in innovative solutions

Moreover, through my work in NGOs (Wildlife Society of Zimbabwe and Environment Africa) I realised that the problems of water in my home area were similar to the problems felt by people in other areas of the country from Matabeleland through the Midlands to Masvingo and Manicaland. We conducted look and learn visits with farmers to sites of community-based innovation such as Chikukwa village in Chimanimani, to the Midlands where we visited Mr Zepheniah Phiri's and Mr Boas Mawara's homestead fields in Zvishavane and Mazvihwa respectively in 2004. When the farmers returned to their homes in rural Mutare and Nyanga, some of them replicated the water harvesting works they had seen and improved on them, improving their agricultural water considerably. Working for Southern African Development Community's[3] Regional Environmental Education Programme (SADC REEP), in November 2012 we facilitated dialogue to establish a multi-stakeholder regional network among agriculture and water practitioners. These included Cedara College of Agriculture and

[3] The Southern African Development Community is a Regional Economic Community constituted by 14 southern African states and seeks to further regional co-operation across nation state boundaries in various areas, including environmental and land management, agriculture, water management and environmental education.

University of Fort Hare from South Africa, the SADC Plant Genetic Resource Centre (SPGRC) based in Zambia, and the Department of Agricultural Education and Farmer Training and water innovators (Mr Zepheniah Phiri – now late – and Mrs Constance Phiri) from Zimbabwe. This meeting stimulated discussion among people from different agricultural learning activity systems from different countries and highlighted the need for rainwater harvesting training and practice in the Southern African sub-region.

1.2.5 A disturbing moral question

I remember vividly the powerfully indoctrinating mobile advertising of sugar by a 'power man' character depicting the role of sugar as a source of super strength which parallels the aggressive advertising of 'improved' seeds and chemical fertilisers today. With the benefit of hindsight it was calculated brainwashing for the capitalist cause. The lack of warning then of the dangers of sugar (some elderly villagers were known to add up to six teaspoons of sugar to a standard mug cup leaving a residual syrup at the bottom after stirring), is paralleled to lack of warnings about poor performance of new seed varieties and fertiliser applications when rainfall patterns and amounts change. I slowly learnt about the disconnection in the values between promoted foods and good health, and the strong connection between imposed market forces and disappearance of seeds I grew up planting, as rainfall diminished over the years. As climate can change, people can also change. The disturbing moral quandary is not without recourse. There is always a moral choice. Before he died, my grandfather made a big one with the risk of dividing or uniting the family. After living at the boundary of mixing African religion (spirit mediums and traditional healers) and Christian living as his source of life and farming motivation, he finally chose the latter calling it an inheritance that he was leaving for his survivors. "I am done with chasing the wind" he said. He left some dwelling in the "wind" and the other two spaces. Through his life choices and changes many of us saw a clear connection between moral values, conscience and motivations for farming systems.

There are clear epistemic and ideological clashes between industrial agriculture and small-scale farming which have economic and health ramifications. The dominant information systems, school textbooks, and agriculture as punishment and cheap labour at modern schools, popularised the culture of buying versus the culture of producing and consuming one's own diverse foods. They are louder than the wise (in some ways wiser) voices of the elderly women and men. However, the small-scale poly-cultures of agriculture remain resilient in many places but under siege from the power of markets and advertising, the threat of climate change, the often false promises of the agricultural revolution and contesting ambivalent voices. Can and should agricultural learning activity systems, farmer innovations, nutrition promotion and the renewed interest in traditional foods learn together by recognising and crossing existing and anticipated boundaries of culture and ethics? These are moral

questions in that they presume the presence of a rift in agricultural learning activity systems attributing causality to livelihood and hunger problems. At the same time they call for experiments in dialectical learning rather than oppositional dualism between the industrial agricultural convention and the small-scale farming ideologies. As I grappled with these moral questions I became reflexive of the balance between reclamation of lost knowledge practices, emergence of new grassroots based and negotiated knowledge practices and the danger of romanticising with local and indigenous knowledges, being aware that the enemies of grassroots food resilience were also falsely using the romanticisation discourse to undermine grassroots agency and freedoms (Freire, 2005a). To confront such problems, I found a boundary-crossing perspective (Akkerman & Bakker, 2011; Engeström, Engeström & Kärkkäinen, 1995) and an ecologies of knowledges approach (De Sousa Santos, 2007) useful as they allow a non-polarised process to knowledge generation and application. It is what made and still makes rural smallholder farming successful where seed saving is combined with niche markets and connections to global networks and movements.

1.3 THE RESEARCH INTEREST AND CURIOSITY

Humankind has survived and developed through learning, adaptation and productive labour in emergent agricultural systems which did not exist before the shift from gathering and hunting for food to settlement. Learning continued with the use of tools and their adaptation and development for specialised use till agricultural systems such as production, agricultural engineering and agribusiness became complex and specialised industries working independently. This independence soon developed into silo approaches creating somewhat exclusionary boundaries between agricultural work spaces, especially between industrialised agriculture and traditional subsistence to semi-commercial rural-based communal farming. The latter is commonly called ‘small-scale’ or ‘smallholder’ farming, both problematic terms as scale does not describe intensity and farming typology while the term “‘smallholder’…tends to obscure inequalities and class based differences” (Cousins, 2010, p. 86). In the process, however, wicked problems such as unequal access and distribution of agricultural resources, value chains of exclusion, and drought leading to hunger and malnutrition have arisen in agricultural systems. This is worsened by uncertainties and vulnerabilities introduced by climate change and variability. Agricultural education is implicated, being presumably at the centre of the knowledge and practice brokering chain connecting industry’s interests with knowledge from research stations transmitted to extension technicians and farmers.

This chapter introduces the curiosity which the study is concerned with regarding discontinuities in sustainability learning and knowledge practices *at and across the boundaries of agricultural learning activity systems*. Activity system is a key concept in this study that is discussed more in the conceptual

framework (see section 1.8). More importantly, it argues why boundary-crossing learning is important to bridge gaps and restore continuity, using water and seed as boundary resources at risk. At this point I will briefly explain why social learning alone is inadequate. Social learning theories differ from each other, with some emphasising the individual learning in a social space (Bandura, 1997) and others the collective learning of a group (Freire, 1970; Ison, Röling & Watson, 2007). While social learning is characterised by "a change in behaviours, norms and procedures arising from development of mutual understanding of issues as a result of shared actions" (Blackmore, 2007, p. 516), expansive learning in boundary-crossing contexts is preferred for its focus on transforming the whole activity system which is complex and contested, not on goal-oriented actions that could easily be biased towards privileged normative knowledge. The chapter also outlines the context and structure of this study.

There is fragmentation, poor representation or absence of the diversity of knowledges, sustainability learning and culturally-sensitive practices between connected agricultural learning activity systems (see Chapter 2) within the wider agricultural learning system (see section 1.4 below). This compromises livelihoods and reproduces poverty and unhappiness. This situation raises many questions around the meanings of connectivity, continuity of work, relevance of information shared, sustainability, agency, transformation and coloniality embedded in the agricultural learning systems and practices of post-colonial states, especially in Africa. This is also characteristic of other developing regions such as in Asia and South and Central Americas, but developed regions are also far from immune to such fragmentation problems. In many ways, the causes of much unhappiness in small-scale agriculture are linked to absence of alternatives to the conventional forms and failure of extension institutions to give practical and effective advice. The failure of extension to provide advice on, for example, alternative sustainable agricultural water cannot stand alone without implicating agricultural colleges that train the extension workers. Alternative sustainable agricultural water can be viewed, on one hand, as an alternative to conventional irrigation (which is not accessible or available to most small-scale farmers) and yet is what is taught to extension workers. On the other hand, it is an alternative to waiting for the rain in the same way that farmers did 50 years ago before climate change became an agro-ecological issue to reckon with.

Discontinuity and poor representation occur at many levels and in various forms such as absences of certain knowledges and values across agricultural education curricula, extension practices and farming that are essential either for small-scale farmers' livelihoods or agribusiness performance. A number of key absences within agricultural education curricula, extension and across these systems have been reported in various literature including World Bank, African Union, Southern African Development Community and academic research reports (see Chapter 2). Agricultural education curricula have deficiencies such as inadequate practical training accompanied by weak supervision, a bias towards

"chalk and talk" transmission of theory and facts, and a disregard or poor valuing of farmers' knowledges or concerns (see Chapter 2). The World Bank's (2007) review reported that "learners are left alone without any guidance, no demonstrations, few explanations, and farm work is not linked with academic learning objectives" (p. 34) in post-primary agricultural education in Africa. These findings also noted good exceptions where students' training included nearly year-long apprenticeships in some countries such as Ethiopia. The same World Bank report (ibid.) also observed that "fortunately, some notable exceptions exist and *demonstrate that change is possible*" (p. 34, emphasis[4] mine). The critical questions that perhaps come to mind here are what type of change, for whom, by whom, using what mediation tools and with what outcomes.

This study is thus interested in investigating the tensions and contradictions that emerge out of interactions and absences at the boundaries of agricultural learning activity systems. It is also concerned with how the agricultural actors together can transgress and expand transformative sustainability learning and agency. While discontinuities can also occur as presences in policies and curricula of normative knowledges and values that disempower small-scale farmers due to their privileging of practices and commodities that are beyond their reach, they can also be interpreted as absences of the desired socially-just philosophies, knowledges and values. These interests and concerns are expressed through the following objectives and research questions.

1.4 RESEARCH OBJECTIVES AND QUESTIONS

The goal of this study was to co-generate knowledge on how agricultural learning activity systems (involving agricultural education college lecturers/ trainers, small-scale farmers, extension officers, local economic development (LED) agency facilitators, and researchers) can learn better together and from each other across boundaries to improve two sustainable agricultural activities of particular concern to smallholder farmers, specifically:

- **sustainable agricultural water provisioning for food production activity** [water (*amanzi*) for food activity[5]] – mainly in the form of *a range of rainwater harvesting and conservation practices*, and
- **locally adaptive seed system preservation for food production, sovereignty, resilience and health activity** [seed system activity] – mainly in the form of *seed saving and exchange*.

[4] Throughout the thesis I have used italics for emphasis, apart from use in foreign words.
[5] The terms used in the 'square brackets' are **the in-field colloquial versions of the more complex academic terms**. These are used throughout the thesis where relevant. In principle, they refer to the wider academic concepts presented here, and should be read as such across the thesis, except where otherwise clarified or explicated – see NOTE.

[NOTE: Throughout the study I use the scientifically more academic term of 'sustainable agricultural water provisioning activity' that is in focus in the research questions interchangeably with the more colloquial field based use of 'water / amanzi for food' or 'rainwater harvesting and conservation practices'. Similarly I use the more academic / scientific term of 'locally adaptive seed system preservation activity' with 'seed saving / exchange' or 'seed systems' activity. All references to these more colloquial or truncated usages of terms are, however, directly related to the more overarching concepts contained in the two sustainable agricultural activities of particular concern to smallholder farmers, namely, sustainable agricultural water activity, and locally adaptive seed system activity. This need for a more colloquial or truncated use of terminology in relation to these more abstract concepts is partly because the scientific terms are abstract and I worked with farmers, and a range of stakeholders who communicated mainly in vernacular languages, not all of whom were conversant with the abstracted versions of the concepts in English. They did, however, have more colloquial ways of expressing the meaning(s) of the broader concepts, most often related to specific practices of interest to them, or matters of concern. Here it should also be noted that no direct word-for-word translation of the concept of 'sustainability' exists easily in African languages. Most African languages translate the concept of sustainability in a range of more colloquial meanings, metaphors or proverbs that are often practice-based or ethically oriented at a broad level. (UNESCO / SARUA, 2017)]

In line with the above, the following research objectives guided this study:

1.4.1 To find out how small-scale farmers, agricultural college educators, extension officers / workers, research technicians and local government agribusiness supporters learn together to mediate sustainable agricultural water [rainwater harvesting and conservation] and locally adaptive seed system activity [saving and exchange] and thus contribute knowledge of the role and value of these livelihood sustainability practices,

1.4.2 To explore and document the socio-ecological histories of sustainable agricultural water [rainwater harvesting and conservation] and locally adaptive seed system activity [saving and exchange] , and socio-cultural histories of agricultural learning activity systems in the context of small-scale farming, and

1.4.3 To understand how learning, curriculum innovation and mediation tools for agricultural extension education and farmer training that can expand learning of sustainable agricultural water [rainwater harvesting and conservation] and locally adaptive seed system activity [saving and exchange] in agricultural education and small-scale farmer activity systems could be co-generated.

The research objectives above are oriented towards activity systems analysis and lead to the research question in the same realm of analysis. Yamagata-Lynch (2010) suggested that "while engaging in activity systems analysis, investigators need to develop questions that will address mediational activities" (p. 25). In this study I extend similar lines of argument for mediated action which were conceptualised and developed respectively by Vygotsky (1978) and Engeström (1987). This research set out to answer the question:

What boundary-crossing learning and mediational processes and opportunities can **expand learning** and **sustainability of agricultural water provisioning [rainwater harvesting and conservation] and locally-adaptive seed system [saving and exchange] activity** for food production amongst diverse agricultural actors, how and why?

This research question was broken down into the following sub-questions for better management:

i. How do small-scale farmers, agricultural educators and extension officers **understand and / or concretise sustainability problems and practices** in **agricultural water provisioning [rainwater harvesting and conservation] and locally-adaptive seed system [saving and exchange] activity**?
Chapters 2, 4 and 5 will address this question.

ii. **What appears to be influencing uptake or absence of sustainable agricultural water provisioning [rainwater harvesting and conservation] and locally-adaptive seed system [saving and exchange] activity** in and across related agricultural learning activity systems, and why?
Chapters 2, 4 and 5 will address this question.

iii. What boundary-crossing learning and mediational processes and opportunities can **expand learning of sustainable agricultural water provisioning [rainwater harvesting and conservation] and locally-adaptive seed system [saving and exchange] activity** amongst diverse agricultural actors?
Chapters 6 and 7 will address this question.

iv. How can boundary-crossing **opportunities** and **mediational processes** expand learning of **sustainable agricultural water provisioning [rainwater harvesting and conservation] and locally-adaptive seed system [saving and exchange] activity** in and across related agricultural learning activity systems?
Chapters 6 and 7 will address this question.

v. How is the mediation of boundary-crossing learning of **sustainable agricultural water provisioning [rainwater harvesting and conservation] and locally-adaptive seed system [saving and exchange] activity** influenced by different **mediation sites** (e.g. agricultural education college farm plots; farmers' plots), **institutional forms** (e.g. agricultural education colleges, farmers associations, local government, extension services, farming families) and **activity systems**?
Chapter 8 will address this question.

1.5 STUDY SITES AND NESTED CASE STUDY DESIGN

The study sites are located in two southern African countries, namely South Africa and Zimbabwe, and shall thus be described separately for each country. The first layer of descriptions focusses on the contexts followed by the conceptual framework. Under context description, further layers include geographical contexts which locate the study areas on maps, and describe the rainfall, geological (topography, rock formations and soil), hydrological, vegetation and demographic characteristics that have a bearing on the agro-ecological, socio-ecological, water availability and use and associated agro-economic and value chain activities. The study sites in each country case are connected functionally. For example, agricultural college sites are related to surrounding farming study sites (through farmer training and student outreach) and their related extension services but all falling within a learning network context as cases within a case, or 'nested' case studies with one unit of analysis (Patton, 2002; see Chapter 3). The range of agricultural actors considered as research participants in both cases was made up of small-scale farmers, agricultural college lecturers, extension officers and LED agency facilitators. These were considered to be sufficiently representative of the agricultural learning activity systems that could adequately inform contradictions in the learning activity system of water and seed activity in small-scale farming systems. The conceptual framework is discussed after the context of the study sites. According to Miles and Huberman (1994) and Robson (2011), it is a visual or narrative product that a researcher uses to explain the key things to be studied, namely the system of concepts, variables, assumptions we make, beliefs, expectations, theories that inform the research and any connections between them.

1.5.1 Context of study site in South Africa: Study site 1

Most participants in the South African nested case study were drawn from Nkonkobe local municipality and a few from neighbouring Amahlati local municipality both in the Amathole District. The Amathole District is part of the former Ciskei homeland which is located in the Eastern Cape Province (see Figure 1.1), one of the country's nine provinces. The district derives its name from the Amatola mountain range in the area.

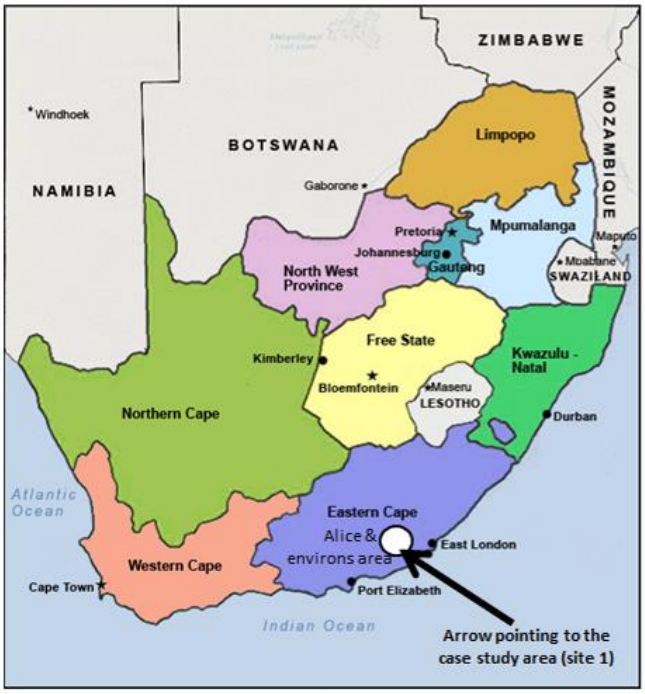


Figure I.1*: Provincial map of South Africa showing neighbouring countries and Study Site 1 (Source: http://exploringafrica.matrix.msu.edu/module-twenty-nine-activity-one/)*

Figure 1.1 shows that the study site is clustered around the famous town of Alice known for hosting the University of Fort Hare and Lovedale Further Education and Training (FET) College that trained many notable African leaders including Nelson Mandela. The Eastern Cape has been recorded as being the poorest province for many years (South Africa. Statistics South Africa [StatsSA], 2017) with a past and continuing contemporary history of marginalisation related to homeland segregation.[6] "Eastern Cape and Limpopo have remained among the poorest provinces since 2001. … The Eastern Cape remained the poorest province in 2016, with 12.7% of its households classified as multi-dimensionally poor" (SA.StatsSA, 2017, p. 34). Figure 1.1 provides a national as well as a sub-regional (southern African) perspective of the location of this nested case study in South Africa. Its significance is that firstly it shows the location of South Africa relative to Zimbabwe, the other case study country. Secondly, it shows the relative location of provinces to which the Eastern Cape is compared in the socio-economic context of the culture of agriculture discussed in Chapter 2 of this thesis.

A purposive sample was derived from the agricultural actors listed above based on a cascade model involving key informants in leadership positions, and ordinary practitioners identified during contextual profiling. All farmers in the case study were from rain-fed farming areas struggling with water for food and typical of the dominant rain-fed farming systems in the area (see Chapter 4). Among

[6] South Africa existed as a racially segregated nation between 1948 and the onset of democracy in 1994, with Black people designated to their tribally-drawn semi-autonomous areas called 'homelands' or 'Bantustans' by the apartheid government.

small-scale farmer leaders, four executive committee members of the Nkonkobe Farmers' Association (representing area farmers' associations namely Alice [eDikeni], Middledrift [Xesi] and Fort Beaufort [Bhofolo]) were selected. Two of these members also represented the committee of the eDikeni Water User Association. Small-scale farmer practitioners were selected at two levels namely individual and group because of the different dynamics that each of these levels brings to organisational and resourcing capacities and agency. Two groups of small-scale farmer cooperatives were selected. These were Lloyd Village (Zamukulunga) Garden Cooperative in Alice which operated between subsistence and commercial levels and Seven Stars Dairy Cooperative Trust in Keiskammahoek which operated as a commercial enterprise. Six individual farmers were initially selected (the number later doubled due to group and networked formations) based on the following criteria to ensure wider coverage of the diversity of small-scale farmers found in the Nkonkobe Local Municipality:

- sites of a previous rainwater harvesting projects facilitated by the Agricultural Research Council (ARC): (Khayalethu and Mpundu villages under Alice) x2 farmers. The ARC facilitated infield rainwater harvesting and conservation (RWH&C) in the study area before this study began;
- a typical former 'Betterment Planning'[7] village where farming and water are issues of risk (Koloni village or Perksdale location under Middledrift) x2 farmers;
- a farming community not disrupted by Betterment Planning near Fort Cox College of Agriculture and Forestry (Amathole Basin) x 1 experienced farmer, later joined by 4 youths to form a group; and
- Participation in the Nkonkobe Economic Development Agency (NEDA)'s smallholder farmer programme and value chains (3 x Open Pollinated Variety (OPV) maize and horticulture farmers from three villages).

The case is wholly located in a former homeland region because these are sites of struggle with small-scale farming, water scarcity and poverty where South Africa's transformation agenda faces both huge opportunities and challenges. Pienaar and Von Fintel (2014) concluded from a study that the "former homeland regions were set up for small-scale intensive farming that had little scope for success" (ibid., p. 26). They observed that the Land Act of 1913 that provided for homeland demarcation left a legacy of hunger, which has been alleviated substantially by social grants. The latter have however created huge dependence on hand-outs in former homeland regions. This dependence is manifested in many ways which includes spending less time working in the gardens (see contradictions under Lloyd Village in Chapter 4) and abandonment of fields (see Figure 1.2 below). The key point they make of relevance to this study is that "very small farmers (those in gardens of various types) also successfully

[7] See Chapter 2 for further explanation of this apartheid / former homeland governments' social engineering 'planning' system.

reduce adult hunger levels... *[hunger] can be tackled by improving the capacity of small scale farmers*" (ibid., p. 26, emphasis mine).

Figure 1.2: *Abandoned fields showing succession by secondary vegetation in Nkobonkobo Village, Alice, Nkonkobe Local Municipality (1 December 2014, Photo taken by author)*

The study site in the South African case has a history of apartheid[8] segregation and underdevelopment (see Chapter 2) and therefore provides a good research context for studying water for food. The case study was made up of one agricultural college (Fort Cox College of Agriculture and Forestry) being the "focal point" in this case area, one university (Fort Hare), three rural village farming sites (Lloyd, Keiskammahoek and Mqayise), two extension offices (Alice and Middledrift) and the Nkonkobe[9] local economic development agency (NEDA) office in Alice. Fort Cox College management and staff quickly showed an interest in participating in the entire formative intervention process. The college was the only extension and farmer training agricultural college located in the study area, and is connected to small-scale farmers and extension advisors. The University of Fort Hare in Alice town is a key education institution historically established to serve Black people at the time and now continues to provide education, including agricultural training, to all population groups. Major commercial activities in the area include citrus and game farming. These cases were all connected within a learning network called Imvotho Bubomi (literally meaning water is life, see Chapters 4 and 6). The Imvotho

[8] Apartheid is an institutionalised system of racial segregation, separate development and discrimination. It was implemented via formalised legislation in South Africa from 1948-1994, and informally under colonial rule for close to 300 years prior to that.

[9] The Nkonkobe local municipality has now expanded geographically by merging with Nxuba Local Municipality and is now called Raymond Mhlaba Local Municipality as from 3 August 2016.

Bubomi Learning Network (IBLN) was initially conceptualised as a web of linkages in the sustainable agricultural water learning community. Potential learning network members expressed the desire to learn together with others through dialogue and training in water for food practices addressing rain-fed farming contexts. The latter led to a training course (see Chapter 6) designed to stimulate expansive learning.

The learning network concept was used as a way of accessing and communicating with the agricultural actors in the study area. The initial concept was hypothesized with the Agricultural College in the centre of the learning network showing its connections to other agricultural learning activity systems based on literature and initial consultations with Cedara Agricultural College and Fort Cox Agricultural College. Fort Cox College's role as a stakeholder in smallholder farming was described and confirmed by NEDA (2013a) as "owners of prime agricultural land and local support for small-scale community based projects" (p. 6). These connections (made in April 2014) were represented in a map as illustrated by the diagram (Figure 1.3) below which I have simplified to show only the principal linkages:

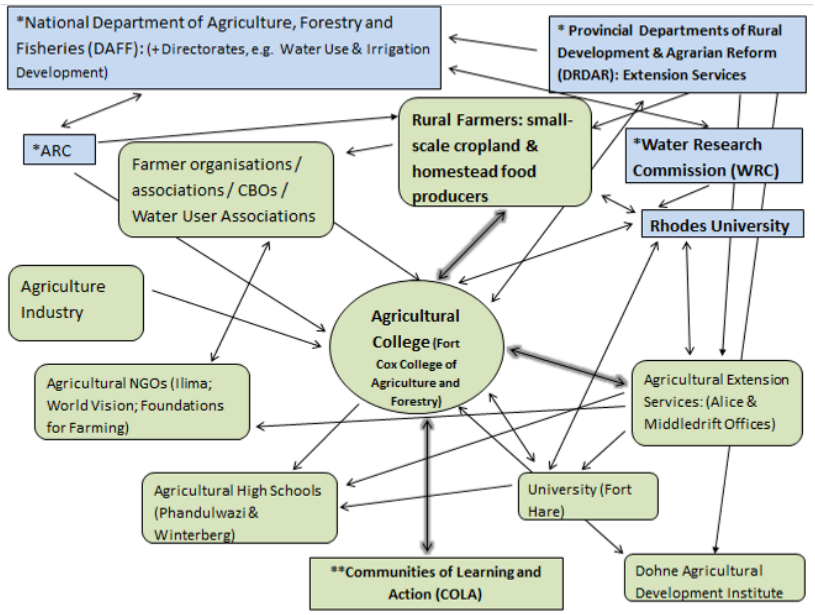


Figure 1.3: *Initial (access stage) conceptualisation of a College-centred Learning Network map (April 2014) [See key for * and ** below]*

Key:

*These organisations, while not necessarily having direct involvement in the clusters are critical external partners, and their support is essential.

****Agricultural Colleges worked with each other in Communities of Learning and Action (COLAs), an organisational structure through which they shared ideas for different aspects of their work, including their curricula. The principal of Cedara Agricultural College headed this COLA, with which Fort Cox was also involved. The COLA therefore provided an opportunity to take the lessons learned through the work with these two colleges to all other colleges.

The agricultural college was placed at the centre as a strong default locus of understanding how it and the other institutions were connected to each other, but also from the evidence of connections discussed

above. It was also based on the college's expressed community outreach mission and the farmer training function of its rural development centre (Fort Cox College [FCC], 2015; FCC, 2016). This college-centric hypothesis later changed as shall be discussed from Chapter 6 onwards. Figure 1.4 is a nested case illustration of the key agricultural activity systems in the learning network.

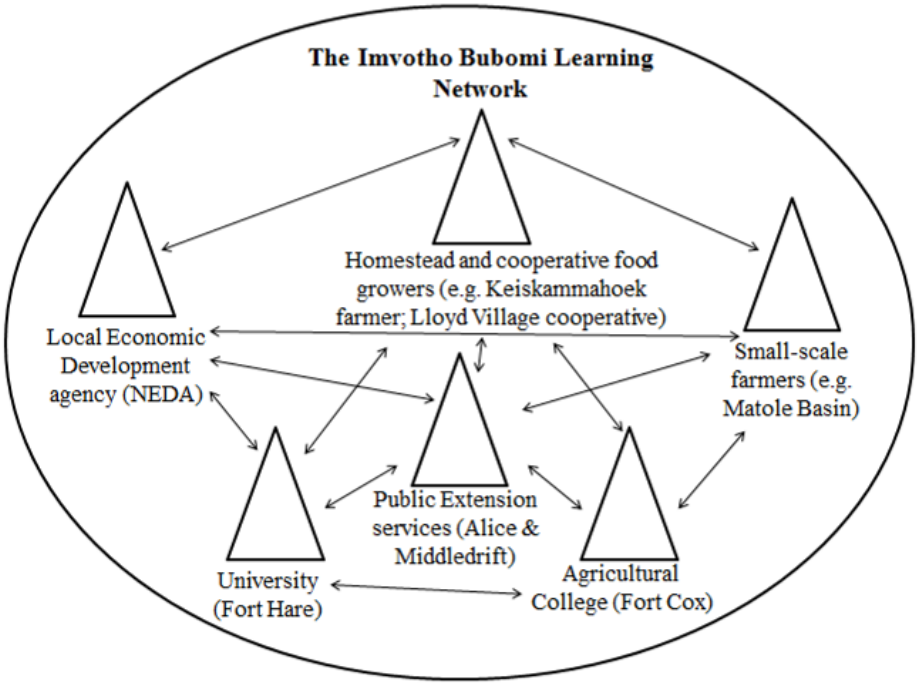


Figure 1.4: *Triangles within a circle: Each activity system case nested within the expansive course-activated learning network in the South African nested case.*
(Nested case study design diagram adapted from Lotz-Sisitka & Raven, 2004)

The emerging water aims and actions of each nested activity system case in Figure 1.4 are reciprocating with, informing each other and learning together on sustainable water for food (see Chapter 6). This study site was selected from within the wider context of a Water Research Commission (WRC) project called Amanzi for Food[10] (Lotz-Sisitka et al., 2016) facilitated by Rhodes University (see Chapters 4 and 6).

Figure 1.5 that follows shows a more specific location of the South African case study site.

[10] "Amanzi" is an isiXhosa word for Water, used here as Water for Food, and is the name of the WRC project in which this study is embedded. More information on this project can be found on www.amanziforfood.co.za

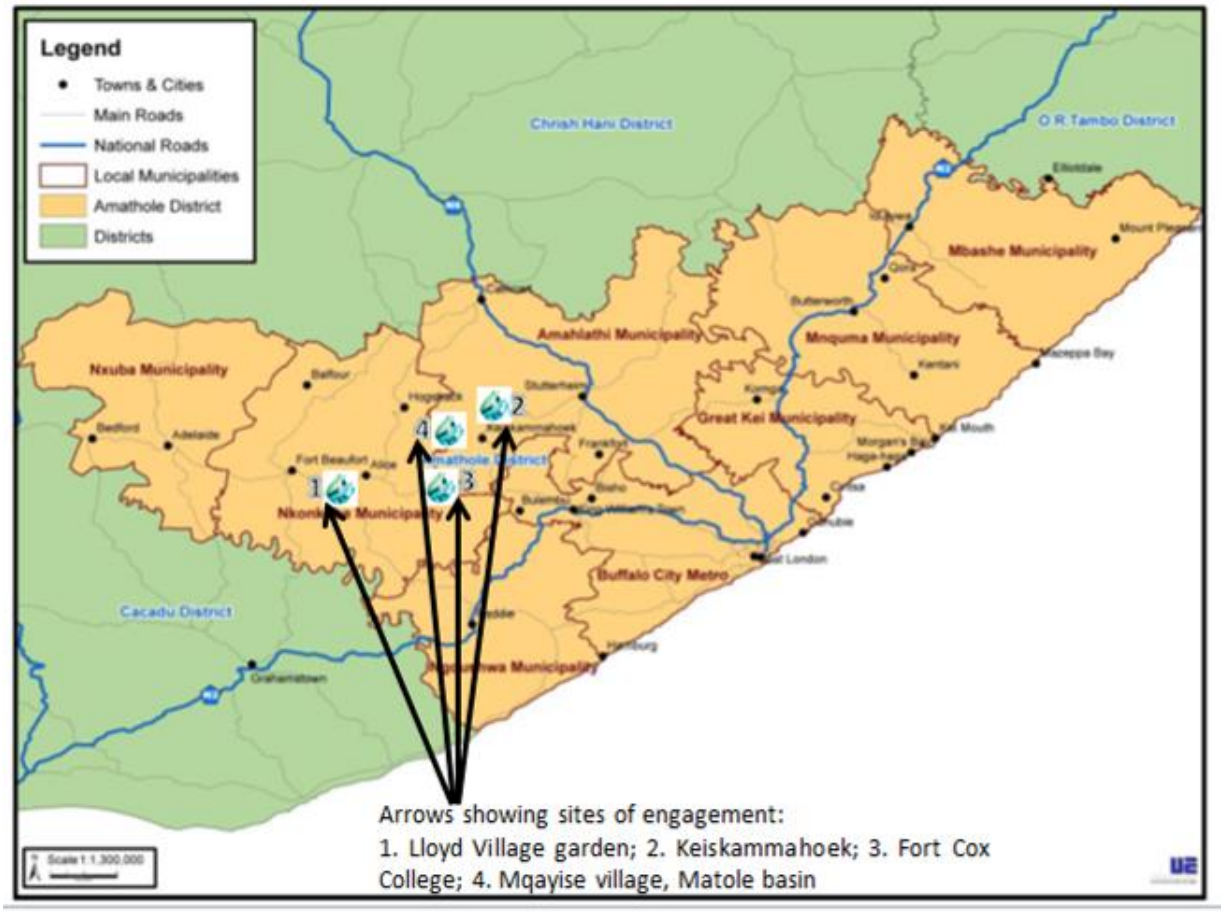


Figure 1.5: *Map of the South African case study site focusing on Amathole District Municipality, with the two Local Municipalities of Raymond Mhlaba and Amahlati and environs of interest.*
(Source: Urban-Econ Eastern Cape, 2011 in Amathole District Municipality, 2012, p. 31)

In Figure 1.5 the epicentres of sustainable agricultural water expansive learning emanating from this study are shown as Amanzi for Food design water droplets, being Lloyd Village in Alice (#1), farmers' homesteads in Keiskammahoek (#2) and Mqayise village, Matole Basin (#4) and Fort Cox College of Agriculture and Forestry (#3) near Middledrift, in the order in which the interventions and demonstration plots developed (see Chapter 6). In the latter, the site was specifically in Mqyayise, one of 13 villages under Chief Mthambiso in ward 10 of the former Nkonkobe Local Municipality which had 21 wards in total (Nkonkobe Municipality, 2014) before the 2016 amalgamation (see footnote 2).

1.5.1.1 Fort Cox College of Agriculture and Forestry as a community learning centre

Fort Cox College of Agriculture and Forestry is situated right inside the boundaries of the former Ciskei Homeland. It has a mission and cultural-history of networking and community engagement (FCC, 2015). The College was established in 1930 making it one of the historically black public institutions in South Africa. It is endowed with rich historical, cultural and diversified socio-economic and biological heritage. In the early years the college provided training only in agriculture until 1969, but from 1970 forestry training was instituted with a Forestry Diploma course. The "New College"

campus was constructed on land bought from Chief Sandile and officially opened by the Ciskei Government in 1977. Fort Cox College was granted autonomy in April 1990 through Decree No 5 of the former Ciskei Government, a status that it has to date. In 1991, the College became affiliated to the University of Fort Hare through a Memorandum of Agreement between the Department of Agriculture, Forestry and Rural Development of Ciskei and the University. In 2010 the Fort Cox College curriculum "was reviewed and implemented in line with the industry and socio-economic needs of the country" (FCC, 2015, p. iv). Fort Cox College also has a unit dedicated specifically to rural development – the Rural Development Centre – which trains farmers and youth making the college a community learning centre.

1.5.1.2 eDikeni Water User Association (WUA)

This study also worked in the area covered by the eDikeni Water User Association (WUA) wherein lies three sites of importance to the study namely the Lloyd Village (shown in Figure 1.5), and Khayalethu and Mpundu villages where the Agricultural Research Council earlier implemented rainwater harvesting demonstration sites (Botha et al., 2003) (see Chapter 4). The eDikeni WUA covers an area demarcated by the boundaries of the Thyume Valley sub-catchment. Figure 1.6 below shows its extent "from the upper boundary of the watershed in the Amathole mountains from Hogsback town down to Alice town and then just beyond to include a few villages on the low-lying plains South of Alice" (eDikeni Water Users Association [WUA], 2013, p. 6).

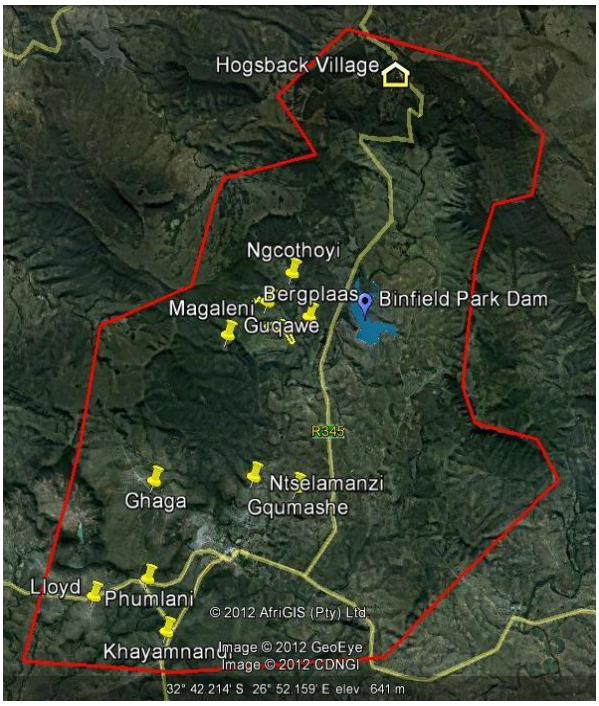


Figure 1.6: *Area of operation of eDikeni Water Users Association (adopted from eDikeni WUA, 2013, p. 6)*

The significance of this area of operation in Figure 1.6 is that it indicates multiple contradictions: such as a major dam (Binfield Park) within a few kilometres of farmers who are struggling with water for farming, the Amathole Mountains which generate significant amounts of relief rain, in the vicinity of much drier areas such as Alice in the rain shadow where Lloyd Village lies.

The eDikeni Water Users Association was established in October 2006 bringing together farmers and their farmer cooperatives in Alice, including the Alice Farmers Association with the objective of improving agricultural water (South Africa. Department of Water Affairs and Forestry [DWAF], 2007; eDikeni WUA, 2013). Water User Associations in South Africa were brought into being by the National Water Act (Act 36 of 1998) (South Africa, 1998). The Water Act of 1998 requires each Water Users Association to have a Business Plan in line with the requirements of the Department of Water Affairs' Water User Association Guidelines (South Africa. DWA, 2006). This requirement was gazetted in 2006 in accordance with the 1998 Water Act of South Africa. The eDikeni Water Users Association was formed amid high hopes, which were backed by government legislation that was interpreted by the agriculture community as enabling and supportive of successful small-scale farming (Tregurtha & Vink, 2008).

1.5.1.3 Keiskammahoek rural town and villages

Keiskammahoek is a tiny rural town in the Amahlathi local municipality (neighbouring Raymond Mhlaba local municipality) also in Amathole District and was part of the Ciskei Homeland from 1981 to 1994. The place is named after the Keiskamma River near to whose catchment area headlands it is situated. The Seven Stars Dairy Trust is a joint venture between emerging farmers (represented by Seven Stars Primary Producers Co-operative), the Department of Rural Development and Agrarian Reform and Amadlelo Agri[11] to resuscitate 750 hectares of irrigation and to milk 2000 cows (Amathole District Municipality, 2010). Residential villages just outside the town area are home to some members of the Seven Stars Dairy Trust who expressed interest in exploring rainwater harvesting as an option for their dire pasture irrigation water situation, and to pilot in their homestead gardens.

1.5.1.4 Mqayise village, Matole Basin

Mqayise village lies in the Matole Basin 10 km North of Fort Cox Agricultural College. This site emerged pragmatically during the boundary-crossing change laboratory processes within the learning network (see Chapter 6). The site was made up of an agro-ecological farming family whose leading farmer was a committee member of the local area (Nkonkobe) farmers association and indicated

[11] A company established in 2004 by commercial dairy farmers in the Eastern Cape and KwaZulu-Natal Provinces to fully develop underutilised land and boost dairy production through training local communities.

interest in participating on behalf of the farmers' association committee and agro-ecological farmers' network; and a group of four youths starting out in farming and mentored by the agro-ecology farmer.

1.5.1.5 General socio-ecological characteristics of the South African study site

This section summarises the local economic status and the soil and rainfall characteristics of the South African research site.

Local economy:

The local area is under-developed as a legacy of apartheid segregation in the former homelands and a perpetuation of the same pattern in the post-apartheid period (Westaway, 2010). The adverse agro-ecological context of the study area may be related to the historical and contemporary poverty and low contribution of agricultural production as shown in Figure 1.7. Chapter 2 will discuss further details of the culture of agriculture of the study area in relation to the country.

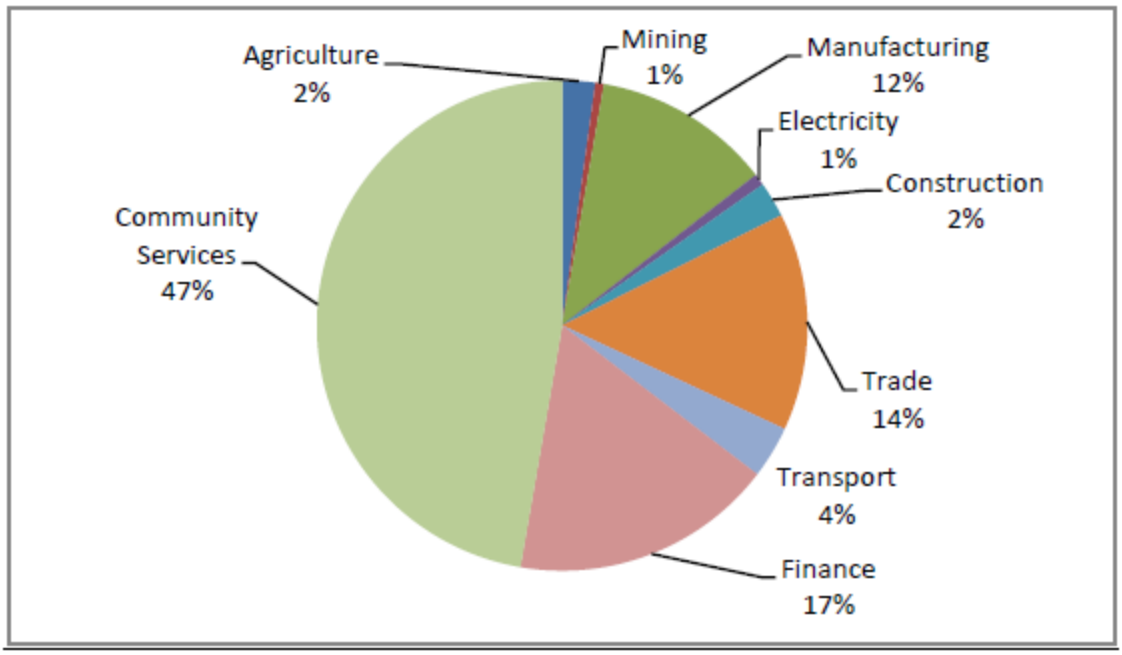


Figure 1.7: *Sectoral production structure of the Amathole District Municipality (ADM) economy, 2010 (Source: Global Insight cited in ADM, 2012, p. 39)*

According to the Amathole District Municipality analysis, the contribution of the agricultural sector "has been very minimal in the period from 1996 to 2010" (Amathole District Municipality, 2012, p. 39).

Soils:

The soils in the South African case study area vary from clay to sandy loam across the nested cases. Specifically, soils at Lloyd Village garden were sandy loam meaning they had a poor water holding capacity, while soils at Fort Cox College were generally clayey loam meaning they could keep water for longer periods.

Rainfall, water and temperatures:

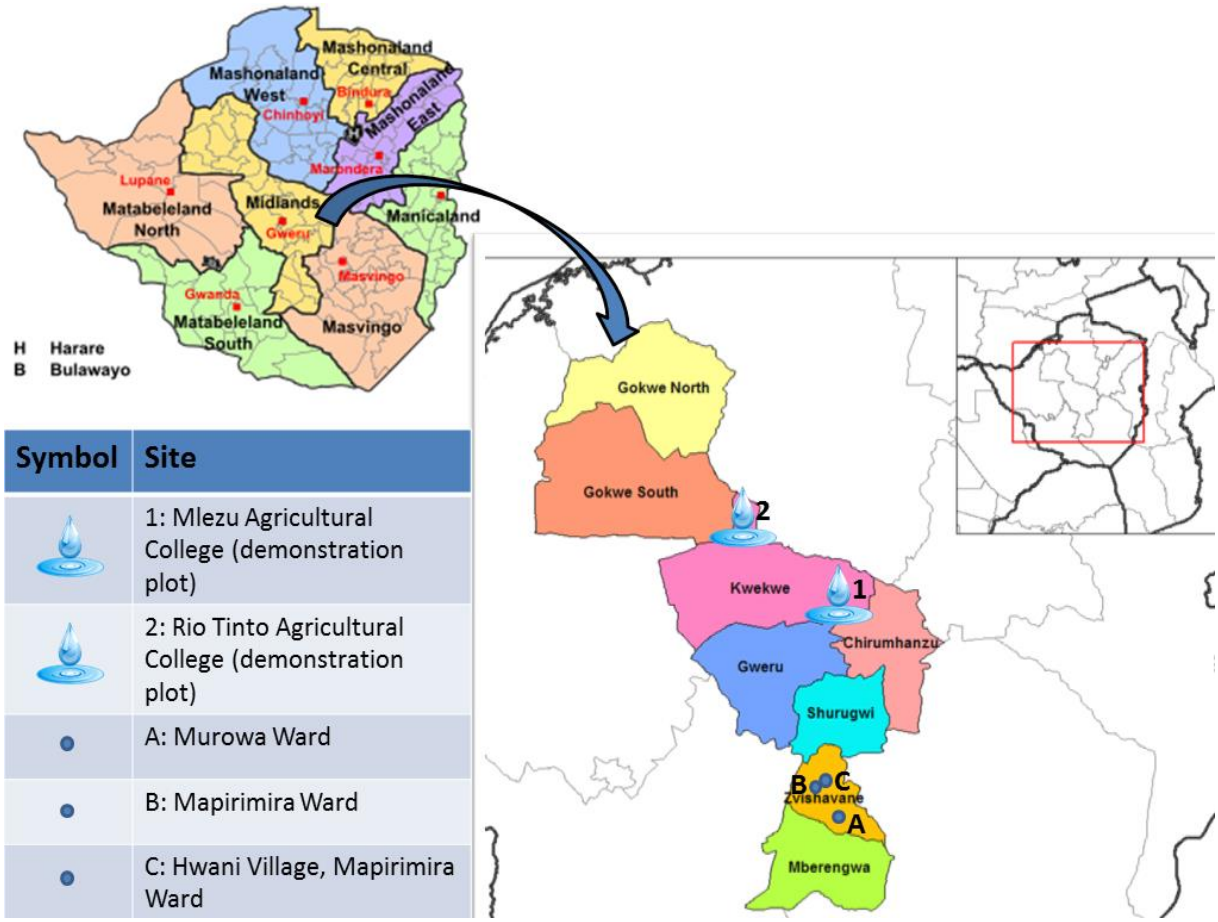
There is distinct variation in the rainfall received in the eastern and western parts of the study area. The rainfall is generally lower on the western side (Alice, Lloyd Village) of the Tyhume Valley compared to the eastern side (around Matole Basin, Fort Cox College and Middledrift). Alice has an average annual rainfall of 386 mm (Fort Hare Research Farm, 2001), most of which falls in the summer season (October to March). Sometimes significant winter rains are received but generally very low rainfall is received in winter which is inadequate for most crops. A significant water feature in the area is the Tyhume River. It springs from the Hogsback mountain forests that form part of the Amatola Mountains, and runs down the Tyhume River Valley. The river then flows through the eastern verge of Alice town, and borders the greater part of the Fort Hare University grounds. Binfield Park Dam near the centre of the valley draws water from Tyhume River and is a key reservoir of water for farms in the area, some of the rural settlements along the river valley and Middledrift town further downstream. The river later joins the Keiskamma River on its way to the Indian Ocean. The Keiskamma River's source is in Keiskammahoek and it passes through Fort Cox Agricultural College which it supplies with raw irrigation water. The College also receives water from Binfield Park Dam. The Seven Stars Diary farming and support enterprises such as pasture lands and maize at Keiskammahoek, one of the sites of engagement, is supplied with irrigation water from the Cata and Mnyameni Dams, with the latter also supplying domestic water to the local area and surrounding villages. The irrigation water supply at Keiskammahoek is erratic resulting in water shortages. Mqayise village farmers like the rest of the farmers in the Matole Basin operate under a rain-fed farming system.

Average midday temperatures in the area range from 19^{o}C in winter (June) to 29^{o}C in summer (February), while night time temperatures range from 5^{o}C to 16^{o}C. Mqayise village experiences an extended frost season that cuts into October thus making its growing season later than the rest of the study area.

1.5.2 Context of study sites in Zimbabwe: Study site 2

The Zimbabwean nested case study had participants made up of agricultural lecturers from the eight agriculture diploma offering colleges, smallholder farmers and extension officers. The case participants included 14 agricultural college lecturers including college management from two agricultural colleges Mlezu and Rio Tinto (of whom six were interviewed), 11 agricultural extension officers, supervisors and workers, 10 small-scale farmers and two local authority staff members. This was a purposive sample in the sense that it focused on the central to southern provinces and in areas which are located in drier parts of the country where crop production faces regular severe moisture

stress. Plate 1.8 shows the location of the sites of engagement where the participants of the formative intervention were derived from.



Symbol	Site
	1: Mlezu Agricultural College (demonstration plot)
	2: Rio Tinto Agricultural College (demonstration plot)
	A: Murowa Ward
	B: Mapirimira Ward
	C: Hwani Village, Mapirimira Ward

Figure 1.8: *Location of study sites in the Zimbabwean case study from the provincial to the district and local contexts*

Mlezu is the largest college while Rio Tinto is the smallest, thus incorporating the two extreme cases of enrolment numbers and capacities amongst the well-established colleges in the system. According to Närman (1991), Mlezu College's location "was appropriate since the land quality in the Midlands province was believed representative of the quality of communal land in general" (p. 44). Addition of new research participants also followed a 'snowball sampling' technique (Morgan, 2008) because some participants, who I did not know before, later joined boundary-crossing change laboratory workshops. This took place as the existing study participants recruited future participants from among their acquaintances and networks. Among the farmers was also a marketing representative for Zvishavane farmers. This range of agricultural actors was considered to be sufficiently representative of the agricultural learning activity systems that could adequately inform contradictions in agricultural water and seed saving value chain practices in small-scale farming. This was confirmed by document analyses and key informant interviews.

Small-scale farmer practitioners who were selected were all operating as individual or family farming units, but most of them belonged to some network such as rainwater harvesters (in Mazvihwa and Zvishavane) and farmers associations (in Zhombe). The individual farmers were selected based on the following criteria to ensure wider coverage of the diversity of small-scale farmers found in the Runde, Zibagwe and Zhombe rural districts:

- farmers at sites of productive farmer-led rainwater harvesting innovations in drylands;
- farmers at sites of typical marginalised dryland areas struggling with water security, drought and heat wave events;
- farmers located around the two selected agricultural colleges in the dryland farming areas who had potential outreach connection with the colleges.

The case is wholly located in dryland farming and marginalised rural areas. Most rural dwelling adults in the case area are engaged in some form of farming and / or vegetable gardening for their own subsistence food production with a few selling to the grain marketing board, supermarkets, farmers' markets or incidental markets for income generation. Marginalised small-scale farming in Zimbabwe was created by colonial legislation such as the Land Apportionment Act of 1930 and the Native Land Husbandry Act of 1951 as discussed further in chapter 2. There was a deliberate push on Black farming communities towards less productive land in dry areas (Maphosa, 1994; Mlambo, 2014), and promotion of local rather than national economies that ensured a steady Black labour supply to White farms (Mlambo, 2014).

The study sites in the Zimbabwean case were made up of two rural areas with rainwater harvesting innovations (Murowa Ward under Chief Mazvihwa and Mapirimira Ward under Chief Mapanzure), two agricultural colleges (Mlezu and Rio Tinto) and their associated hierarchical agricultural learning system and surrounding rural communities (see Chapter 5). The college sites were selected in liaison with the umbrella body the Department of Agricultural Education and Farmer Training mainly for their location in dryland areas (see section 1.5.2.1 below). The first set of two rural areas selected were typical of areas most affected by dryland rain-fed conditions and climate change, namely agro-ecological regions 4 and 5 (see section 1.5.2.3) where the colleges also fall, and have produced water innovations that are relevant for these colleges. The second set of two rural areas is serviced by the two selected agricultural colleges; hence they are nested together. These cases were all connected within a learning network as shown in Figure 1.9.

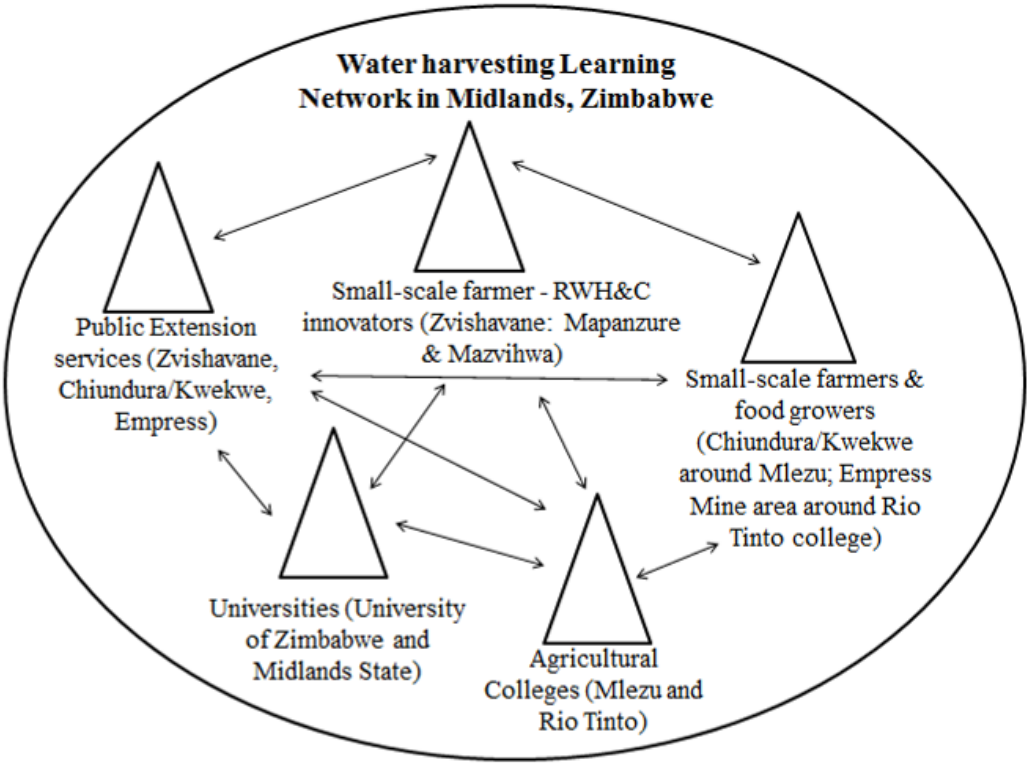


Figure 1.9: *Triangles within a circle: Each case nested within the expansive learning network in the Zimbabwean nested case (adapted from Lotz-Sisitka & Raven, 2004)*

The nested cases in Figure 1.9 had varying levels of importance with the universities serving as key informants of curriculum content and practice. The innovators, extension officers, agricultural colleges and typical small-scale farmers from the areas surrounding the colleges served as both key informants and co-generators of model solutions in the formative interventions (see Chapter 7).

1.5.2.1 The Department of Agricultural Education and Farmer Training, Zimbabwe: Mlezu and Rio Tinto Agricultural Colleges

Two agricultural colleges were selected as case studies within the Zimbabwean nested case study, namely Mlezu and Rio Tinto Agricultural Colleges, and as in the South African case study they are the 'focal points' in the case areas. Both are located in hot, dry areas of the Midlands Province near Kwekwe City and Empress growth point (about 55 km from Kadoma City) respectively. Both colleges were suffering visible technical and social effects of irrigation infrastructure dysfunction and drought impact and are in close proximity to each other. Other agricultural colleges were left out because the curricula are uniform across the system and hence the selected colleges are representative of them and of those operating in other dryland areas. These agricultural colleges fall under the Department of Agricultural Education and Farmer Training within the Zimbabwean Ministry of Agriculture, Mechanisation and Irrigation Development (MAMID) as shown in Figure 1.10.

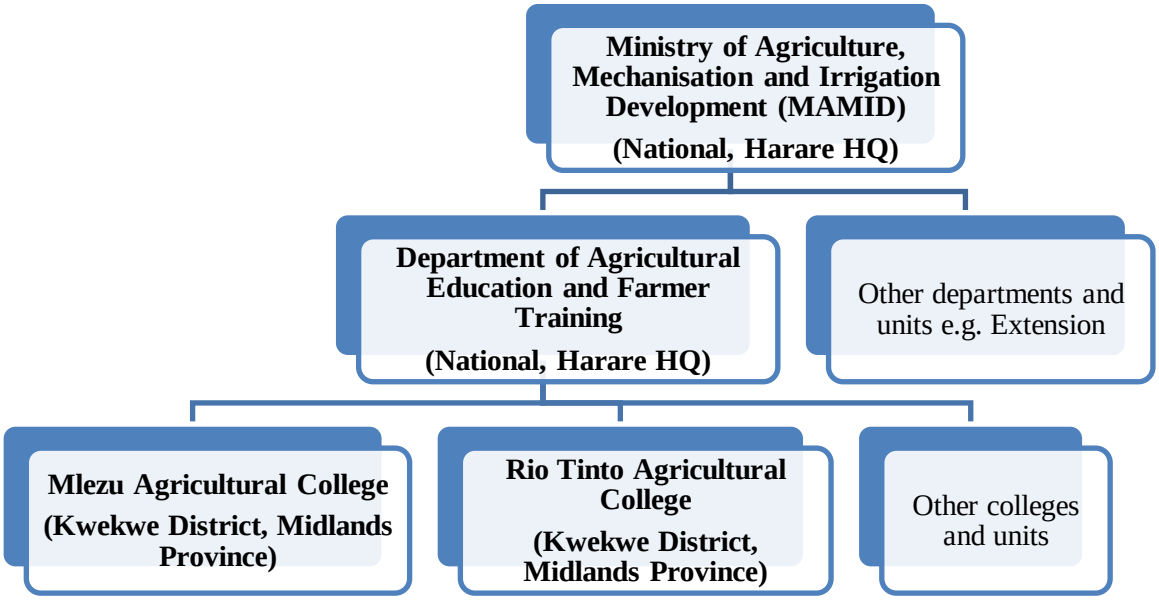


***Figure 1.10**: Organisational structure of agricultural colleges within Zimbabwe's Department of Agricultural Education and Farmer Training*

1.5.2.2 Mapanzure and Mazvihwa communal lands, Zvishavane (Runde) Rural District, Zimbabwe

Two of the sites of engagement in this study lie in Murowa Ward (ward #18) under Chief Mazvihwa which lies in the southwest of Zvishavane District and in Mapirimira Ward (ward #7) under Chief Mapanzure in the north-western corner of the district. Both these wards lie in the rural district council organ of Zvishavane District local government, the Runde Rural District Council. This choice of study sites was made because it marks the epicentre of innovative rainwater harvesting activities that have made remarkable changes to people's lives (Witoshynsky, 2010) by availing water for crop production and domestic use in an otherwise very dry and hot area with erratic rainfall and poor dam development. It is also an area where people continue to struggle with poor availability and access to agricultural water thus providing a large scope for possible learning and scaling-up actions for harvesting rainwater. In addition it is an area where the identification, choice and saving of the right seed adapted to the local climatic conditions makes a difference between food security and starvation or food aid.

The greater Runde Rural District Council area surrounds Zvishavane town, and shares borders with four other Districts; Filabusi/Insiza to the South West in Matebeleland South Province, Mberengwa to the South still in the Midlands Province, Chivi to the East in Masvingo Province, and Shurugwi to the North still in the Midlands Province (see Figure 1.6). Runde Rural is one of eight districts in the Midlands Province and is divided into 19 political wards. Zvishavane town was established during the colonial period from its long-fibre asbestos mines which provided jobs and therefore attracted many people from the surrounding rural areas. Despite the depletion of the asbestos deposits in the late 1990s

and global ostracisation of the mineral which led to a period of over ten years of near relegation to a 'ghost town', the town has had a renewed lease of life and continues to attract workers today through the newly discovered Mimosa diamond and platinum mines.

However crop production and livestock husbandry continue to play an important role in the livelihoods and economies of the people in the communal lands (also called rural areas). These activities have become even more important as communal areas have expanded with the opening up of former commercial farms to ownership by small- to medium-scale farmers through the sweeping fasttrack land reform programme that began in 1999 (Mlambo, 2014).

Below is a description of the soils, rainfall and water situations in the sites of engagement and in the rainwater harvesting innovation sites in Zimbabwe, providing a socio-ecological context of both.

Soils and terrain:

The soils in the different target areas were varied and are described separately. The soils in Murowa Ward, where in-field rainwater harvesting innovations were implemented by several people, varied from sandy loam to clayey loam. They were generally well-manured, a factor that increased the water holding capacity. The terrain in the fields was almost always gently sloping due to the mountainous characteristic of the land. This enabled gentle water flow both overland and subterranean. The soils in Mapirimira Ward where rainwater harvesting innovations were implemented were mostly sandy loam but well manured with some places benefitting from addition of clay soils to increase water holding capacity and fertility. One of the sites in this ward also had a granitic outcrop in its micro-catchment area that increased water capture (Witoshynsky, 2010).

The general soil types in the Kwekwe area where Mlezu Agricultural College lies vary from sandy to loam. Soils at Mlezu Agricultural College's cropping area varied from sandy to sandy loam and clay in some areas, with the site selected for rainwater harvesting in the farm area having deep sandy loam soils. The site selected for rainwater harvesting demonstration at Rio Tinto Agricultural College also had deep but clayey to loam soils. The target area has predominantly loam soils. Soil testing was therefore an essential step in the selection of successful rainwater harvesting and conservation demonstration sites (Botha et al., 2012, pp. 3, 11).

Rainfall and water:

On average, rainfall is below 300mm/year in Zvishavane and Mazvihwa (Zimbabwe. Meteorological Services Department, 2015) with frequent early season droughts (Drinkwater, 2016) in the Rio Tinto Agricultural College area (Simba & Chayangira, 2017). This average persists in cycles of four years intercepted by a good year of 350-450 mm / year. Average rainfall is slightly higher at 350mm/year in the Mlezu Agricultural College area (ibid.). Rainfall is important for crops, watering livestock and recharging ground water reserves. While some farmers believe that rainfall quantities have fallen over the years, climate variation statistics collected over a 50+ year period between 1961 and 2015 by the Meteorological Services in Zvishavane shows that on average rainfall has remained generally the same in quantities with episodes of drought in 1982, 1987, 1992, 1995, 2001-2003, 2013-2015 (Zimbabwe. Meteorological Services Department, 2015; Simba & Chayangira, 2017). Drought events and crop losses are common and increasing occurrences across all the study areas.

Historical national level predictions in a southern African climate change context indicate that "Zimbabwe will reach its water resources limits by the year 2030" (Magadza, 1999, p. 121). This current water scarcity situation in Zimbabwe is shown by persistent drought events that make water unavailable for farmers' crops and livestock and the inaccessibility of dam water to most smallholder farmers. To clarify different levels of scarcity Turton and Ohlsson (1999) made a distinction between primary water scarcity ("refers to the amount of water available in the country …assessment of water stress and water scarcity", p. 50), and secondary water scarcity ("indicating level of water development in a particular country, and the ability to provide reliable sources", ibid.).

1.6 CONCEPTUALISING THE AGRICULTURAL LEARNING SYSTEM AS ACTIVITY SYSTEMS: LEARNING AND AGENCY ACROSS THEM

Agricultural learning systems are conceptualised in this study as related activity systems made up of actors inclusive of farmers, agricultural educators, researchers and extension officers who are prepared to learn from each other collaboratively to work on a shared object. Temu, Per Rudebjer and Chakeredza (2010) conceptualised agricultural learning systems as a particular "organization of knowledge and institutional structures" (p. 2179) at agricultural education and training institutions such as universities and colleges that allow for products of higher education to be able to understand and work with complex systems that farmers work in and to advise them accordingly. They critiqued the problem in universities and colleges as "where *reductionist* approaches prevail, leading to production of graduates with *insufficient competence* in the *analysis of complex systems*" (ibid., 2179, emphasis mine). They therefore proposed integrated approaches that are sensitive to the way small-scale farmers work on a day-to-day basis.

In most contemporary conventional agricultural research literature, the combination of activity systems referred to here are called agricultural knowledge and innovation systems (World Bank, 2007). The problem with this terminology as used in the mainstream agricultural literature, is that it most often assumes and advances a normative agricultural knowledge usually derived from research stations and transmitted to farmers via agricultural training institutes, ignoring other knowledges. According to the World Bank (2007, p. 34) agricultural extension students

> … have little opportunity to develop technical competencies, problem-solving experience, or organizational skills... Adhering to the linear model of technological innovation, *the graduates then go out to instruct farmers on what they should do*, with *the risk that the classroom instruction may not be relevant to the specific problems confronted by the farmers*. (p. 34, emphasis mine)

Wallace (1992) argued earlier in the same direction for the need for integrated agricultural learning systems whereby agricultural education needs to be treated as a complex knowledge sub-system, linked to broader rural knowledge and learning systems. He stressed the importance of mutual learning process from interactions at the interface of formal and non-formal sectors and

> … across their boundaries with the wider rural environment in which they operate … through an examination of experiences in five major dimensions of innovation across the interface: university-based extension, outreach from agricultural colleges and institutes, student attachments, distance learning and community schools and colleges. (p. 51)

Through an application of theoretical models on experiences, Wallace (1992) argued that listening and learning institutions can emerge when practitioners in agricultural institutions and farmers interact and consult each other through partnerships formed across boundaries separating the formal with the non-formal. In a later article, Wallace (2007) proposed mechanisms for strengthening the agricultural learning systems approach in Rural Education and Training that included "enhancing interactions between different service providers; creating synergy through mutual learning between educational institutions, local community organisations and rural households" (p. 584). In this argument, Wallace used the term Rural Education and Training instead of, but including, 'Agricultural Education and Training' to denote more inclusive and broader perspectives aiming to "*meet the diversity of learning needs* of all those involved in rural production" (p. 582, emphasis mine).

1.7 WHY BOUNDARY-CROSSING LEARNING IN AGRICULTURAL LEARNING ACTIVITY SYSTEMS?

My curiosity with the link and gaps between agricultural learning systems resonated with the ideas of transformation, formative intervention and transgressive learning embodied in activity systems and their third generation cross-boundary interactions. Agricultural learning systems are theoretically

connected to each other by design, but disconnected from each other in their epistemic actions as discussed later in this section. Figure 1.11 below represents a national agricultural innovation system showing practical and theoretical connections between agricultural learning systems (World Bank, 2007). This is an emerging popular concept used to "study ... how societies generate, exchange, and use knowledge and information" and an apparently improved version building up on the mostly used concept of 'agricultural knowledge and innovation systems' (AKIS).

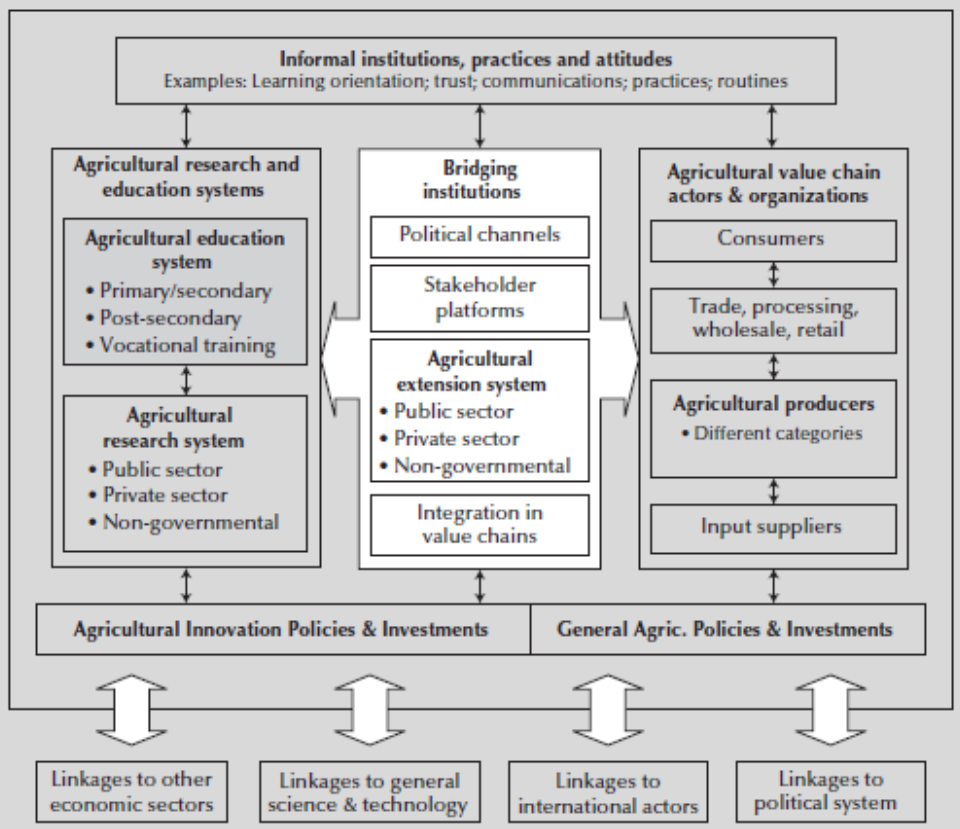


Figure 1.11: *Conceptualisation of a National Agricultural Innovation System (adapted from Birner & Spielman, as cited by World Bank, 2007, p. 2)*

International agricultural research has realised for some time that agricultural learning in colleges and universities falls short of being relevant to farmers' needs. This is partly because of failure of agricultural education and extension to recognise and utilise farmer knowledge (Ceres, 1992; McIntyre, Herren, Wakhungu & Watson, 2009). Hall (1995) contended that

> In some cases, the *extension workers have more to learn from farmers than to teach to them, but unfortunately they're not learning*. *No one is taught at university to listen to farmers*, or attempt to understand their priorities or problems or to explore their potential. (p. 33, emphasis mine)

From the above discussions it can be seen that the key agricultural learning activity systems of concern to the research question are agricultural college and university agriculture lecturers, small-scale

farmers, extension agents (workers, officers or advisors), LED agency facilitators and, to some extent, research personnel from agricultural research stations.

1.8 KEY CONCEPTS CONNECTED TO AND ROOTED IN LEARNING ACROSS BOUNDARIES

Learning and agricultural education are built on the foundation of several concepts; however this section endeavours to discuss only a few selected key concepts necessary to explicate the approach to the study and thesis and to avoid ambiguity. These concepts include primarily boundary-crossing and its associated boundaries, boundary objects and boundary learning in the context of expansive learning, and agricultural learning systems (see sections 1.6 and 1.7). In addition the other concepts worth discussing in this section are activity system, mediation, dialectics, sustainability, culture, value chains, praxis and agency. These concepts rest on the fundamental concepts of learning, development and change that I discuss here. Illeris (2009b, p. 1) admitted that while "the fundamental primary function of learning is one of the most basic abilities and manifestations of human life", learning is a very complex concept that has no generally accepted definition. However, he provided a broad definition of **learning** as "*any process that in living organisms leads to permanent capacity change and which is not solely due to biological maturation or ageing*" (Illeris 2009a, p. 7). My understanding of learning is a process of **transformative change** (see section 3.4.4) leading to informed individual and and collaborative agentive action. Engeström (1987) extended the concept of learning to expansive learning (see section 1.8.2 below) which is connected to the zone of proximal development (see section 3.6.2.3). **Development** in this study is thus linked to learning (see sections 3.2.2 and 3.6.2.4) and is defined under section 3.2.3.

1.8.1 Activity, activity system and mediated action

An activity system is a representation of the relationship between the human mind and what people do (activity) collectively as they attempt to make meaning and to solve challenges they face. Lev Vygotsky and his colleagues in the Russian school of cultural psychology connected human subjects to their objects of activity through mediating artefacts (see below) and tools that help them to make meaning (including but not limited to semiotic tools). Vygotsky (1987) in his attempt to develop psychology through socio-cultural lenses in the revolutionary environment in which he lived in the early part of the 20th Century in Russia, developed a theoretical concept of mediated action in human activity. This concept proposes that mediated action takes place through a semiotic process, rather than relying on Pavlovian stimulus-response factors. Such a socio-cultural mediated process enables the development of human consciousness through interactions with tools, artefacts and other humans in the environment. This gives rise to new human activity as new meanings are developed. Such

interactions are dynamic and in constant flux. Engeström (1987; 2001) in his second and third-generation of cultural-historical activity theory introduced rules, a community and its division of labour interacting with the other elements introduced by Vygotsky to explain mediated activity in context (see Chapter 3).

1.8.2 Expansive learning

Expansive learning has been described as "a historically new type of learning which emerges as practitioners struggle through developmental transformations in their activity systems, moving across collective zones of proximal development" (Engeström, 1987, p. 7). It is achieved by ascending from the abstract to the concrete, through mastering successive cycles as described in detail in Chapter 3.

1.8.3 Boundary-crossing

The *boundary-crossing* concept as it appears early in the literature refers to practitioners at work who endeavour to enter into new unfamiliar territory (Suchman, 1994). Reporting on studies of work relations in technology production and use, Suchman (ibid.) identified a concern among professionals who encounter new knowledge and skills demands in the process of innovation. Like in agricultural learning, practitioners encountering new global change challenges such as climate change who choose to do something about it, frequently find themselves in work spaces they are unqualified to operate in. This is not because of incompetence but because they are breaking new ground which represents a boundary-crossing process.

The first theoretical conceptualisation of boundary-crossing in expansive learning research perceived that the process "entails *stepping into unfamiliar domains*. It is essentially a creative endeavour which requires new conceptual resources. In this sense, boundary-crossing involves *collective concept formation*" (Engeström, Engeström & Kärkkäinen, 1995, p. 333, emphasis mine). They have also regarded it as an endeavour in horizontal expertise requiring movement by practitioners to "seek and give help, to find information and tools wherever they happen to be available" (ibid., p. 332). In so doing, people negotiate, learn collectively and blend contextually different constituents to realise hybridised conditions with the potential to address common issues more holistically. As a spatial process, Suchman (1994) identified boundary-crossing as usually referring to a person's transitions and interactions across different sites.

1.8.3.1 Boundary objects

Object is a key concept in the activity theory tradition (see Chapter 3) as it defines the activity systems and is the focus for expansive learning (see Chapter 3). Boundary objects from an activity theory perspective are defined clearly by Engeström (2001) as "the *potentially shared* or *jointly constructed*

object" (p. 136, emphasis mine) between two or more activity systems. This perspective is applied in this study as it resonates with the activity theory lens used by the study (see Chapters 3, 6 and 7). It should, however, be noted that there is a tension in the literature (Akkerman & Bakker, 2011) with the perspective provided by Star (1989) who considered them as "artifacts doing the crossing by fulfilling a bridging function" (p. 20).

1.8.4 Boundaries and borders

Literature on boundary-crossing in cultural historical activity theory (CHAT) and expansive learning indicates that boundaries can be conceptualised in different but related ways (Daniels, Edwards, Engeström, Gallagher & Ludvigsen, 2010, p. 2; Akkerman & Bakker, 2011). Akkerman and Bakker (2011) perceived a boundary as "a socio-cultural difference leading to discontinuity in action or interaction" (p. 133). What is special about these boundaries for this study is that they carry potential for learning as they "can come to function as resources for development of intersecting identities and practices" (ibid., p. 132). An example would be in the intersection of water practices across small-scale farmers' work and curriculum practice by lecturers in agricultural training institutes. This conceptualisation of boundaries can be further seen as *space*; boundaries as *sites of action* within and across institutions and organisations; and boundaries as *barriers to collaboration*. Mignolo (2010) and Alcoff (2007) described borders in a similar way as discussed below.

The notion of boundaries as *spaces* to be created for negotiation of understandings implies room for joint meaning-making, and perhaps deliberating hidden implications in practice. An example of the latter is dependence on complex agricultural input packages that may contradict farmers' resilience in times of shocks such as when fertilisers synergistically work with water scarcity to suck out soil moisture faster thereby stressing crops. *Sites of action* also provide opportunity for examining the "negotiating of meaning between practitioners from different backgrounds in discussions of past, present and future practices in Developmental Work Research (DWR) sessions" (Daniels et al., 2010, p. 2; see Chapter 3). In this study, these sites of action were agricultural education college curricula and classes, productive rainwater harvesting demonstration sites, and value chains connected to local non-formal seed systems. Barriers to collaboration in these sites of action were examined through contradictions emerging from work on the objects of activity. Caruso, Rogers and Bazerman (2009) analysed boundaries in terms of *barriers to collaboration* that need not be so when efforts are made to deconstruct and collectively reconceptualise the 'intergroup bias [and] group territoriality" (ibid., p. 116). The latter characterise the foundational principles that establish organisations as distinct in the first place. Such barriers may stem from organisational structure or culture (O'Leary & Gerard, 2012).

Walter Mignolo (2000) used the concept of borders and border thinking to describe the epistemological and socio-ecological divide between the subaltern and the coloniser or oppressor in order to transcend it. This perception is important in the application of CHAT work in southern Africa where the concept of the primary contradiction is more of *the struggle between coexistence value and commodification value*[12] rather than the classical contradiction of use value versus exchange value in Marxian capitalist societies (see Chapters 3, 4 and 5). Small-scale farming is part of a bifurcated farming system that saw the creation of a colonial ruling class in southern Africa and a disadvantaged rural farming class forced into corners of the country with poor agro-ecological and economic potential as explained in my introductory story above, and also further in Chapter 2. Mignolo also suggested a way to change the rules of engagement (the 'terms of the conversation'). Mignolo (ibid.) thus described 'border thinking' as "the moments in which the imaginary of the modern world system cracks" (p. 93). This idea of border thinking is used in this thesis to mobilise the border's "epistemic resources" to achieve what Mignolo describes as "epistemic rupture" (ibid.). The structures and agency to achieve this epistemic rupture can emanate from either or both the subalterns and members of the oppressing class who commit 'class treason' by genuinely joining the subalterns in their fight for emancipation. Challenging and critiquing hegemonic structures, however is not an easy task as it can attract resistance, infiltration, economic and social isolation and / or direct attack. The application of these concepts in this study is further explored and discussed in Chapters 4 to 7 and in the synthesis of findings in Chapter 8.

1.8.5 Boundary-crossing learning

Boundary-crossing learning is a concept that works with the idea of learning together between institutions, practices and expertise. Edwards (2011) recognised what she called "relational expertise" in the learning that takes place when professionals from different work settings engage with each other and with other specialist practitioners. In agricultural innovation and education, professionals are constantly crossing boundaries as, for example, extension workers, NGO development workers, agricultural colleges and agri-business agents interface with farmers. Akkerman and Bakker (2011) proposed that learning can be shaped in various ways by movements of people, objects and interactions across boundaries of institutionalised practices. They went on to define boundaries as "socio-cultural

[12] This formulation of the primary contradiction was first proposed by my supervisor (Lotz-Sisitka, 2018, pers. comm.) in her reflections on my draft study, and is currently being more widely discussed in our research group, where we are collectively working out the primary contradictions shaping environmental learning and sustainability challenges in our context and more widely. We are finding that that these are in some cases related to use value and exchange value, but are also fundamentally different in nature and form to the labour and production related primary contradiction of use value and exchange value that Marx presented as the primary contradiction emerging from his analysis of the formation of capitalist society in the 19th and early 20th century (Lotz-Sisitka, 2018, pers. comm.). I found strong resonances with this broader, sustainability oriented framing of the primary contradiction as being between *co-existence value and commodification value* in the data of this study.

differences leading to discontinuity in action or interaction" (ibid., p. 1), caused by differences in norms, power or knowledge.

1.8.6 Dialectics

The concept of modern dialectics is a philosophical method used to explain phenomena and their causes and in the process resolve disagreement through logically identifying tensions, conflicts and contradictions in interactions (Maybee, 2016). Dialectical reasoning is believed to have originated from ancient Greek philosophy (Aristotle), was taken up by Kant, developed by Hegel and then Karl Marx from a critique of Hegelian dialectics, and refined by Roy Bhaskar who recognised the power of absenting of absences via agency and transformative praxis in response to depth inquiry in social-ecological contexts. Kant's conception of the dialectic from Aristotelian reasoning was criticised for creating a series of dichotomous splits such as "between knowledge and thought, knowledge and faith, theory and practical reason, this world and the next" (Bhaskar, 1993, p. 15). Marx's dialectic was based on materialism and the need to transform oppressive relations to ones where people had real freedom to be found in positive community relations and equitable access and use of communal resources (ibid.). Building on the Marxian dialectic, Bhaskar (1993) described dialectic as "essentially involving contradiction, and as a dynamo of conceptual and social change" (p. 175). In his introduction to Bhaskar's (2008a) *Dialectic: The Pulse of Freedom*, Hartwig (2007) explained that the Greek *dialectikē* refers to "the art of conversation or discussion" (p. 14), which is literally translated as "reasoning by splitting into two" (ibid.). In this study, working with CHAT, and a primary contradiction that appears to exist between co-existence value and commodification value in the colonially shaped agricultural learning systems of southern Africa, I used *the dialectic of contradiction* in exploring problems in the learning activity system of agricultural water and seed saving activity, via a process of studying the modelling and implementation of boundary-crossing solutions to these emerging contradictions in the learning activity system of agricultural water and seed saving activity under study (see sections 3.2.2.2 and 3.2.2.7, and Chapters 4 and 5). The dialectical approach in this study is therefore building on a Marxian tradition of working with contradictions in CHAT, but is underlaboured by critical realism's further work on the dialectic, especially the focus on absenting absences, which I also see as important in the decolonising of agriculture, as local people's agency and knowledge was largely exorcised from the modern education and training systems, as will be shown in this study as it unfolds.

1.8.6.1 Absenting absence as a dialectic

Bhaskar (1993) defined dialectic as "absenting absentive agency" (p. 164). This implies that in the process of building transformative agency, there are possibilities for negating undesirable agencies that are present in society and that manifest themselves as absences or lack of desired freedoms. Using

this dialectic, the absence of agency for sustainable agricultural water and seed-saving activity found amongst many small-scale farmers working under rain-fed farming systems may be absented by modelling solutions that address the root causes of such absence. These possibilities, among other ways, can be explored through formative interventionist research approaches. In CHAT, however, contradictions are not expressed as absences but presences of opposing forces. I therefore also viewed such absences in terms of the forces replacing the desired freedoms (see Chapters 4 and 5).

1.8.7 Culture(s)

For the purpose of this study, cultures shall be viewed in the plural as there is no single culture, or conception of it, that can explain practices in agriculture and small-scale farming in different societies and organisations even within a segment of southern Africa. Therefore a historicised conception of culture was used which connects with the cultural-historical activity theoretical lens for context. It is also in sync with UNESCO's global connection between culture and agriculture, looking at human societal changes from hunting and gathering to farming and nomadic life, and from subsistence farming to the pursuit of markets (Leander, 1995). The concept of culture is believed to have developed with the development of humans, and thus lends its origins to the ongoing contestations between evolution and creationism, which modernist and post-modern literature paints as having been won by normative science. The subject of culture of agriculture is discussed in greater detail in Chapter 2 of this study.

1.8.8 Small-scale farming

Small-scale farming in this study refers to subsistence to semi-commercial crop and livestock production and household food growing, that is the nature of production rather than the size of landholding per se although the idea of size and scale of production is useful (Murphy, 2012). It is by no means a simple concept because a smaller-sized farm plot may be a lot more productive and efficient than a larger one, and vice versa, while the demands of the type of farming e.g. large livestock production may also determine land size (see Chapter 2).

1.8.9 Sustainability

This study is centred on exploring learning for sustainable agricultural water and seed saving activity with a focus on water for food, making sustainability a key concept. Sustainability is a value-laden and abstract concept that has been interpreted in various ways by environmentalists, business corporates focused on profit-maximisation, agriculturalists seeking to reduce environmental impact of the sector and civil society in general seeking to create a better socially-just world, among others (Busco, Frigo, Riccaboni & Quattrone, 2014). Sustainability is thus made up basically of economic, social, cultural and environmental components. It has been argued that sustainability is not the same as sustainable

development as the latter became a more pronounced agenda through the United Nations' Agenda 21 from the influence of the corporate sector in collusion with governments (Giovannoni & Fabietti, 2014). Dumanski and Smyth (1994) defined five pillars of agricultural sustainability that attempt to tie together the components of an agricultural learning system with life support systems and socio-economic factors. These pillars are: Enhancement of production (including food security); Viability (including financial and rural wealth creation); Social acceptance (rural and other development); Market demand, decreased risk (of production); and Conservation of natural resources. I thus used sustainability to refer to socially just and inclusive processes of ensuring equitable access, availability, distribution, responsible use and rights to agricultural water and preferred seed for food production, such that the knowledges and cultures around them afford the flourishing of people, the protection of life support systems, stewardship of other life forms and a culture of sufficiency in economic activity.

1.8.10 Agency

The concept of agency, whose roots are in the social sciences, has been applied widely across disciplines including education. In the process, a wide range of definitions and conceptualisations have been used by distinguished researchers but with divergent views (Eteläpelto, Vähäsantanen, Hökkä, & Paloniemi, 2013; Emirbayer & Mische; 1998; Giddens, 1984; Archer, 2003). For the purpose of this study, agency was explored within a socio-cultural approach that recognises the subject and the community's active exercise of internal powers and capabilities. The latter should result in constant historicised intervention and steering of events in the subject's reach as a post-colonial critique and a transformative practice (Mamdani, 2005; Barnes & Prior, 2009). That is agency is exercised by professionals, non-professionals and communities at work when they "exert influence, make choices, and take stances in ways that affect their work and/or their professional identities" (Eteläpelto et al., 2013, p. 62). Emirbayer and Mische (1998) have problematised agency and in the process argued for the reconceptualisation of

> … human agency as a *temporally embedded process of social engagement, informed* by the *past*… but also *oriented toward the future* (as a capacity to imagine alternative possibilities) and *toward the present* (as a capacity to contextualize past habits and future projects within the contingencies of the moment). (p. 963, emphasis mine)

The temporal nature of human agency proposed here fits well with the structure of the expansive learning cycle followed in this study and its agentive assumptions, although it is not explicit on transformative change. Hence Sannino's (2008) idea of transformative agency is useful for the formative interventionist stance that this study takes as it provides for examining generative mechanisms for transformative actions in activities (Virkkunen, 2006; Sannino, 2008; Sannino, Engeström & Lemos, 2016). Sannino (2015a), building on Vygotsky's earlier research, perceived **transformative agency** as a series of volitional actions, being purposeful actions out of one's own

choice or will, that emerge out of conflicts of motives. Section 3.3.1.5 dicusses relational agency in the context of transformative agency, while section 1.8.11 below links it with reciprocity.

1.8.11 Reciprocity

Reciprocity is a special way of relating to each other in a mutually dependent way that calls for two or more parties to exchange material or conceptual things in a way that benefits both. It was an important concept for this study because people looked for beneficiation in investing time in intensely collaborative work and time-consuming expansive learning when they had productive work to do elsewhere. Knowledge (expertise, context), resources (seed, human power, time, workspaces) and opportunities had potential to be exchanged. According to Edwards 2007, reciprocity has some resonance with relational agency "to enhance the collective competence of a community... Where it (relational agency) differs is by focussing more directly on the nature of the relationships that comprise a network of expertise" (p. 4).

1.8.12 Empathy

The Cambridge English Dictionary defines empathy as "the ability to share someone else's feelings or experiences by imagining what it would be like to be in that person's situation" (University of Cambridge, 2017). Empathy is thus an emotional state that is relational between two or more human beings such that one person identifies with the matters of concern of the other. It may or may not be reciprocated. Singer (2007) contended that empathy is a strong motive for contributing to the common good and challenges capitalist development models of greed:

> In contrast to the prominent self-interest hypothesis of classic economics which assumes that all people are exclusively motivated by their self-interest, scholars have pointed out that human beings are also strongly motivated by other-regarding preferences such as the concern for fairness and reciprocity. (p. 21)

Empathy guides people's behaviour in environmental, economic and political domains as well as the personal.

1.8.13 Praxis

According to Dunayevskaya (2009), "praxis has many forms and each and every one is dialectical - develops through contradiction" (p. 15). However in considering these many forms, he warned against a reduction of Marx's concept of praxis to 'practice' as a perversion. In the context of Marx's time where he observed and conceptualised class struggles and political struggles as iterations leading to social revolution, Marx defined praxis as "revolutionary, critical-practical activity" (ibid.). Freire (2005b), who derived his work from Marxist and existentialist thought, defined praxis as "reflection and action upon the world in order *to transform* it" (p. 51, emphasis mine). Kincheloe (cited by Cohen,

Manion and Morrison, 2007) described praxis as "action that is informed by reflection with the aim to emancipate" (p. 28). The context in which Freire uses this term centres around how oppressed people can liberate themselves by identifying the source of their oppression, realising that oppression tames them and developing agency to emerge from it. 'Oppression' whether symbolic or physical, direct or indirect, current or historical or otherwise is a strong reality that meets small-scale farmers at their doorsteps, eating places, cattle pens, pastures, crop fields and market places every day in southern Africa (see Chapter 2). This scenario is due to the conditions of marginalisation and poverty that many of them live in, and the power-relations they encounter in their livelihood activities and in transacting knowledge, values, inputs and products (Burton & Kagan, 2003).

Praxis, as described by Kemmis and Smith (2008), is the process of delivering a public good with a view for social justice in the sense that it calls for moral intentionality in educational actions. This idea of the purpose of praxis is further proposed by UNESCO (2015) as an essential requirement to act towards a common good through reflexive educational processes. "The creation of knowledge, as well as its acquisition, validation and use, are common to all people as part of a *collective societal endeavour*. …beyond the influence of an individualistic… notion of 'public good'" (p. 11, emphasis in original).

In this study, the concept of praxis is used to refer to a particular kind of action that is purposive, qualitative, morally-committed, critical and collective as "it emanates from people …when they think about what their action will mean in the world" (Kemmis & Smith, 2008, p. 4). In describing the quality of praxis, Carr and Kemmis (1986) contended that it is

> Not simply action based on reflection. It is action which embodies … a commitment to human well-being and the search for truth, and respect for others. It is the action of people who are free, who are able to act for themselves. Moreover, *praxis* is always risky. It requires that a person "makes a wise and prudent practical judgement about how to act in *this* situation". (p. 190, emphasis in original)

This study has an interest in praxis because it has implications for how farmers, extension workers, agri-business promoters and agricultural educators make meaning and sense together out of what they do jointly for the common good. Farmers are engaged in praxis when they select, store and exchange seed, or decide to buy seed; when they ensure fertility of their soil in ways that are reflexive; and when they combine nutrition with farming. When the season shifts, the farmer must reflect on the timing of planting with respect to soil moisture content, and therefore plan to have the draught power (if needed) in time and in good order. In minimum or no-tillage systems, this may mean planning to restore moisture conservation works. Endeavouring to have and maintain cattle as part of crop-livestock integration in mixed farming systems is a mechanism for improving local livelihoods. Wolmer and

Scoones (2000) lamented the lack of a serious reflection space they find in what they term pipeline approaches to transfer of technology from researchers to farmers via the Training and Visit approach of extension services, where "the opportunities for reflection, learning and challenging of assumptions remains limited…" (p. 166).

The question of transformation in praxis is portrayed as an act of agentive power informed by knowledge and fuelled by confidence and emotion (Vygotsky, 1926/1997, Freire, 2005b). Building on Freire's idea of praxis, Breunig (2005) observed that because we have no absolute knowledge and we can only endeavour to know more,

> Praxis therefore starts with an abstract idea (theory) or an experience, and incorporates reflection upon that idea or experience and then translates it into purposeful action. Praxis is reflective, active, creative, contextual, purposeful and socially constructed. (p. 111)

Bawden (1996) added values and ethics to his idea of praxis, perceiving it as "the art and craft of being a practitioner who is consciously informed by theories, values and beliefs" (p. 1). To be consciously informed requires an element of reflexivity, which is discussed below.

1.8.14 Reflexivity

Reflexive deliberation is a purposive act that views agents including researchers as active rather than passive subjects in analysing social phenomena. Charmaz (2006) defined reflexivity as

> … the *researcher's scrutiny of his or her research experience, decisions and interpretations* in ways that bring the researcher into the process and allow the reader to *assess* how and to what extent the researcher's interests, positions and assumptions influenced inquiry. A reflexive stance *informs* how the researcher conducts his or her research, relates to the research participants, and *represents them* in written reports. (pp. 188-189, emphasis mine)

In this study reflexivity is a key ethical issue because of the formative interventionist design of this study which requires multi-voicedness as a factor of boundary-crossing learning and its fair treatment and representation. The application of reflexivity begins in this chapter, takes off in Chapter 2 and becomes an integrated way of working throughout the study. I saw reflexivity as an affirmation of my judgements as fallible, coming to terms with a limited trust in self while nonetheless having confidence to uphold my developing conscience.

1.9 OUTLINE OF THE THESIS

This study is organised around eight chapters which are summarised below.

Chapter One: Learning across boundaries

As discussed above, Chapter 1 provides a background and introduction to the thesis by first narrating my own personal orientating experiences, context and research concern. The chapter then presents the research objectives and question. To orientate the reader, the chapter conceptualises agricultural learning systems as activity systems and problematises agricultural learning and agency as collaborative endeavours rather than as individual effort. This opens a way for utilising the concept of boundary-crossing learning as a possible framework to examine co-engaged learning. This discussion is followed by a description of the research sites in South Africa and Zimbabwe. It then outlines the concepts used in the study and how they were applied, such as boundary-crossing learning, agency and reciprocity, among others.

Chapter Two: Cultural history and contexts of agricultural learning systems

In Chapter 2 the culture of agriculture in southern Africa is reviewed, starting with a foregrounding of cultures of agricultural practice and learning from a historical perspective and focussing on Africa and southern Africa. This is followed by a discussion of agricultural policies as key drivers of agri-cultures. This leads to a discussion of the culture of praxis, that is what agricultural education and training institutions, extension services and smallholder farmers do in the light of policy, science, indigenous knowledge, innovation and local contextual influences. The discussion highlights the impacts of changing technology, economic, social and environmental landscapes on the culture of agricultural praxis, and then the slow and contested move towards sustainability in agricultural learning systems. This sets the base for reviewing the emergence of sustainability practices in agricultural learning systems with a focus on rainwater harvesting and locally-adaptive seed systems. The discussion then identifies in the literature the need to engage with learning across institutions and organisations and its conceptualisation as boundary-crossing.

Chapter Three: Generative theory and methodology for boundary-crossing expansive learning research

Chapter 3 discusses how I used cultural-historical activity theory as the lens for describing agricultural learning systems described in Chapter 2, its related methodology of developmental work research and critical realist philosophy as under-labourer. CHAT is described from its historical roots in Soviet cultural psychology from the Vygotskian tradition to post-Vygotskian approaches that were developed by other scholars in socio-cultural approaches and elaborated by Yrjö Engeström through to the second, third and into the emerging fourth generation of CHAT. The third generation of CHAT was useful in this study to describe interacting activity systems and this lens was augmented by the boundary-crossing learning as a theorised tool for understanding collaborative expansive learning in learning network contexts. The heuristic of double stimulation was also discussed as having potential to explore uncertainty and agency in mediated learning contexts, according to Vygotsky's

understanding of capabilities inherent in human beings to intentionally shape and transform their actions. The contradictions generated from CHAT framing were explained using concepts from critical realism such as absences where the dialectic of absenting absences became a heuristic and explanatory tool for expansive learning and transformative agency. Critical realism was further employed as an explanatory tool for explaining learning and agency resulting from boundary-crossing.

Chapter Four: Descriptions of key related activity systems and emerging contradictions from the South African nested case study

The agricultural learning systems discussed in Chapter 2 were contextualised for the South African case study in Chapter 4. Four key activity systems emerged that were interacting with each other in third generation agricultural water and seed saving activity formation, namely smallholder farming, agricultural education, extension and LED agency. The smallholder farming' activity system was made the reference point as the study was interested in this cultural practice and its water for food object which emerged as the main activity focus in this case study. However because the aspirations and changes desired by research participants were relational in that the object was influenced by knowledge flows from other activity systems, a boundary-crossing learning approach was adopted. The latter was designed to understand quaternary contradictions emerging and historically developed between these activity systems. The formative intervention processes and expansive learning processes and results from these activity systems in the South African case context are discussed in Chapter 6.

Chapter Five: Descriptions of key related activity systems and emerging contradictions from the Zimbabwean nested case study

Chapter 5 performs a similar function to Chapter 4 except that it focusses on the Zimbabwean case study. The four key interacting activity systems studied in the Zimbabwean case study were small-scale farming, agricultural education, small-scale farmer innovation and extension. While the small-scale farming activity system was also the reference point, a closely related small-scale farmer innovation activity system involved in successful rainwater harvesting appeared to hold a germ cell that could respond to the former's aspirations. The potential for mediation of this germ cell was found lying within the other two activity systems, hence historical contradictions between the objects of these four activity systems were described. The formative intervention process for the Zimbabwean case is discussed in Chapter 7.

Chapter Six: Boundary-crossing expansive learning in the South African case study

Processes and results of formative intervention in the South African case study are presented and discussed focussing on boundary-crossing in a learning network context across the multiple interacting activity systems identified in Chapter 4. The learning network formed by the participants provided

them with a new platform for new ways of interacting regularly rallying around a joint boundary object of sustainable agricultural water. The initial normative $power_2$[13] relations (Bhaskar, 2008a, Hartwig, 2007), evident between agricultural educators and extension officers on one hand and smallholder farmers on the other, are gradually challenged and reframed as smallholder farmers' voices are heard more. The farmers' voices were enabled by careful facilitation of boundary-crossing laboratories where mirror data of contradictions in work stimulated reflexive deliberation. A training of trainers' course activated the learning network by providing a series of second stimuli leading to generation of new solution models. Agricultural college lecturers quickly came to the realisation of the profound deficiencies in their curricula regarding their relevance to the lived circumstances of farmers they intended to serve. Empathy emerges as a key generative mechanism as agricultural educators battle with ethical deliberation and begin to innovate their curricula, while at the same time farmers respectfully demand better service from colleges on mutually agreeable terms. Transformative $power_1$ relations emerge this way. More reciprocal relational agency generally develops, supported by a WhatsApp group, community radio agricultural programmes and productive demonstration plots. The generative capacity of expansive learning is witnessed on many dimensions as a new cooperative emerges with youths under an experienced mentor, an agricultural college sustains student practical learning at farmers' plots and the learning network prevails with little or no external support.

Chapter Seven: Boundary-crossing expansive learning in the Zimbabwean case study

Like Chapter 6, Chapter 7 presents and discusses the processes and results of formative intervention in the Zimbabwean case study also focussing on boundary-crossing in a learning network context. The learning network formed by the participants provided a forum from very keen agricultural college lecturers and extension officers to learn from smallholder farmer innovators excelling in rainwater harvesting. At the same time, it provided a platform for examining the problem of marketing ecologically-promoted but poorly marketed produce such as small grains and organic vegetables. Local marketing structures at ward and district levels and a local mine were engaged resulting in remarkably improved sales of millets. An immanent critique by college principals and lecturers of their diploma curriculum through curriculum reviews, boundary-crossing laboratories and expert-led workshops in principals' forums resulted in innovations in the agricultural college system. The agricultural education department and colleges started opening up to rainwater harvesting demonstration sites, small grain production trails and dietary shifts for boarding students reflecting these previously neglected grains, thus also providing a market for agro-ecological farmers' excess produce. Mutually beneficial and reciprocating $power_1$ relations have been generated between actors, but need further support to complete the boundary-crossing expansive learning cycle.

[13] $Power_2$ is used by Bhaskar (2008a) to describe the way in which powers external to the agent may impact on the agent. $Power_1$ refers to the inherent powers of the agent to act.

Chapter Eight: Synthesis: Strengthening possibilities for boundary-crossing expansive learning via learning networks and associated mediational processes

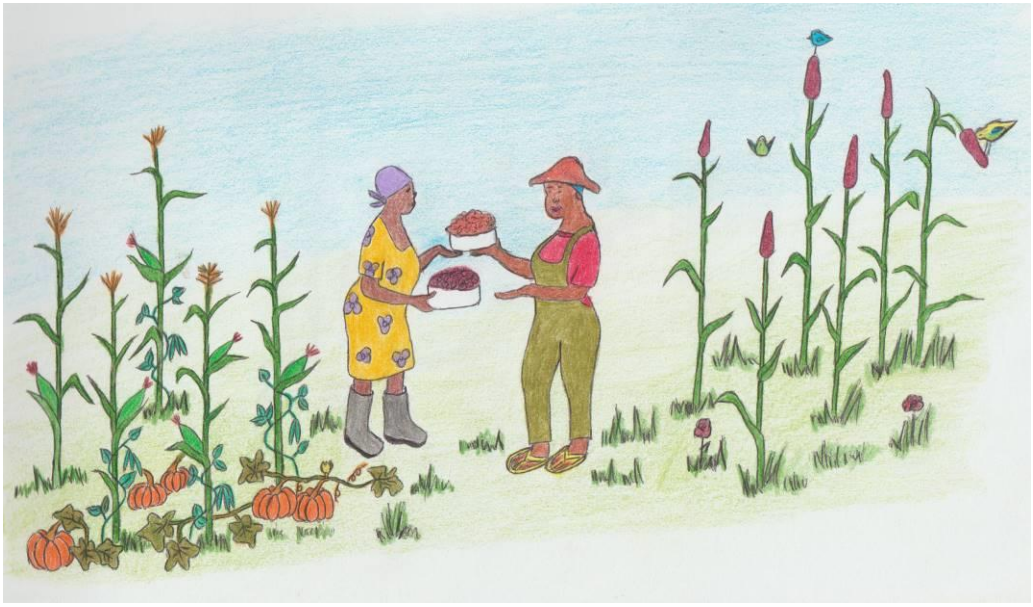
Chapter 8 provides a synthesis of this study. The study found that diverse combinations of mediational processes including change practice courses, change laboratories, curriculum development and review workshops, leaders actions, productive demonstration sites and media engagements strengthened the possibility for boundary-crossing expansive learning. This took place in the context of learning networks across activity systems of agricultural college lecturers, smallholder farmers, extension workers and local economic development agency facilitators. Generative mechanisms for boundary-crossing included empathy, reciprocal and relational agency, and individual leadership and effort among farmers, agricultural college lecturers and senior decision makers. The study concludes that learning networks are an enabling mechanism for boundary-crossing expansive learning across activity systems and that diverse mediational processes enrich the possibilities for such boundary-crossing learning.

1.10 CONCLUSION

This chapter began with a personal and historical justification of the study, pointing to my interest in sustainability and boundary-crossing learning in leading transformation. The chapter proceeded to introduce the contours of the thesis, and to provide insight into the two case study sites, which are described as nested cases of interacting activity systems linked by common interest in the main focus of this study, namely expanding learning around agricultural water and seed saving activity systems for sustainability and social justice. The chapter introduced the research questions, as well as the key concepts that will be used in this study. The concept of boundary-crossing learning and associated concepts in the context of interacting agricultural learning systems conceptualised as activity systems were presented to ground the study. The chapter also briefly overviews the study's construction and positions me as researcher in an emerging formative interventionist research process where I was co-engaged with farmers and interacting activity system partners to expand their object, a process which developed against the cultures of agriculture as found in southern Africa. Chapter 2 which follows takes the focus on boundary-crossing learning further into a socio-cultural and temporal framework by tracing the cultural history and contexts of agricultural learning systems, with emphasis on southern Africa.

CHAPTER 2
CULTURES OF AGRICULTURE, WATER AND AGRICULTURAL LEARNING SYSTEMS IN SOUTHERN AFRICA

Okonkwo: "I have come for your help. I have cleared a farm but have no yams to sow… If you give me some yam seed I shall not fail you."
Nwakibie: "It pleases me to see a young man like you these days when our youth has gone so soft… I shall give you twice four hundred yams." (Achebe, 1959, p. 6)



2.1 INTRODUCTION

This chapter reviews the histories, contexts and policies underlying the cultures of agricultural learning systems with a focus on water and seed systems, giving a brief global overview but with a focus on Africa and specifically southern Africa. As introduced in Chapter 1, a culture of agriculture is characterised by the principles, ethos, values and philosophy underpinning agricultural practices among a defined community. With the diversity and mixing of humans across space and time, it is perhaps more appropriate to speak of cultures of agriculture. At the same time, it important to recognise and challenge the globalising normalisation of agricultural learning systems and the boundaries thus created between centralised industrial and independent traditional agri-cultures (McIntyre et al., 2009). The one size fits all agricultural system blurs diversity through the lens of a single market economy system with few benefitting players and the fallacy of adequate input subsidies to smallholder farmers (African Centre for Biodiversity, 2016a). These boundaries have value-laden cultural, conceptual and

symbolic boundary objects (e.g. water, seed and relations) that have a strong bearing on sustainable livelihoods (De Schutter, 2010). They determine what students and farmers are taught in modern formal institutions such as agricultural colleges, agricultural faculties and rural development centres (World Bank, 2007; McIntyre et al., 2009; Chittoor & Mishra, 2012). This review therefore analyses the historical trends and cultural contours in agricultural learning practices, and policies and their influence on the cultures of agriculture and collective learning in southern Africa.

2.2 HISTORY OF AGRI-CULTURE IN AFRICA AND SOUTHERN AFRICA

This review of agri-cultural learning systems in Africa deliberately starts with a historicised socio-cultural context because it illustrates how small-scale farming and water practices have shaped people's livelihoods, sustainability values and land management. It also provides opportunities and pointers for connecting with other agricultural learning systems in globalised post-colonial contexts seeking to enhance learning for social and cognitive justice (Kramer, 1998; Kariuki, 2011). According to the World Bank (2007), agriculture has been practised in sub-Saharan Africa for many ages cutting across important changing times where it has

> … provided a shared basis for community interaction and inspired both culture and religion … indigenous knowledge of agriculture in Africa has a long, rich, and proven tradition that extensively predates the colonial era. (p. 13)

However, in line with the spirit of mobilising multiple knowledges for improved sustainability praxis in agricultural education, a wider and global historical and cultural context of agriculture is important to consider in this discussion.

2.2.1 A history of smallholder family-based and communal farming and water in Africa with a focus on southern Africa

This section reviews the cultural history of agriculture and water in Africa and southern Africa focussing on the cultural practices in smallholder cropping and mixed farming systems (Bennet, 2010). Agriculture in Africa is said to have begun in a place that hardly promotes farming today, the arid Sahara desert some 2000-5000 years BC when the area still enjoyed seasonal flooding, as a result of influences from southern Mesopotamia where the practice originated (von Soden, 1996). African farming and food security had various episodes of prosperity in terms of livelihoods and economic development in the past 1 500 years that is often overlooked by historians (Jörg, 2016). Historians trace the domestication of several native food crop species, especially pearl millet, sorghum and cow peas to this area with gradual movements to West Africa and southern Africa (Vavilov, 1992). Mali, for example, has documented evidence of the growing of different varieties of pearl millet, sorghum and rice based on the flooding and recession of such rivers as the Niger and Senegal (Harlan &

Pasquereau, 1969). “Crops, varieties and cultural practices are sensitively adjusted to variations in the height of the flood, soil texture… nutritional needs and food preferences” (ibid., 70). This shows that water for food production was dependent on the natural climate and hydrology and cultures of agriculture were determined by agro-ecological and social needs. This continues to hold true for smallholder farming today. The first African farmers who moved to southern Africa are believed to be Bantu-speakers whose farming practices became, to some extent, integrated with those of the pastoral Khoikhoi already in the area (Elphick, 1979).

Smallholder farming in sub-Saharan Africa is a complex practice operating in tight and changing socio-ecological and economic spaces not without risk, in many ways different from large-scale commercial farming such as the seed systems and water sources. The conversations between the fictional characters Okonkwo and Nwakibie in Chinua Achebe’s (1959) *Things Fall Apart* illustrate ambivalent spaces showing hope and trust, people challenging uncertainty and risk to work together for their common good in farming under rain-fed systems.

> *Okonkwo:* “I know what it is to ask a man to trust another with his yams, especially these days when young men are afraid of hard work. I am not afraid of work.” …
> *Nwakibie:* “Go ahead and prepare your farm.” (Achebe, 1959, p. 6)

This conversation raises at least three issues about the culture of agricultural practice in rural African societies. Firstly, seed saving, sourcing and farm planning are cultural practices that have been developed across several generations of farming families and communities (Koo et al., 2005). The farm must be prepared in the right season usually using distributed local resources. The necessary equipment may belong to the family or be borrowed, the labour likewise or bought. Secondly, transactions, promises and agreements are not necessarily written down, which not only shows assumed respect and trust between people and in the performance of seed but may also raise red flags of risk and potential conflict. The latter may be based on a consideration of the shifts in the cultures of social justice, conflict resolution, seed efficacy and the evident generation gap. The question perhaps is: should such shifts undermine traditional ways and knowledges that are accepted by societal norms and values or should there be a hybrid space of indigenous knowledge blending with the modern, as suggested by Altieri, Funes-Monzote and Petersen (2011). Thirdly, this extract of the conversation assumes water availability and access. In fact, when the whole story is considered, it is clear that there is a dependence on rainwater, a trust that the rain will fall, the crop will flourish, and the borrowed shall be returned. In this particular season in Achebe’s novel, the rain fails the crops and the people, and drought strikes wickedly. In the same season, drought was succeeded by a torrential wickedness of unceasing rain and no sunshine leading to a second crop loss after farmers replanted in the hope of seeing rain. This scene in Achebe’s (1959) story illustrates how climate variability and change threaten traditional rain-fed small-scale farming systems in sub-Saharan Africa. This cycle of drought has

become ever more frequent, familiar and unpredictable with climate change set to impact sub-Saharan Africa most (International Panel on Climate Change [IPCC], 2014). This trend was predicted over 20 years earlier by southern African technocrats at their very first regional climate change conference (SADC, 1992a). The same conference reported an increase in the range of regional climate variability. Makarau (1992) linked climate variability to economic development and recommended improved early warning systems and contingency planning for agriculture to be carried out through "*crop life saving techniques (water harvesting and moisture stress alleviating practices) [and] alternate cropping strategy*" (p. 112, emphasis in original). The impact of rainfall scarcity and unevenness on rural African farmers was graphically illustrated by Achebe (1959) when he observed that "nothing happened at its proper time - it was either too early or too late. … That year the harvest was sad, like a funeral" (p. 17).

The majority of people in southern Africa rely on mainly rain-fed agriculture, in particular smallholder farming for their livelihoods (Food & Agriculture Organisaton [FAO], 2002; Altieri, 2009; SADC, 2013a). Such farming, unlike industrialised, commodified farming, depends more on human labour, diverse crop-animal systems, locally-based inputs, solidarity among farmers and neighbours, seed exchange and direct rainfall. It has a long-term co-existence legacy backed by farm experimentation in seed, rainwater or other locally sourced water and farming systems. Unfortunately this legacy is being challenged by several factors that result in episodes of hunger, and these – according to the World Economic Forum on Africa – include climate change, technology and education, financing and policy and infrastructure (Patel, 2016). The solutions that Patel proposed are government-driven, assume that farmers do not have the ability to adapt to climate change and lack knowledge, and are oriented towards commodification values. They propose higher fertiliser use, land ownership, departure from traditional staples especially maize to cash crops and use of improved seeds including GM crops (ibid.) which rely on commodified intellectual property of seed companies. These proposals are ambivalent and typical of most conventional economics arguments for transforming smallholder farming (African Centre for Biosafety, 2014a). Land tenure is indeed an aspiration by agro-ecological farmers who shun inorganic chemical fertilisers (ibid.), but maintain values of co-existence as the foundation for their enterprises. Chemical fertilisers are derived from fossil fuels whose extraction and use is linked to anthropogenic climate change.

Climate smart agriculture has emerged as another global solution proposed for sustainable agriculture especially for smallholder farmers. It has been advanced by the World Bank, FAO and other world bodies for its prospects for climate change adaptation and mitigation, sustainable agricultural production and increased productivity (World Bank, 2010a). Arslan (2014) emphasised the building of resilience as a climate proof approach to food security. The 'climate smart agriculture' discourse

has, however, been heavily criticised for being too abstract in the realisation of these goals resulting in the commercialised high-input models with their own climate change problems as dominant drivers of agricultural production at the expense of social justice (Taylor, 2017; Karlsson, Nightingale, Naess & Thompson, 2017). Climate smart agriculture has also been identified to both overlap with and contradict agroecology making it less socially just than the latter (Pimbert, 2015). Taylor (2017) proposed a more encompassing 'climate-wise' vision that supplants concerns of the food sovereignty movement into the 'climate-smart' rubric as a trade-off.

2.2.2 A brief history of agriculture and water for food in the South African case

The agricultural history of South Africa is characterised by traditional farming and water conservation systems that were disrupted by displacement and dispossession of people from the land under colonial occupation and apartheid policies (see sections 2.3.2.1, 2.3.2.2 and 2.3.2.3). The earliest history of agriculture recorded in South Africa is that of the Khoisan people (Khoikhoi and San) who were pastoralists and hunter-gatherers respectively, having lived in the area since a number of millennia BC (Thompson, 2001). The Bantu arrived south of the Limpopo River from northern and central Africa by the second century AD, bringing with them crop farming cultures that were integrated with the pastoralists' cultures as the latter were absorbed or driven away. They practised mixed farming that included arable farming (crops), livestock (cattle, sheep, goat) rearing and traditional hunting. They also kept poultry. They used various farming tools such as iron hoes (where metal was available) with long wooden handles or sharp sticks and wooden spades to till the land (Raum, 1997; Thompson, 2001). Various tribes settled in different parts of the land south of the Limpopo who included the Zulu and the Xhosa (the dominant Bantu and most populous tribes in the land; both of Nguni descent), the Tswana, BaSotho, Venda, BaPedi, Swazi and Ndebele, among others. The rise of the Zulu kingdom wars (Mfecane) with other tribes resulted in scattering, mixing and settlement of various tribes in different parts of the territory now called South Africa. The Xhosa people eventually settled in the south of the land and today are more concentrated in the Eastern Cape Province, while the Zulu people stayed further north and are concentrated mostly in present KwaZulu-Natal province. The interest for this study is with the Xhosa people, a heterogeneous group, so the rest of the discussion will follow their agri-cultural history.

2.2.2.1 Pre-colonial agricultural history

The pre-colonial history of South Africa documents gendered division of labour in agriculture. Cattle rearing, grazing and milking was the major Xhosa male occupation in early Xhosa history. Cattle was the sole responsibility of the father of the family with help from sons and they employed a system of grazing (Thompson, 2001):

> Cattle were moved from one type of pasturage to another during the year. In the summer, the Xhosa grazed their cattle in what is now known as *sourveld-grasses* that are nutritious in their early stages of growth but then lose their protein and mineral content and become unpalatable and indigestible to animals; and in the autumn they moved them to *sweetveld,* which remains nutritious through the year. (p. 18)

Crop farming, including land preparation, among the Xhosa was mostly practised by women (Hebinck & Lent, 2007), with every married woman cultivating a minimum of one crop field. The farmers practised fallow culture whereby the field would be given rest for a few years after several years of cultivation, which is a type of swidden agriculture (shifting cultivation) that restored soil fertility (Austen, 1987; Hebinck & Lent, 2007). They did not apply cattle manure probably because of the sacredness placed on cattle, but applied organic mulch from uprooted weeds (Hebinck & Lent, 2007). "The uprooted weeds were left as a mulch to protect the emerging crops against desiccation and birds, and this was removed when the crop was ready for weeding" (Stuart, Malcolm, & Brown cited in Hebinck & Lent, 2007, p. 39). The crops the Xhosa grew included sorghum, millets of several varieties, pumpkins, watermelons, and calabashes, and a type of tobacco; in some places they produced beans and yams (Thompson, 1991, p. 19). The farmers relied on rainfall for watering their crops. With the development of tillage the Xhosa also developed soil conservation methods that also conserved moisture such as *gelesha* which will be described in more detail in section 2.4 as praxis.

2.2.2.2 Colonial impact on the culture of agriculture in South Africa

The colonial occupation of South Africa and the Cape region in particular had unprecedented effects on the culture of farming and water among the Xhosa people as a result of wars, apartheid policies, dispossession, displacement and migration (Mostert, 1992). The Natives Land Act of 1913 passed by the Union Parliament of South Africa deprived most South Africans especially Blacks of the right to own land and left the Blacks with less than 10% of the Union's total land. It was the first major piece of segregative legislation. The Act forced many Black people into wage labour in the White areas, while locally it strengthened the chiefs as the custodians of communal land (Modise & Mtshiselwa, 2013). Chiefs who were originally custodians of the land, became an extension of the colonial state, and according to Mamdani (1996) were held in place (often artificially) by colonial governments in subservient positions to produce a powerfully bifurcated colonial power and governance structure that mediated racial domination and subjugation, with continuities into the present. An example is the way that small-scale farming among the Xhosa in the former Ciskei 'homeland' during apartheid took place mostly under betterment policy engineered by the apartheid state (McAllister, 1991) on lands held by Xhosa Chiefs. In the betterment villages which restricted black farmers to certain land areas in the 'homelands' (which were effectively Native Settlements for Blacks on marginal lands), farmers could farm crops in fenced areas and rear livestock in separate fenced areas. Household food production was

encouraged. However farming was constrained due to less land available resulting in serious land degradation. Land degradation has continued after democracy in 1994. Hebinck and Van Averbeke (2007), among others, reported an overall deterioration in agricultural production in South Africa's former homelands including the former Ciskei where this study is located. An in-depth discussion of the colonial and contemporary policy landscape in South Africa and its impact on the culture of agriculture, water and agricultural learning systems is found in section 2.3.2.

2.2.2.3 Impact of climate variability and change on the culture of small-scale agriculture in South Africa

South Africa has experienced a history of frequent drought events with the culmination of the worst drought event in 35 years during the 2015/2016 season (during this study) that Oxfam South Africa described as a 'harvest of dysfunction' due to the non-climatic human factors involved (Hornby, Vanderhaeghen, Versfeld, & Ngubane, 2016). South Africa is a water scarce country with diverse and uneven distribution of rainfall across its vast territory as reflected in the South African Water Act and National Water Response Strategy (South Africa, 1998, Section 27(1)[b]; South Africa. Department of Water & Sanitation [DWS], 2013). Due to its vast territorial size, South Africa has a vast range of climates but is dominated by semi-arid conditions. Drought conditions in South Africa have increased in frequency and intensity historically and are expected to increase in the next century impacting heavily on the agricultural sector (Rouault & Richard, 2003). El Chami and El Moujabber (2016) therefore raised a concern that the National Water Resource Strategy 2, the Department of Water Affairs' strategic framework for the period 2012 -2032, lacks a framework to specifically address agriculture, the biggest user of water in the country.

2.2.3 A brief history of agriculture and water for food in Zimbabwe

A history of agriculture and water for food in Zimbabwe is inevitably an inquiry of migration, settlements, colonial occupation, dispossession, struggle, independence, extended struggle and re-historiography. It is therefore a contested history but without it, current agricultural and water knowledge practices and their mediation become dislocated as cultural activities. As far back as 200 BC history documents that the country was firstly home to the San (so-called Bushmen) who were Stone Age hunter-gatherers, and were later replaced by the Bantu – ancestors of present-day ChiShona-speaking people (Mlambo, 2014). Another group of Bantu people of Nguni lineage settled in present day south-western Zimbabwe (Matebeleland region) through incursions in the early nineteenth century from South Africa which introduced the Ndebele. The isiNdebele-speaking people are a heterogeneous group of mainly Nguni people incorporating the BaSotho-BaTswana, Kalanga and local VaRozvi peoples through northward migratory conquest and intermarriage.

The pre-colonial period in Zimbabwe was characterised by a succession of empires which practised hunting and gathering, with people eventually settling into sedentary farming communities. Evidence of early farming systems exists in various places such as Ziwa National Monument and Site Museum in Nyanga in North Eastern Zimbabwe where it is most vivid (Zimbabwe. National Museums and Monuments of Zimbabwe, 1995). During this period, various indigenous ways and types of crop and livestock farming are identifiable, which were by no means uniform, varying according to place, soil types, rainfall, among others. Early crop farming was characterised by small grain staples particularly rapoko and sorghum, pulses such as Bambara groundnuts (Latin *Vignia subterrania*; *nyimo* in ChiShona) and cow peas (*nyemba* in ChiShona), traditional leafy vegetables and cucurbits (e.g. pumpkins) usually mixed in the same plots except for special agro-ecological requirements such as wetlands (Bourdillon, 1982; Beach, 1983; Palmer, 1977; Mazikana, Douglas & Johnstone, 1984). The food from these crops was prepared and used in a variety of ways, including revival of the gravely sick using finger millet porridge, and brewing of beer for ceremonies and making of non-alcoholic beverages for collaborative work. It is noteworthy that these small grains and pulses use less water compared to other crops, and pulses have been shown to help reduce greenhouse gases and increase carbon sequestration (FAO, 2016a). Some open-pollinated varieties (OPVs) of maize were also grown having been introduced by the Portuguese around the sixteenth century AD from South America (Wills, 1985). They included multi-coloured varieties and the famous large grained Hickory King variety popularly known as ‘eight lines’. Cattle were a symbol of wealth and status and still play a role in traditional ceremonies, marriage and mixed farming systems today. Shifting cultivation allowed the soil to rest and recover but was less employed as populations increased and with the advent of colonial control (Manzungu & Machiridza, 2005). Johnson as cited by Pollak (1975) reported that African farmers had learnt to cope with climate and had “fairly well adjusted ... [to their] harsh and uncertain environment” (p. 263) before permanent White settlement.

Agricultural systems changed remarkably with the arrival of the Pioneer column in 1890, and concomitant wars of resistance and subsequent settlement of the colonists in Matebeleland. British law facilitated the occupation of present-day Zimbabwe through the Lippert Concession of 1889 which granted land rights to would-be settlers. The period of colonial occupation saw the establishment and consolidation of Cecil Rhodes’s British South Africa Company (BSAC) – de facto agents of the British Crown, through purchase of concessions from the latter that were used as a foundation for expropriating land. This new authority with policing powers over Matabeleland (and later Mashonaland, thanks to the notorious Rudd concession) replaced the traditional authority of the Kings and Chiefs over land, people, cattle, water and other natural resources in 1888 (Mlambo, 2014). The Ndebele people rebelled against the BSAC in 1893 and 1896 (Umvukela 1 and 2 Wars) in response to their losses but were defeated. This was soon followed by the Shona rebellion (Chimurenga I War) in

1896-1897 which was also crushed (Ranger, 1967; Mlambo, 2014). The BSAC which started administering the country as a British colony had a clear mission to expropriate land for mining concessions. With no agricultural interest at the time, the settlers relied on the indigenous farmers for food and agricultural produce (Herbst, 1990; Zimbabwe Congress of Trade Unions [ZCTU], 1996). Revenue accrued from the expropriated land was repatriated to the United Kingdom. The new settlers' hope of mining what they believed to be vast gold resources quickly turned to disillusionment, leading to a re-evaluation of their economic options and to the development of white settler agriculture (Pollak, 1975; Zvobgo, 2009; Mlambo, 2014). Agricultural development meant appropriation of land and to maximise productivity the settler government selected the best land including occupied land, and moved the local farmers to largely marginal areas. This was accomplished through a British legal process called an Order in Council in 1898 that haphazardly created the notorious Native Reserves (later called Tribal Trust Lands and subsequently the present-day Communal areas) for Blacks only in areas deemed not suitable for White settler occupation (Mlambo, 2014). According to Manzungu and Machiridza (2005), the land in these reserves "was generally of inferior agricultural quality in terms of inherent fertility and moisture availability" (p. 2). A contradiction here is that what was deemed legal for the British monarch was illegal for the local traditional governance systems.

The British government established the government of Southern Rhodesia as a self-governing British colony on 1 October 1923. The Southern Rhodesia government enacted the Land Apportionment Act of 1930 that made the division of land along racial lines legal, resulting in more than half the land falling into White hands early in the life of the new colony, who had unrestricted rights among myriad other policies (see section 2.2.3). Black people had no land ownership but had the right to use the land according to the directions given by the colonial settler government. Further, women were disenfranchised with virtually little or no land rights. Between 1953 and 1963, Southern Rhodesia was a member of the semi-independent Federation of Rhodesia and Nyasaland till its dissolution. The Federation government had begun to bow down to demands for more land by black farmers and nationalists, which created divisions in the white community and resulted in radical political action. The colonial government lasted till the infamous Unilateral Declaration of Independence in November 1965 by the sitting Rhodesian Front government which created the unrecognised state of Rhodesia (1965 to 1979) in an effort to delay transition to Black majority rule. The conservative Rhodesian Front Government reversed some of the concessions that had been made by the Federation government to black farming. These unfortunate interactions and circumstances sowed seeds for further mistrust and future conflict.

Maize was one of the main crops initially grown and promoted by the settlers for food which increased its market demand. The market forces around maize were translated by the colonists into a political

and counter-cultural food tool which resulted in maize rapidly replacing traditional grain crops not only for food but also to enable the local population to produce bulk for sale so as to pay colonial taxes (Mudenge, 1988; Zeleza, 1993). Plant breeding in research stations provided a few hybrids of white maize that slowly dominated the maize market and landscape and overshadowed maize diversity and seed systems including locally-adapted seed systems largely replanting them with varieties found in seed outlets (see sub-section 2.4.3.2). The success of maize is seen not only in its large-scale production and use as the staple of choice (from only the early 20th Century) by indigenous Africans, but also by the introduction of the Maize Control Act of 1931 designed to control differential pricing (i.e. less payment to indigenous Africans compared to colonists) (Ndlela & Robinson, 2007; Keyter, 1978). Lower payments did not deter the colonised Africans from maize production. The introduction and politics of maize can also be seen as contributing to the current problems of food security, social cohesion and collaborative work among Zimbabweans (Tavuyanago, Mutami & Mbenene, 2010).

With maize on the political-economic agenda of the settled colonist farmers, labour quickly became a need and soon they employed coercion to mobilise and create labour from the native population, which saw the systematic interruption of traditional agri-culture. This disrupted the local farmers' own traditional crop farming of grain crops, especially millets, and also their cattle rearing, manufacturing and hunting. Cash crops such as tobacco (and maize in the early years of settler rule) were grown by the colonial settler community for the market and the latter endeavoured to align rural farming with the settler economy using coercion that yielded reactions.

A culture of sustainability in agricultural practice can therefore not be discussed with the exclusion of peasant and nationalist struggles for national, agrarian and epistemic liberation. Literature indicates that there are contradictions in the historiography of peasant consciousness and nationalism in Zimbabwe regarding resistance to colonial repression in land ownership and agricultural production (Raftopoulos, 1999). One school of thought advances a composite ideology that proposes unity of purpose and cooperation at national level between peasants and guerrillas (so called Africanist and liberal schools). This ideology is represented by such historians as Ranger (1988), Lan (1988) and Manungo (1991). Raftopoulos (1999, p. 122) viewed Ranger's (1988) perspective on peasant consciousness as having "developed out of the experiences of colonial conquest, land alienation and centralised, authoritarian state interventions in the agrarian questions from the 1930s". An alternative school of thought, advanced by history scholars such as Sithole (1979), Kriger (1992) and Alexander (1993), views the peasant struggle and political consciousness as differentiated based on place, ethnicity and specific challenges faced, among others. A more recent history of Zimbabwe by Mlambo (2014) recognises aspects of differentiation and unity, and challenges a much deeper engagement with

specific contexts in order to understand the historical and current issues around the land question and agriculture.

2.3 POLICIES

The colonial period saw the introduction and role of policies influencing displacement, access to land, land ownership, types of crops that could be planted, consumed and marketed, livestock ownership, agricultural education and training, and wage labour, as shown in both the South African and Zimbabwean introductory discussions above. However, little has been done to improve water access and seed security in practice. The gaps and absences of water and seed security for smallholder agriculture are discussed in detail in this section.

Agricultural, economic, trade and development policies based on commodification value in Southern Africa are key drivers of government and non-government sponsored cultures of agriculture because of their impacts on access to extension, inputs, resources and markets and on livelihood development. These policies play out at international, regional, national and local levels depending on the institutional structures and arrangements. At a regional level, the Southern African Development Community (SADC)'s Agriculture and Water Protocols have played key roles in the agricultural practices of Member States by shaping and being shaped by national policies, and also deriving from the African Union (SADC, 2015a; African Union, 2003) and from global neo-liberal policies. SADC policies are based on a general goal of achieving regional integration, on the lines of the European Union and other economic blocs, and poverty eradication through four priority action areas one of which is industrial development and market integration with agriculture as a major driver (SADC, 2015b). Regional agricultural practice in southern Africa is based on the premise that the agriculture sector is the key driver of the economies of the region and an important facet of regional economic integration (SADC, 2004; SADC, 2011a). Agriculture in SADC has an important share of the Gross Domestic Product (GDP), which in 2010 stood at 19-43% in the low-income countries (8 out of 15 Member States) except Lesotho (World Bank, 2010b). Reliance on agriculture varies greatly by country. Overall agriculture contributed 15% value added to GDP in 2015 trailing behind industry that just more than doubled it, and services with the lion's share above 50% (SAIIA, 2016, p. 20). SADC (2013a) recognises the centrality of agriculture to poverty reduction and food and nutrition security in the region,

> Agriculture … provides a livelihood including subsistence, employment, income and wealth creation for nearly 61% of the Region's 277 million people (2010). Furthermore, it contributes 8% of the SADC region's Gross Domestic Product (GDP) which rises above 28% when all middle income countries are excluded. (p. 6)

Regional policy aspirations and regionalisation processes have high political and economic stakes that have an impact on the sustainability of SADC's smallholder farming. Thompson (1991) approached the regionalisation process in Southern Africa cautiously, arguing that it was first created not by politicians but by commercialisation of the mines that had an ever-increasing demand for labour and drew workers from as far away as Tanzania. These workers preferred to work their land, but were motivated to go to the mines (popularly known as 'Wenela', after the Witwatersrand Native Labour Association [WNLA] set up by gold mines as an agency to recruit migrant labour) by the need to pay livestock taxes to colonial masters and because they had been displaced from productive to marginal land. When the frontline states leaders were forming SADC's predecessor the Southern African Development Coordination Conference formed in 1981 (SADC, 1992b), they were forming a resistance organisation. Their aim was to coordinate development efforts, counter the economic and military might of apartheid, liberate South Africa and avoid future subjugation by the latter due to its potential hegemonic influences, concerns confirmed elsewhere (Africa Confidential, 1995; Lalbahadur, 2015). Regional policies therefore need to be reviewed critically for their contribution to real, non-racialised and non-globalised local development rather than to globalised and neo-colonial goals that can destroy local livelihoods. SADC protocols and declarations provide the common official and authoritative direction and discourse for integrated sectoral development under the banner of the SADC Treaty and the Regional Indicative Strategic Development Plan (RISDP), SADC's blueprint for coordinated and integrated action (SADC, 2015b).

2.3.1 SADC protocols and agreements on agriculture and water development

In 2004, SADC Heads of State and Government signed the Dar-es-Salaam Declaration on Agriculture and Food Security committing themselves to "promote agriculture as a pillar in our national and regional development strategies" (SADC, 2004, p. 2). While the declaration gives prominence to conventional agricultural production such as high fertiliser application and technicist mechanisation, it also addresses key contexts of the historically marginalised smallholder farmers. Firstly, it commits these leaders to "*increase production of drought tolerant crops* such as sorghums, millets, cassava and other root crops as well as disease resistant crops" (ibid., p. 4). Secondly, it commits the leaders to alternative sustainable agricultural water, specifically to "*develop water harvesting technologies*, flood control, and strategic water storage infrastructures" (ibid., p. 4, emphasis mine). These commitments are backed up by recommendations of recent regional vulnerability assessments. In its policy recommendations, the SADC Regional Vulnerability Assessment and Analysis dissemination forum (SADC, 2015c) requested

> Governments, international cooperating partners and civil society organisations to promote and scale-up appropriate technologies including *climate smart agricultural practices*; take measures to *promote water conservation techniques*, efficient use, re-use and recycling of water and where possible *encourage and advocate for rain water harvesting*; … (p. 17)

This is a ten-year manifestation of a contradiction between the commitments in the declaration made by SADC leaders (alternative sustainable water strategies) (SADC, 2004) and what is done in practice at national levels (policy requests by technical experts on the same strategies as cited in SADC, 2015c above). The ambivalence and poor commitment to rainwater harvesting at regional political level is further evidenced by its absence in SADC's current five-year Regional Strategic Action Plan on Integrated Water Resources Development and Management (SADC, 2016) despite its explicit occurrence in the Regional Water Policy (SADC, 2015a). In addition, 24 years after the first SADC water harvesting practical workshop (SADC, 1992a), SADC is still planning for pilot projects and demonstrations, and confesses that "the impacts of inadequate research and development are evident across the region through the limited innovations such as ... rainwater harvesting that are adapted for practice and use" (SADC, 2017, p. 15).

SADC hosts the sub-region's Food, Agriculture and Natural Resources (FANR) Directorate that coordinates matters of food security, research, vulnerability assessments, early warning systems and protocol implementation. A technical committee of national Directors of Agriculture and Food Security under the direction of the Ministers of Agriculture governs the FANR. SADC (2013a) produced an Agriculture Policy in 2013 that recognises and supports the role and contexts of smallholder farmers:

> Scarcity of water resources and growing competition … reduces its availability for agriculture, particularly irrigation. Key focus areas … include … *water management options including water harvesting for the vast majority of farmers who are unlikely to access irrigation within the mid to long term*. (p. 14, emphasis mine)

Despite being housed in the Food, Agricultural and Natural Resources (FANR) sector of SADC and in the FANR Directorate at SADC Secretariat since restructuring and centralisation in August 2001, the SADC environmental and sustainable development policy of 1996 has been acting peripherally. The environmental protocol only came into being in 2013. The environmental policy and protocol encourage the mainstreaming of environment and sustainable development across all sectors (SADC-ELMS, 1996; SADC, 2013b). The SADC environment and sustainable development programme generally strives to have its policies taken up by all the sectors (SADC, 2015b).

Other related protocols directly or indirectly support agricultural water development in various ways. The SADC Protocol on Shared Watercourses, housed in a different sector, contributes to agriculture by promoting irrigation development by watercourse states, while upholding principles of balancing resource development for sustainable livelihoods with environmental conservation and sustainable

development (SADC, 2000). SADC launched a Climate Change Adaptation Strategy for the Water Sector at the 17th Conference of Parties for the UNFCCC in Durban, South Africa in 2011 that promotes rainwater harvesting for food production, among other actions (SADC, 2011b).

2.3.1.1 Agricultural policy and seed systems in SADC: Vigorous GMO debate

The issue of resilient seed systems in the context of genetically modified organisms is silent in the SADC protocols on agriculture and environment probably as a matter of diplomacy not to offend South Africa whose agriculture is dominated by genetically engineered and GM technology (Sidaway, 1998; Africa Confidential, 1995). However, the application of genetically modified organisms (GMO)s in agriculture remains a contentious issue in SADC discussions and negotiations, with divergent views as revealed in the relatively new SADC Agricultural policy (SADC, 2013a):

> Worldwide … genetic modification technology has been in use for more than two decades. However, debate about the food safety, environmental safety and socio-economic impacts of (GMOs) is still vigorous. Whilst biotechnology can contribute to solving agricultural productivity and environmental degradation challenges, the lack of capacity to regulate GMOs is a potential deterrent to embracing and adequately harnessing its potential. Therefore, the proposed interventions will include ... clarifying how to deal with GMOs… (p. 12)

The argument advanced by the SADC Agricultural Policy regarding GM technology premised on its use elsewhere, as a basis for possible use in the region, noting deterioration in agricultural productivity and the aggravation of climate change on poorly adapted remnants of stock. It is about current inhibition from regulated use, an important factor regarding possible contamination, and not on the resilience of and cultural fit to smallholder farmers. The policy does not discuss the ethics of considering recombinant DNA technology (transfer of genetic material from one organism to another) as 'improved' cropping practice either. Improved tolerance to drought, pest resistance, herbicide tolerance, nitrogen utilisation and product characteristics are taken as a given good of end justifying means.

The Alliance for Food Sovereignty in Africa (AFSA), a coalition of civil society and farmers' organisations, advocates for farmers' voices in conferences and legal processes where issues of farmers' rights and the right to food are at stake (African Centre for Biosafety, 2014b) such as at SADC protocol fora and the African Regional Intellectual Property Organisation (ARIPO) fora. In SADC, a current key policy process is the development and review of the draft SADC Protocol for Protection of New Varieties of Plants (Plant Breeders' Rights), in short Plant Variety Protection (PVP). In 2014 AFSA, despite being marginalised, successfully convinced SADC Member States to "amend key provisions of the SADC PVP Protocol dealing with disclosure of origin and farmers' rights" (ibid., 2014, p. 6). AFSA, like other advocates (such as the UN Special Rapporteur on the Right to Food),

has argued that absence of farmers' rights in policy and practice is tantamount to denying farmers their right to food. AFSA (2014) expressed this right as

> … the right of farmers to freely save, use, exchange, sell farm-saved seeds and to provide farmers and farming communities rewards for their contribution to agro-biodiversity and give them incentives to continue improving and making available plant genetic resources for food and agriculture which are the foundation of modern plant breeding and sustainable agriculture. (p. 2)

This right is not new but is steeped in farmers' traditional cultural practices of seed sovereignty. Modern plant breeding depends on this culture of valuing and breeding wild and landrace varieties by these smallholder farmers who have learnt to cope with climate variability and change. AFSA's membership is wide and includes the African Biodiversity Network (ABN), Participatory Ecological Land Use Management (PELUM) Association, Eastern and Southern African Small Scale Farmers' Forum (ESAFF), the Coalition for the Protection of African Genetic Heritage (COPAGEN), Comparing and Supporting Endogenous Development (COMPAS) Africa, Friends of the Earth–Africa, Indigenous Peoples of Africa Coordinating Committee (IPACC) and La Via Campesina Africa. In its advocacy in the ARIPO, AFSA found a serious lack of knowledge about the meaning of upholding farmers' rights to food and seed control among policy makers. The danger of this scenario is that policy makers are prone to adopt international legal frameworks that are not suitable for African farming systems such as the UPOV 1991 Convention. This convention favours a monoculture system of industrial plant breeding and corporate seed systems at the expense of smallholder farmer's local seed systems. In 2015 ARIPO adopted the Arusha PVP Protocol which still gives plant breeders strong intellectual property rights whilst restricting smallholder farmers in their seed saving, sharing and selling rights.

From the discussion above it is clear that learning networks, alliances and coalitions are important for ensuring that farmers' voices are heard in high-level policy processes and for learning by all involved within and those reached out to.

2.3.1.2 Connecting policy with practice for sustainable smallholder farmer development in SADC

SADC as a body corporate has endeavoured to put its policies for sustainable smallholder farmer development into practice through a number of projects and initiatives such as the Implementation and Coordination of Agricultural Research and Training (ICART) project and the SADC Plant Genetic Resources Centre (SPGRC). The ICART project, which ended in 2010, had the aim of strengthening the FANR Directorate's capacity to coordinate agricultural research and training in SADC in line with the SADC RISDP and the Dar Es Salaam Declaration on Agriculture and Food Security discussed above. ICART was designed with the objective of contributing to the economic development and

poverty alleviation of the SADC region through innovative research and training activities for improving livelihoods of smallholder farmers (SADC, 2008). The purpose of ICART is to enhance the capacity of National Agricultural Research Systems (NARS) in the SADC Member States to address common researchable constraints and opportunities in agriculture through regional initiatives. A key area of ICART work is the formation and strengthening of collaborative and functional networks involving agricultural researchers, farmers and development practitioners. One key finding in the ICART regional situation analysis applicable to many Member States was a gap in networked collaborative learning and an exclusion of farmer leadership in research:

> There are *no institutional or functional linkages* between research, extension, crops, livestock services, and private sector organisations. This has resulted in *gaps in technology packages promoted for rain-fed agricultural production systems*. There is no coherent strategy or on-going programme … in order to formulate research agenda directed at solving these problems, *collaborate with farmers to carry out farmer-managed research*… (SADC, 2008, p. 9, emphasis mine)

Another SADC institution supporting sustainable smallholder farmer practice and resilience is the SADC Plant Genetic Resources Centre (SPGRC), a regional seed bank based in Lusaka, Zambia. The SPGRC was established in 1989 as a 20-year donor and SADC member country funded project, and was assessed for sustainability after March 2009 leading to its continued functioning to date with the plan of a 30% own budget generation. The Centre has been entrusted and mandated by SADC with the conservation and evaluation for sustainable utilisation of regional (SADC) plant genetic resources for sustainable development. It is also required to coordinate all activities through the network of National Plant Genetic Resources Centres (NPGRCs) most of which have been equipped with basic gene-banking equipment. The SPGRC trains experts and farmers, conserves germplasm, conserves and preserves seed (landraces developed by farmers and wild relative varieties), and conducts learning tours for learners and consultative meetings with stakeholders. In these respects, the SPGRC supports agroecology and open pollinated varieties, including cereals, pulses and other crops used in most traditional rural communities in SADC countries such as sorghum, millets, maize, cowpeas, beans and Bambara nuts (SPGRC, 2016). SPGRC faces various challenges such as electricity load-shedding affecting its freezer storage facilities, complementary conservation facilities and finance. Despite these challenges the Centre has scored various achievements including rescuing and restoring various ‘lost’ varieties, including an indigenous variety of Bambara nut that had been lost from a rural community in Zambia (SPGRC Officer, personal communication, November 8, 2012). The SADC Plant Genetic Resources Network has potential to anchor local level seed networks via national and SPGRC structures, and the “voice of beneficiaries” is crucial for sustainability (Marandu & Kamau, 2008, p. 240).

2.3.2 National Development, Agriculture and Water Policies in South Africa

The South African democratic government mapped a path for poverty alleviation and transformation based on redress, equitable access to land and resources, promoting partnerships, capability development and education (South Africa. DP, 2012). The South African National Development Plan (NDP) (ibid.) argues that transformation programmes such as affirmative action for the previously disadvantaged groups emerging out of apartheid bondage "are most effective when the economy is growing and the education system is improving. Without such an environment, these measures can raise the level of social tension..." (p. 35). The concept of improving educational quality with respect to agricultural learning systems and enhancing partnership across them as supported by policy is of interest for this study. The South African NDP is the nation's policy blueprint for poverty eradication and equity. The dominant development discourse in the NDP is about rapid growth of the economy, and agriculture is implicated as "another area of potential growth. Current output does not match Africa's agricultural potential. From being a net food exporter in the early 1960s, the continent is now a net importer" (ibid., p. 88).

Regarding smallholder farming, the NDP hails the Alliance for a Green Revolution in Africa (AGRA) for "promoting sustainable agricultural growth through smallholder farmers. … supports smallholders with good seeds …access to markets, storage, transport and finance, while seeking to improve agricultural policies" (ibid., p. 89). This is based on AGRA's (2009) promise of food security based on stressing the economic value of food and productivity (*commodification value*), whereby smallholder rural farmers are supported to produce for the market using new and imporved inputs, through integration. However AGRA's actions on the ground are fiercely opposed by the African Centre for Biosafety (2013), Friends of the Earth International (Bassey, 2012), and individuals (e.g. Ashton, 2012) among others. Friends of the Earth International accuse AGRA of introducing a western green revolution under the guise of an African one, through hi-tech industrial agriculture. Critics allege that this approach will sideline more ecologically sound approaches to farming, contaminating smallholder farmers' seeds with GMOs and result in land grabbing (AFSA, 2014; Nhemachena & Mawere, 2017). AGRA enjoys support from the Rockefeller Foundation and the Bill and Melinda Gates Foundation from the USA. The NDP's aim of building capabilities connects with education and training as a means towards poverty eradication. In the light of the NDP's ambivalent messages, the question from smallholder farmer contexts is: what type of education and for whose benefit? The Eastern Cape Provincial Development Plan recognises the impact of climate change on development and agriculture and has planned for water development to improve smallholder farming noting the current poor agricultural production and old irrigation infrastructure (Eastern Cape Planning

Commission, 2014). The plan identified Raymond Mhlaba[14] (formerly Nkonkobe), Qoboqobo (Keiskammahoek) and Amahlathi (Stutterheim) local municipalities as nodes of potential agricultural growth.

2.3.2.1 Agricultural policy in South Africa

Agricultural policy in South Africa has undergone vigorous transformation since democracy in 1994 (South Africa. NDA, 1998; OECD, 2006). This review focusses on the effects of agricultural policy on smallholder agriculture within the broader national context. Kirsten et al. (1994) reported that during apartheid different agricultural policies applied to White commercial operations and to Black small-scale farmers in the homelands, also termed Bantustan areas.

> For the Black sector, three clearly defined approaches to agricultural development …, i.e. improvement planning from 1936 to the late 1970s; centrally managed farmer settlement projects during the 1970s and 1980s, and the more broad-based farmer support programmes since the late 1980s. (p. 37)

These schemes were however not adequately supported by government and suffered financial losses resulting in disillusionment of the participating Black farmers. The racially polarised duality during apartheid was marked by the colour bar hence the language of 'Black' and 'White' is dominant in the literature to describe population groups. Failure of these government schemes can be attributed to the contradiction between a business approach aimed at increased production with capital injection and labour under heavy government control in the schemes versus reluctance by the government to stimulate independent sustainable smallholder farming. As a result, 'project farmers' never developed beyond being mere wage labourers because they had no control over planning, production, means of production, management and marketing (Kirsten et al., 1994). In this scheme of socially engineered control, government policy in the Bantustan areas became focussed on intervention, of which the betterment planning process (McAllister, 1991) was prominent in its impact on the culture of smallholder agriculture.

The official aim of betterment planning was to reduce natural resource degradation. Its implementation was characterised by dispossession, dislocation and resettlement of people in new areas. The latter were demarcated and fenced off in zones for human settlement, livestock grazing commonage and crop production, and this reorganisation of space resulted in "loss of autonomy and local control" (McAllister, 1991, p. 119) for purposes of rehabilitation and developing economic viability. Contrary to its aim, 'betterment' resulted in massive soil erosion due to large population concentrations and other effects of dislocation such as mistrust among new neighbours (ibid.; Vogel, 1994). McAllister

[14] As indicated in Chapter 1, Raymond Mhlaba municipality is the site of my South African case study.

(1991) therefore observed that many writers argued that the real motives of betterment were far removed from ecological integrity and agricultural development, having

> … more to do with ensuring a steady supply of migrant workers to the mines and industries of white South Africa and, later, with control of the rural population. As such, betterment is closely associated with the development of racial segregation and the ideology of apartheid. (p. 116)

Betterment imposed appalling conditions on livelihoods of people in the Bantustans resulting in an agrarian crisis. However, the apartheid government blamed the communal land tenure system as responsible and therefore employed measures of conservation, 'improved' farming practices such as reducing livestock densities and modern production methods using 'better' crops. Vogel (1994) described 'Betterment Planning' as "attempts by South African government to improve on small-scale agriculture in the Bantustans, combat soil erosion and conserve the environment" (p. 160) deriving its legal power from the Native Trust and Land Act of 1936 and gaining impetus from the Tomlinson Commission Report of 1955. Vogel further argued that Betterment planning did much to influence agricultural production and ultimately to also degrade the land in the Black rural areas, and in many cases, agricultural practices were developed in ways that perversely exacerbated impacts of drought, failing to 'improve' farming practices. This discussion on the perversely structured so-called 'betterment' approach is important to understand factors influencing agricultural practice and its culture, governance systems and water for food in the area where my study was undertaken.

Westaway (2010), undertaking a post-apartheid analysis of ongoing marginalisation of rural peoples in South Africa 16 years after the official fall of apartheid in 1994, argued that the culture of marginalisation of the smallholder Black farmer has been reproduced by the democratic government if not "assimilated as a technique of power" (p. 11) by the ruling African National Congress (ANC) party, thus further entrenching rural poverty. He claimed that this has been achieved through 'contemporary segregationism' through policy and legal processes linking territory, citizenship and homage. For instance, he argued that the Traditional Leadership and Governance Framework Act of 2004 is there to consolidate governance by non-democratic structures in parallel to municipalities, particularly in the former Bantustan areas, thus maintaining the people in these spaces at socio-political risk (continuing the governance bifurcation that Mamdani pointed to, mentioned above). In addition, he claimed that the maintenance of the betterment system under the protection of the Land Redistribution for Agricultural Development Policy of 2000 prevents land restitution to those dispossessed in these areas (ibid.). Moeletsi Mbeki (2009) concurred with the tendency of this mentality as state capture by political elites whose motives he described as to exclude

> Outsiders – the mass of the population and weak sections of the political elite whose inclusion would reduce the benefits accruing to the dominant group(s). …They sustain and reproduce themselves by perpetuating the neo-colonial state... devised by European colonialists. (p. 141)

During the 1980s, South African agricultural policy of the apartheid state aimed for self-sufficient food production for two reasons: to earn foreign currency from export trade and to reduce dependency on an increasingly hostile international community that eventually implemented sanctions in the late 1970s and 1980s (Kirsten et al., 1994). White farmers received subsidies and loans in the form of drought aid, disaster risk payments, soil conservation works, among others. Meanwhile, poor farming practices resulted while consumers experienced high food prices. This indicates the need for a holistic approach to agriculture that accounts for prosperity (economics), while at the same time accounting for the social (equity and justice), the cultural (sustainable ways of farming) and the environmental costs.

I shall now review post-1994 agricultural policies in democratic South Africa. The development of a post-apartheid agricultural policy in South Africa has been a daunting transformation project as shown by the myriad of issues raised in the policy discussion document published in 1998 by the National Department of Agriculture (South Africa. NDA, 1998). Contemporary history shows ambitious policies by the democratic government geared towards rapid transformation through grand programmes such as the Reconstruction and Development Programme (RDP) of 1994, and later the Growth, Employment and Redistribution (GEAR) macroeconomic strategy of 1996 (South Africa. DBE, 2013). These were succeeded by such programmes as the Accelerated and Shared Growth Initiative for South Africa (ASGISA) in 2006 that was a *policy shift* towards *greater support for smallholder, resource poor farmers***.** However, ASGISA implementation faced bottlenecks such as the hurdles to water access that farmers face from climate constraints and even through restrictions of the Water Act (South Africa. NDA, 1998).

Sustainable smallholder agriculture was seen by the policy discussion document (ibid.) as a key strategic activity to redress past injustices of apartheid which separated land access, compromised people's capabilities to farm and be self-reliant, and the quality and effectiveness of extension support. The policy discussion document also had the vision of bringing people living in rural areas into self-reliant food production and improved income generation while at the same time ensuring conservation of the agriculture resource base. For the interest of this study, the aspirations of the policy discussion document covered self-reliant small-scale farming, agricultural education, participatory extension, local economic development through farming and collaborative partnerships. These have been captured in the key South African policy documents for Agriculture, namely the 1995 White Paper on Agriculture (South Africa. NDA, 1995) and the Integrated Growth and Development Plan for Agriculture, Forestry and Fisheries (IGDP) (South Africa. DAFF, 2012a) which replaced the 2001 Strategic Plan for Agriculture and the Agricultural Policy Action Plan (South Africa. DAFF, 2014).

The South African Agricultural Policy Action Plan (APAP), a more recent attempt to operationalise the South African agricultural policy landscape, recognises the problem of agricultural water scarcity for smallholder farmers and has prepared support through climate smart agriculture including water harvesting (South Africa. DAFF, 2014).

Agriculture policy in South Africa is underpinned by the White Paper on Agriculture (South Africa. DoA, 1995). The vision for post-apartheid agriculture that it presents focuses on "a highly efficient and economically viable market-directed farming sector, characterised by a wide range of farm sizes" (ibid., p. 4). Productivity for the economic sector and trade is therefore a huge demand. The White Paper acknowledges a historical error regarding the importance of small-scale farming whereby "in the past, ensuring food self-sufficiency was a goal of agricultural policy and the development of small-scale farming was seen as detrimental to this goal" (ibid., p. 4). This error is addressed as the role and potential of small-scale farming is regarded as important for food security. Drought is considered a natural phenomenon in the White Paper and therefore farmers are expected to practise farming that is appropriate to their agro-climatic region and to use "hardy seed varieties and suitable farming systems" (ibid., p. 7). The view on drought fails to cater for climate change however, yet by 1994 when the UNFCCC came into force, South Africa had already started participating in climate change debates and activities (South Africa. DoA, 2007). However, the reference to hardy seeds and suitable farming systems integrates climate adaptation, and may encompass agroecology, and it can also include GM-seed systems.

2.3.2.2 The South African Water Act and agriculture

All water in South Africa is governed under the new Water Act (Act #36 of 1998) which is administered by the Department of Water and Sanitation on behalf of Parliament (South Africa, 1998). This includes water for agriculture, which currently has the greatest allocation compared to any other use. Water use for irrigation must first be authorised through this Act. A group of people intending to use water for any purpose is required to provide notice of application to the Minister of the Department of Water and Sanitation before they can form a cooperative called a Water User Association (WUA). The WUA's functions will depend on their approved constitution.

The Water Act (Act #36 of 1998) replaces the colonial Water Act of 1956 as one of the provisions of the White Paper on a National Water Policy for South Africa (South Africa. DWAFF, 1997). The White Paper clearly addresses the history of poverty and depravation with regard to water under apartheid rule and aims for equitable access, distribution and redress as part of fulfilling the right to life and access to water enshrined in the Constitution. It recognises the historical lack of adequate water

and sanitation in rural areas where 75% of South Africa's poor resides, and commits to improving water for farming, but at a cost.

> Farming, including dry-land agriculture … is an important part of the economy and sustains millions of people in the rural areas; it is also however the sector which accounts for around half the nation's water use. … (with the mining industry) both these sectors will have to re-evaluate their use of and impact on our water resources, and will have to pay a price for water that reflects the real economic cost … for their water use. (ibid., p. 6)

This indicates a problem for smallholder farming regarding developing new irrigation schemes as it will be difficult and costly, while all the water is already allocated. In addition, the policy regards unconventional water sources such as water harvesting as not "yet practical or affordable except on a very small and localised level" (p. 40) indicating its low priority; however, it also supports research through the Water Research Act as discussed below.

2.3.2.3 Water research policy and legislation in South Africa

The South African Water Research Act (Act No. 34 of 1971) provides for agricultural water research much of which is done through the Water Research Commission (WRC), a statutory body established following a period of acute water shortage. The WRC is mandated with promoting, coordinating, cooperation, communication and capacity building in water research and development (Water Research Commission, 2016). Policy and law expects the WRC to provide solutions to the water scarcity problems faced by South Africa, including in the field of agriculture which is one of its programme areas. For example in its research programming, Key Strategic Area #4 is designed for 'Water Utilisation in Agriculture', and thrust 3 under it focusses on 'Water Utilisation for Poverty Reduction and Wealth Creation in Agriculture' (ibid.). The WRC has conducted sound research on rainwater harvesting and conservation (RWH&C) that has shown its high potential and impact especially in smallholder crop farming and larger-scale livestock pasture in drylands (Denison et al., 2011; Botha et al., 2014). However the WRC's attempts to have the results of this research disseminated have been largely ineffective. The WRC used the conventional 'research-develop-disseminate-adopt' (RDDA) approach that is used by many scientific research bodies but has been shown to be weak, facing criticisms of social engineering, modernist and reductionist assumptions (Lotz, 1995, p. 79; Babikwa, 2003, pp. 100, 212-213). This approach will be discussed later in this chapter. In 2014 the WRC designed a project to develop an action-oriented strategy for knowledge dissemination which was implemented by Rhodes University – Environmental Learning Research Centre (ELRC). In this project, a training-of-trainers' course was used to activate new learning and knowledge sharing in a learning network (see Chapters 4 and 6). My study took place within this project context.

2.3.2.4 South Africa's seed and food security policy and its impact on small-scale farmers

The seed policy in South Africa is determined by the nation's policy on food security which is heavily influenced by trade. The South African NDP (South Africa. DP, 2012) downplays self-sufficient staple food production, arguing that the nation has a positive trade balance (earns a surplus from agricultural exports) and hence can buy food for its population. The OECD (2006) noted that "South African agriculture is increasingly export-oriented with about one third of total production exported" (p. 2). The food security / trade link is seen in the NDP's conception of food security as existing "when everyone has *access to sufficient, nutritious and safe food at all times*. This implies that food must be *available* and that people must have *the means to access it*" (South Africa. DP, 2012, p. 230, emphasis mine). There are two pertinent questions to this conception, first the ability of households to pay for the food that may be available (food on the table), and secondly the availability on the market of what is nutritious, healthy, safe, informative and emancipating. Such questions are not normally answered by the corporate-driven market (African Centre for Biodiversity, 2017a) and therefore point to the need for an agro-ecological component which spells out self-sufficiency in the conception, definition and practice of food security (De Schutter, 2010, De Schutter, 2011). Self-sufficiency has been critiqued by economists on the grounds of disrupting trade (FAO, 2016).

The NDP's attitude towards GM-seed as a way of achieving food security was already discussed at the beginning of section 2.3.2, and shows a comfort in leaving smallholder farmers at the mercy of multinational corporations promoting gene technology without due regard for local seed systems. The NDP recognises the problem of malnutrition as a derivative of food insecurity and how it affects one in five young children and many infants; and also the health problems associated with obesity. Watkinson and Makgetla (2002) explained the cause of this scenario as "most households in South Africa depend on food industries and food retailers for their food supplies" (p. 2). Food security is therefore a priority. However, the NDP's approach to food security is considered by agro-ecological experts as exclusive of food sovereignty and therefore incomplete. This view is supported by the UN Special Rapporteur on the Right to Food's (De Schutter, 2010) recommendation that

> States should implement public policies supporting the adoption of agroecological practices by making reference to agroecology and sustainable agriculture in national strategies for the realisation of the right to food and by including measures adopted in the agricultural sector in national adaptation plans of action (NAPAs) … in their efforts to mitigate climate change. (p. 20)

The South African NDP's view on food security misses out locally-adaptive seed systems, sustainability and participation of farmers which are strong dimensions of agroecological farming and climate change adaptation and mitigation practices from the lens of a right to adequate food projected

by the United Nations (ibid.). However, South Africa is in the process of developing a strategy on agro-ecology, which is still at draft stage, with the intention of mainstreaming it in the agricultural sector, which has been commended by civil society (African Centre for Biosafety, 2015a). Although in its eighth and final draft, civil society organisations (CSOs) have raised several concerns such as lack of political understanding of agroecology, especially confusing it with isolated components of conservation agriculture (such as "continuous minimum mechanical soil disturbance" no-tillage agriculture") and climate-smart agriculture. Agroecology activists believe the GM-corporate Monsanto is confusing sustainable farming because it is providing its weed management herbicide solution Roundup (containing the carcinogenic poison glyphosate as active chemical ingredient) to conservation agriculture as a "no-tillage agriculture" solution (ibid..).

> Monsanto has effectively marketed glyphosate (roundup) as an essential tool in no-till agriculture because ploughing usually assists with weed management, in its absence, roundup is extensively used and as such is considered to be a tool in the sustainable agriculture toolbox. (African Centre for Biosafety, 2015a, p. 13)

In addition, there are concerns about the omission by the national Draft Agroecology Strategy of key agroecology principles that need to be addressed along the entire food chain (ibid.), "CSOs also noted that the plan does not address the key issue of land and water access, which makes the policy a 'paper tiger'. In addition, the issue of gender is absent" (ibid.). It remains to be seen whether the policy will be finalised to include principles of water access among others for mainstreaming into agricultural policy.

South Africa passed a GMO Act, 1997 (Act No. 15 of 1997), three years into her democracy (South Africa, 1997). The Act was amended by GMO Amendment Act 23 of 2006. Liability for potential damage by GMO products and responsibility for prevention of damage and remedial action rests on users, mainly the consumers. The GMO Act applies to a number of sectors including agriculture, health, environment, science, technology and trade, among others. The purpose of the GMO Act of South Africa is "to provide for measures to promote the responsible development, production, use and application of genetically modified organisms" (ibid., p. 1). The implementation of the GMO Act is administered by an interdepartmental Executive Council (2005) and has been watched closely by South African and other environmental organisations with concerns being raised. For example, during 2004/2005,

> … one appeal was lodged … on behalf of the Biowatch Trust, against the decision of the Executive Council to authorise commercial growing of maize event Bt11, which is maize resistant to certain lepidopteran pests. …the decision of the Executive Council in this appeal was also upheld. (Executive Council, 2005, p. 4)

South Africa carved a unique path in its food security policy as according to WWF-SA (2010) it is "*the only country in the world to allow genetic modification of its staple crop, maize*... In 2008, white GM maize totalled 1,04 million ha, an increase of 48% over 2007, representing a market share of 62%" (p. 16, emphasis mine; Jaffer, 2016). The genetic modification of the maize in South Africa has been for insect resistance and herbicide tolerance, and field trials for drought resistant maize are on course amid objections from activists (African Centre for Biodiversity, 2015). In the Eastern Cape Province of South Africa the Department of Rural Development and Agrarian Reform (DRDAR) has implemented the Massive Food Production Programme (MFPP) since 2003 (Masifunde Education and Development Project Trust, 2010), that distributes genetically modified maize seed to smallholder farmers. A study by the latter argues for local food sovereignty based on locally adapted open-pollinated seed systems and is very critical of the MFPP as an external green revolution programme imposed on the local level,

> The Green Revolution of the Eastern Cape Department of Agriculture is modelled on the ... AGRA. This is a strategy backed by the World Bank and powerful international interests that seek to facilitate entrenchment of agro-multinational corporations (MNCs) in African agriculture. (p. 11)

Now called the Cropping Programme, or Fetsa Tlala Food Production Initiative (South Africa. DAFF, 2013), the MFPP vision continues to be rolled out in Amathole District where the South African case of my study was conducted through encouragement by the extension officers. A study conducted by the Nkonkobe Farmers Association and the University of Fort Hare, ARDRI (2015) on Fetsa Tlala revealed similar concerns found by the Masifunde study,

> … *lack of choice as to crop and crop variety*; the use of chemical fertilisers; the lack of proper training so that the farmers had a better idea what was going on; … and the lack of a proper market... Regarding the choice of seeds, *discussants disliked the fact that the seed they were provided under the programme could not be used for planting the next crop,* i.e. because that is the nature of much GM seed. (p. 6, emphasis mine)

The policies that pertain to agriculture, water and seed for the South African case study are thus quite complex and contested especially with the GM-seed factor. The next section discusses the policies for the Zimbabwean case study.

2.3.3 National Development, Agriculture and Water Policies in Zimbabwe

To understand national development, agriculture and water policies in Zimbabwe one needs a historical background of the pre-colonial and the colonial periods to build a case and to identify key objects for re-viewing current policies; this was provided in subsection 2.2.5. A number of policies and laws during the colonial period had influence on current national development, agriculture and water policies and these include the Native Land Husbandry Act of 1951 and the Land Tenure Act of

1969. The Native Land Husbandry Act of 1951 heralded a major policy shift in Southern Rhodesia government policy at the end of the second world war and attempted to respond to the resulting loss of food self-sufficiency and hunger (Pallotti & Tornimbeni, 2016). It introduced individual land tenure under government control and reduced land rights in the African reserves at the expense of the customary system of landholding, fair distribution, communal networks, gender equity and soil sustainability. The Native Land Husbandry Act of 1951 introduced and entrenched such policies as centralisation inaugurated in 1929 and continuous crop cultivation (instead of fallowing) of impoverished soils as a way of integrating African agriculture into the settler economy (Kramer, 1998). Cultural practices introduced by settler colonial policy included four-course crop rotation, contour ridge development and fertiliser use on the now more frequently used croplands where shifting cultivation was considered wasteful. Contour ridge making was a laborious manual activity which was enforced harshly such that it caused misery (Cavanagh & Veracini, 2016) called *nhamo yamakandiwa* in Shona-speaking communities. The Native Land Husbandry Act gave very few land and grazing rights to women and was biased towards men regarding land ownership, transfer and use. The contour ridge requirement for all crop lands was a forced labour matter and this defeated its acceptance as a soil conservation measure. The channelling of water out of the crop fields using contour ridges was also inconsistent with semi-arid rain-fed farming where water retention was a priority (Mhizha, Ndiritu & Nyagumba, 2009). The Land Tenure Act of 1969 was passed by the UDI government to replace the frequently amended Land Apportionment Act of 1930, and consolidated land segregation according to race and the further marginalisation of Africans into less productive poor soils and water stressed farmland.

Right from the beginning of colonial settlement, the politics of land in Zimbabwe began with racial, gender, economic and socio-ecological dimensions and is generally referred to as the land question. Land access, landholding and agricultural productivity among the largely disenfranchised Africans in the rural areas was not uniform and ranged from communal at subsistence level which represented the majority farming in the Tribal Trust Lands, to individual freehold tenure by a handful. Pollak (1975) reported that the freehold pattern among Africans was in 1975 (four years prior to independence),

> … followed by approximately 8,500 farmers, occupying over 2,250,000 million acres in 86 scattered African Purchase Areas. Though this latter group is demographically insignificant, within a total population of 5½ million, it has played a disproportionately large role in articulating rural problems through the African Farmers' Union. (p. 263)

Zimbabwe's liberation struggle in the third Chimurenga War (1975-1979) was largely fought over the land question, racial discrimination and associated divide and rule described above. The contexts and voices of communal farmers were drowned firstly by those of the more influential freeholders and secondly by those of the White large-scale farmers.

Upon attaining independence in 1980, Zimbabwe, like South Africa, inherited a bifurcated agricultural system with many of the above policies separating large-scale commercial farming from small-scale subsistence or commercial farming as reflected in her post-independence policies. The post-independence government itself produced a myriad of development policies and plans as it tried to redress past injustices. The dual agricultural systems were reproduced in the Federation of Rhodesia and Nyasaland (1953-1963), the Rhodesian UDI era (1965 to 1979) and in most of the Zimbabwean independence era before fast-track land reform (1980 to 1999). According to Närman (1991),

> The State of Zimbabwe, at Independence, inherited a dualism in agriculture dating from the colonial period which is still very present and deep-rooted. Large modern commercial farms were producing, on average, 81 per cent of the total agricultural output, and there appeared to be little optimism for the future of other types of agricultural activity in the rest of the country. (p. 9)

In independent Zimbabwe, a variety of old and new contentious land, agriculture and water issues have emerged at various points in Zimbabwe's over 35 years of democracy. These have ranged from pronouncements by government at independence of reconciliation across racial lines within a bifurcated agricultural system that has racial dividing lines to land reform that transferred ownership from white commercial farmers to new black owners. The independent state of Zimbabwe thus started off with an unresolved land question that inevitably precipitated land invasions, the fast-rack land reform programme and compulsory land acquisition policy within twenty years (Mlambo, 2014). The process of policy change took place under the shadows of a reconciliation policy and 'sunset clauses' in the Lancaster House Agreement granting protection to minority white interests at independence, disagreements regarding land compensation funding and pressures on government regarding land demand. The government of Zimbabwe passed the Land Acquisition Act (Act 15 of 2000) giving the state the power to acquire private land without compensation and has undergone amendments to prevent stalling by the courts. The land acquisition process then proceeded characterised by controversy, violent and sometimes fatal clashes between white farm owners and land occupiers, no environmental impact assessments and delayed extension guidance. The aftermath is still contested over 15 years into the land reform process, with mixed results that indicate decline in commercial staple grain production under a depressed economy and vandalisation of farm infrastructure on the one hand, and case studies of successful production on the other (Scoones, Marongwe, Mavedzenge, Mahenehene, Murimbarimba & Sukume, 2010).

Writing well into the radical land reform programme that claimed a huge policy shift towards black empowerment in agriculture and water, Manzungu and Machiridza (2005) critiqued the policy processes for agriculture water reform as failing to benefit the smallholder farmer. Noting that limited

access to good quality land and comprehensive supporting services such as well-maintained transportation networks, credit and marketing depots has continued, they (ibid.) observed that

> Black agriculture has not really recovered because the post-colonial state has not managed to reverse the trend due to a lack of a strong ideology backed by appropriate laws and policies. (p. 4)

Some attempts to develop a better ideology for smallholder farming development policy have since been made. One of the policy priorities given by the Zimbabwe Agricultural Policy framework (Zimbabwe, 2012) is increasing crop diversification, whereby government is committed to "promote research and adoption of high value crops such as horticulture as well as small grains, green legumes, pulses and tubers for inclusion in cropping patterns" (ibid., p. 11). Small grain support in drought prone areas is given particular policy commitment which connects well with the context. In 2013 the Government of Zimbabwe produced a new five-year plan called the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset), described as "a new trajectory of accelerated economic growth and wealth creation" (Zimbabwe, 2013a, p. 6). Agriculture and food security are high on the priority list among Zim Asset's four strategic cluster areas, namely Food Security and Nutrition; Social Services and Poverty Eradication; Infrastructure and Utilities; and Value Addition and Beneficiation. Zim Asset has as some of its strategies under the 'Food Security and Nutrition Cluster Matrix' to

> Provide smallholder farmers with subsidized agriculture inputs; prepare summer and winter input programmes; promote production of *drought, high yielding and heat tolerant varieties*; institute measures for all the beneficiaries of the Land Reform Programme to dedicate a certain quota to cereal crop and small grains production. (p. 52)

Unfortunately the current Zimbabwean economic policies such as Zim Asset, have been criticised by economics analysts as mere 'blue prints' or 'dead in the water' because of the lack of financial capital commitment to implement them as the country continues to face an economic downturn (Kuwaza, 2014; FBC Securities, 2014). With the country's protracted economic challenges compounded by drought and food aid, there is growing vulnerability of open pollinated drought-tolerant crops from grain imports and the GMO lobby that is making an immanent critique of government's food security and GMO-free policy, as shown below by Mutambara (2015):

> The question is *which farmers will benefit, and who will really benefit*, farmers or the GM-promoting agro-chemical corporates who worldwide are buying seed companies … This is creating unfair competition for the local industry as the country is promoting GMO tolerant industries in other countries by allowing importation of finished products with GMO ingredients. It is *recommended that the country reconsiders its GMO policy position* to maximise its agro-technological absorption capacity, and hence improve farm gate incomes. (p. 49, emphasis mine)

Like Shiva (2002)'s citation in section 2.4.1 below indicates, Mutambara's report cited above appears to equally recommend the "disease as a cure" in the form of GMO technology as a competitive

advantage for commercial farming but which for small-scale farmers would enhance dependency. This would affect property rights, inputs implicated such as new seeds and agrochemicals and loss of traditional seeds adapted to an increasingly changing climate.

Regarding water policy in Zimbabwe, the country made some promising reforms which resulted in a new Water Act in 2001 but in practice the process did a dis-service to smallholder farmers by failing to provide for sustainable water for food support. The effect is still felt over 15 years on. In its report to the United Nations Commission on Sustainable Development at its fifth session in April 1997 (Zimbabwe, 1997), the Government of Zimbabwe reported its plans to build a medium-sized dam in each district. The aim was to increase water supply mainly for irrigation in addition to building more large dams, irrigation systems and drilling more boreholes and wells. Manzungu (2001) argued that the Parliament of Zimbabwe lost an opportunity to debate water for small-scale agriculture, and build up on government's earlier commitment, when they tabled a water reform bill, as parliamentarians focussed more on the market ('economic-technical') and less on their constituencies ('people-oriented', 'social objectives'). Writing four years after the water reform debate, Manzungu and Machiridza (2005) observed policy inertia in water access:

> A discussion of access to land alone, without extending it to water, in such a semi-arid environment does not bode well for an informed analysis of the agrarian question in general or an understanding of how sustainable smallholder agricultural production can be structured. *Ideally both land and water accessibility should be addressed simultaneously* as these two resources complement each other in agricultural production. (p. 1, emphasis mine)

More recently, the Zim Asset policy (Zimbabwe, 2013a) has also developed strategies to improve and develop agricultural water, specifically "initiating a programme of rehabilitation of irrigation equipment; … putting in place a livestock drought mitigation programme for the drier regions of the country" (p. 37) and "develop captive water supply for irrigation" (p. 60). The water scarce situation is also reflected in policies of international financing institutions such as the World Bank (2012) that recognises that "Zimbabwe has limited water resources with much of the country being semi-arid with highly variable rainfall" (p. 1). The Zimbabwe Comprehensive Agricultural Policy Framework also recognises the challenge of "inadequate investment in the rehabilitation and development of irrigation systems to combat the effect of recurrent droughts" (Zimbabwe, 2012, p. 9). The translation of these policy discourses, or their absence into practice, is discussed in section 2.4 below.

2.4 CULTURES OF PRAXIS OF RAIN-FED SMALL-SCALE FARMING AND AGRICULTURAL WATER

This section reviews the cultures of praxis of small-scale farming, agricultural water and associated locally-adaptive seed development in Africa with a focus on southern Africa. The concept of praxis discussed in Chapter 1 is applied in this section in order to re-view what smallholder farmers, agricultural education and training institutions, and extension services do in the light of policy, science, indigenous knowledge, innovation and local contextual influences. The review focusses on learning, knowledge 'transfer' and exchange, and agency.

2.4.1 Cultures of small-scale (or smallholder) farming praxis

The literature shows that there is no single definition of small-scale farming. Each definition depends on the context but all converge in recognising the subsistence, semi-subsistence and commercial farmer at household, group and company levels taking into account territory and socio-economic conditions (McIntyre et al., 2009; Wolfenson, 2013). Huvio, Kola and Lundström (2005) observe that small-scale farmers constitute "a widely diversified group from middle class family businesses well-integrated into the market economy to subsistence farmers, who constitute almost 75 per cent of the world's poor" (p. 14). Nagayets (2005) observed that "small-scale agriculture is often, albeit not always appropriately, used interchangeably with smallholder, family, subsistence, resource-poor, low-income, low-input, or low-technology farming" (p. 1). Kirsten and Van Zyl (2010) provided a critique of the limited view of the concept of small-scale farmers in the South African context as backward and non-productive, arguing that it is value-laden and offered a redefined view of a diverse group. Cousins (2010) also problematised the 'smallholder' farmer terminology as obscure (see section 1.3). To avoid confusion of terminologies and meanings, I have used the terms smallholder and small-scale farming interchangeably unless explained otherwise, close to the meaning ascribed by Huvio et al. (2005) and including field crop and livestock farmers and household food producers.

In Africa the majority of farmers are smallholders, most of whom are women. Of all African farms, two-thirds are below 2 hectares and 90 per cent below 10 hectares (Altieri, 2009). On a global scale, small-scale farming has made a big mark in terms of contributing to food production and productivity, food and nutrition security, environmental sustainability and innovation (Wolfenson, 2013). It is estimated that currently small-scale farming contributes more than half of the world's food production, and accounts for up to 90 per cent of the food Africa grows, with little or no use of agro-chemicals and improved seed (ActionAid International, 2011; Altieri, 2009; FAO, 2002). Despite these important attributes, the challenges to the changing landscape of smallholder farming need to be acknowledged while any romanticisation and ostracisation of it needs to be avoided in order for objective engagement with its development to be possible (De Schutter, 2010).

The cultures of small-scale farming often conserve biodiversity by growing indigenous varieties and breeds, integrating crops with indigenous plants and valuing domestic animals, insects and wildlife (Altieri, 2009). Such farming systems in turn require little or no chemical fertilisers, pesticides or fortified feeds to grow in their locally-adapted environments and thus help farmers to adapt to and mitigate impacts of climate change and variability (Reynolds & Nierenberg, 2012).

Despite its importance, small-scale farming has been sidelined in global, regional and often national food policy decisions, but advocacy voices have started to emerge. Agricultural education and farmer training have followed a similar pattern, but with slower transformation (World Bank, 2007). The small-scale farming constituency has had an absent or silent voice in many international food and water fora which make decisions directly affecting their farming systems (Unisféra International Centre, 2005). In such meetings as the World Trade Organisation (WTO) ministerial conferences and agricultural negotiations, agriculture ministers talk a language of investment, trade, markets and commodities that is often unfavourable to or decontextualised from the small-scale farmer (Künnermann, 2009) and their more traditional cultures founded on local praxis and co-existence values. The relationship between trade policies and small-scale farmer resilience in rain-fed systems is described by Unisféra International Centre (2005) as follows,

> Small farmers are often neglected or disadvantaged by the policy environment, … the trade regime. … unless something is done to facilitate the integration of small farmers in the global market, trade liberalization will not succeed in alleviating poverty in rural drylands. (p. 14)

This view is in agreement with Shiva (2002) cited below. In recent years, small-scale farmer organisations, indigenous people's groups and food sovereignty groups have and are holding side events and sometimes plenary meetings at agriculture, human development, environment and climate change conferences and meetings (Künnermann, 2009; ESAFF, 2014). Small-scale farmer groups are increasingly being supported by NGOs to elevate their voices at such important meetings and are also forming resistance to food security capture by the corporation through social movements in various other forums (African Centre for Biodiversity, 2017b). FAO has started paying more attention to indigenous smallholder farmers' contexts of praxis (Wolfenson, 2013) leading to the development of manuals of indigenous people's food systems (FAO, 2009; FAO, 2010a; FAO, 2013). These organised farmer-driven food systems take into account agricultural water and locally-adaptive seed (De Schutter, 2010; SAFSC, 2016).

The World Trade Organisation has been known in the past to produce international policy that violates small-scale farmers in major ways, attracting large protests at its meetings. In 1947, in the aftermath of World War II, 23 nations formed the General Agreement on Tariffs and Trade (GATT) with the purpose of liberalising, expanding and stabilising world trade in a global community. As more

members joined in the ensuing decades, GATT grew to form the World Trade Organisation in 1995 with the constitution of a single global economy. The WTO, with a membership of 150 members controls 90% of world trade and is powerful enough to impose punitive fines on non-complying Member States although it claims to be a free trade institution. While the WTO purportedly expands free trade and assists developing countries to benefit from its trading system, in practice it has been viewed by small-scale farmer organisations as more to do with promoting the operation of large multinational corporations than promoting trade. Trade restrictions are still very strict thus defeating the freedom to trade especially of developing countries; rather it is the multinational corporations that are free to operate where they wish without interference from governments and people or border controls. The WTO's governance system has thus been questioned as a form of neo-colonialism as it was not put in place by the democratic participation of citizens of nations where the benefitting corporations are operating and its debut meetings had little transparency (Khor, 2000).

Civil movements have had a profound effect in transformation of trade and social justice to attract due consideration to small-scale farming systems, but true transformation remains elusive as civic education on socio-ecological justice issues is lacking or even restricted. Hence transformative formal and non-formal education remain vital avenues for improving the participation, recognition and resourcing of small scale farmers in developing post-colonial states so that they counter negative globalising influences by the corporation (Mazoyer, 2001). This is because small-scale farmers do not get the support they are promised by international trade organisation as shown by the poor progress in WTO policy alignment to small-scale farming systems despite many mass protests (Britannica, 1999; Ghosh, 2013).

The significance of a discussion of the tensions in world trade to this study is to understand how globalising policies can affect national policies on the performance and success of small-scale agriculture and food sovereignty in developing countries. The role of grassroots social movements, on the other hand, shows that local co-engaged learning and international collaboration can contribute to the survival, recognition and development of artefacts that ensure food sovereignty for food security. Food sovereignty has been described by FAO as

> A system that returns the land to its social function as the producer of food, *puts the people who produce, distribute and consume food at the centre of decisions about food systems and policies, as opposed to the demands of markets and corporations*. It is based on small-scale farmer-driven agriculture that prioritizes local and national economies, as well as markets based on environmental, social and economic sustainability. Food sovereignty *implies new social relations*. (Wolfenson, 2013, p. 26, emphasis mine)

Vandana Shiva (2002), a leading critique of globalising trade policies, revealed the problem of national economic policies which are blind to the effects of world trade thereby threatening local small-scale

farming and household food security. She offered a word of caution on the importance of connecting local production to global trade by critiquing the analysis of a leading economics and famine expert thus,

> Amartya Sen is the world's leading expert on the causes of famine. But he is wrong in his analysis of contemporary famine. His analysis ignores trade liberalization and globalization as a cause for why people are hungry today. In offering free trade solutions to hunger, he is offering the disease as a cure. (ibid., p. 6)

Shiva's (2002) argument, which runs across many of her writings on the emancipation of small-scale farmers from neo-liberal trade policies, biopiracy, biotechnology, the plunder of knowledge and social injustice (Shiva, 1992; 1997; 2005), echoes what Africa also needs, but from an Indian and international experience. It is no wonder that grassroots activists are emerging in southern Africa and particularly in South Africa and Zimbabwe advocating for food sovereignty (ESAFF, 2014; SAPSN, 2014). Their voices are not heard in the mainstream discourse because of the dominant voices of normalised government policy, extension services, agricultural education curricula and the influence of multinational corporation greed on research and extension (Murphy, 2012). Some of the cases discussed in this study (Chapters 4 and 5) will show the efforts of these emerging voices and how formative intervention in CHAT, which rests on principles of multi-voicedness (see Chapter 3), allowed their voices to be heard (Chapters 6 and 7).

2.4.2 Cultures of agricultural water praxis: Rainwater harvesting and conservation and irrigation

This section briefly traces the cultures of rainwater harvesting and conservation in southern Africa, within a global perspective of agricultural water and other competing uses. The global picture of water supply and sanitation coverage indicates that only 56% of Sub-Saharan Africa has access to water. The largest number of unserved people also occurs in this region, totalling 332,351 million (Potter, Binns, Elliot, & Smith, 2008, p. 247). The statistics for sanitation are even worse, with only 31-37% (the lowest) in Sub-Saharan Africa having access to sanitation, just one notch below South Asia (ibid.; UNESCO, 2016). The UK Department for International Development (2001) estimated serious lack of access to safe drinking water to affect over one billion people at the beginning of the 21st Century. Water supply and sanitation improvements, on the other hand, also have positive effects on reducing morbidity due to diarrhoea. Studies have shown the following contributions of improvements to morbidity reduction: quality of water (16%), availability of water (25%), and quality and availability of water (37%) (World Bank, 1992). In addition, water harvesting becomes crucial when considering how many aquifers and rivers are over-used: many aquifers have reduced recharge due to changes in surface conditions and siltation of reservoirs reduces capacity by an estimated 1% per year (a loss of 66 billion cubic metres per year) (Postel, 2009).

Rainwater harvesting in this study is understood as the natural or systematic collection, channelling and storing in the soil or reservoirs of rainwater for domestic and on-farm use especially crop and animal production (Lancaster, 2009; Denison et al., 2011). A global scope reveals that rainwater harvesting and conservation (RWH&C) emerged with civilisations in North Africa and around the Mediterranean region, with the knowledge practices gradually mixing with those from parts of Asia, the Middle East and Near East (Oweis, Hachum & Bruggeman, 2004; Falkenmark, Fox, Gunn & Rockström, 2001; Denison & Wotshela, 2012). Through migration and learning, RWH&C has been practiced successfully in various dry places of the world including southern Africa, Asia and South America among others. The wide-scale successes of RWH&C in places like Rajasthan in India give inspiration to many semi-arid places across the world of the potential to grow more food with less rain. In Africa, Mali, Burkina Faso, Sudan and Somalia among others have a documented history of rainwater harvesting and other water innovations such as flood-assisted farming (Harlan & Pasquereau, 1969; Critchley, Reij & Seznec, 1992). South Africa also carries a good documented history of RWH&C that includes indigenous and indigenised practices such as *gelesha* and *saaidamme* (Auerbach, 2003; Denison & Wotshela, 2009; Denison & Wotshela, 2012).

Gelesha is an indigenous soil conservation technique that helps to conserve moisture and has been practised by the Xhosa in South Africa. The technique involves post-harvest ripping of the soil usually during the winter to spring period to conserve the moisture still in the soil and mulched by the crop residue (Denison & Wotshela, 2009). In isiXhosa *gelesha umhlaba* is a term that means tilling, hoeing or scrapping the soil to break the hardened top crust, and has another version in some areas of turning over the soil where it is called *ukuphethula umhlaba*. It was and is still done after harvesting crops. This practice is used to ensure that rain or dew could infiltrate the tilled soil and be absorbed by the soil particles so that it can provide moisture for the next planted crop. According to Denison and Wotshela (2009), "historically *gelesha* was done when a digging star (the Orion constellation) *isilimela* appeared in the autumn and after the harvesting of the summer crops' (ibid., p. 19). This natural phenomenon coincided with the season (reported as mid-winter, or July) when cattle for draught power were still strong enough as forage was still abundant. A similar type of practice to *gelesha* is carried out in Zimbabwe where it is called *kuvundukura* in ChiShona. It came with the advent of the plough in the early 1900s; farmers traditionally practised winter ploughing known as *kuvundukura* in ChiShona meaning to turn over the soil using an ox-drawn plough, mimicking the earlier practice using wooden sticks (Kramer, 1997). The principle applied here was to break the hard top soil crust and to plough down crop residues left by roaming cattle after harvests, so that moisture would percolate the soil and be trapped in it for a long time till the next planting season.

Saaidamme is another rainwater harvesting and conservation practice based on a system of harvesting flood water, which arose from farmer innovations in the Northern Cape Province of South Africa (Denison et al., 2011). *Saaidamme* is an Afrikaans word for 'planting dams'. Denison and Wotshela (2009) gave a detailed description and history of the *saaidamme* in a report to the WRC. Describing a farmer's *saaidamme* system in the arid western part of South Africa, Denison et al. (2011) noted that,

> The *saaidam* itself is a large flat field which is surrounded on all sides by a low earth wall… about 1 m to 1.5 m high. Once every year or two, a flood comes rushing down the dry riverbed from the mountains about 120 km away. This floodwater is diverted into the saaidamme over a few days… The water is held knee-deep in the *saaidams* for 2 to 3 days and soaks deeply into the soil… (p. 7)

The *saaidamme* system has been known to work effectively, nourishing and watering fodder crops such as deep-rooted lucerne to support large livestock volumes that would otherwise not survive in such arid to semi-arid conditions. Despite its effectiveness, *saaidamme* have gone largely unnoticed in the past by the Department of Water Affairs planning and reporting in areas where it occurs (Denison & Wotshela, 2009). This indicates a type of bureaucratic blindness to innovation that ends up absenting important alternative sustainable water praxis. It is hoped that since the Department of Water Affairs partly funds the WRC, it will take the latter's research reporting into its mainstream strategic planning and reporting in the future for implementation and scaling and not only for ensuring licensing, monitoring and compliance with the law.

From intensive on-station and on-farm research on improved food security using in-field RWH&C in Thaba Nchu in the Free State Province, Backeberg (2009) saw huge opportunities for scaling of RWH&C among rural smallholder farmers in South Africa, but also some obstacles. Opportunities included the replicability potential that had already been demonstrated, taking account of soil tests and types for suitability, aspirations and keenness among some to improve their food security through improved access to water, and access to knowledge and people's capabilities. While research participants in the Free State had relatively low potential soil and rainwater available, they were keener to pursue rain-fed crop production scaling from homestead gardens, while in the Eastern Cape participants did not prefer such arable production as a livelihood strategy. Backeberg (ibid.) (citing Robertson) reported that in the Eastern Cape case study "the composition of households, dominated by young children and old people, appears to be an impediment" (p. 5). This project was later rolled out to some selected households in the Alice area of the Eastern Cape.

Rainwater harvesting and conservation innovations in Zimbabwe do not have a long documented history in the literature, but have a recent history of reported effective use, apart from the shifting cultivation and soil turning discussed earlier. However there are some highly effective RWH&C

innovations that have been recorded in Chivi communal lands (Masvingo Province) and Zvishavane / Mazvihwa area (Midlands Province) and Mutoko communal lands (Mashonaland West Province), (Murwira, Wedgwood, Watson, Win, & Tawney, 2000; Lancaster, 2009; Denison et. al., 2011). Another well-developed practice of these innovations are the deep contours developed by Zepheniah Phiri in Zvishavane and Mazvihwa communal lands as a farmer innovator, project officer and Director of Zvishavane Water Project, an NGO he founded in 1986 (Witoshynsky, 2000; Denison et. al., 2011; Pesanayi, 2012; Pesanayi, 2016a; Mabeza, 2016).

Having reviewed the benefits of RWH&C, it should also be noted that it is not a panacea for agricultural water, as it has its own challenges and at large scale raises questions around catchment-wide impacts. “While Water Harvesting is a valuable tool for the increase of water yield in a catchment, it may be detrimental to the environment if not implemented in a responsible manner” (South Africa. DAFF, 2008a, p. 42).

A recent conservation agriculture technique was introduced in 2013 to mechanise conservation farming as a way of strengthening the practice in sub-Saharan Africa. Farm Mechanisation and Conservation Agriculture for Sustainable Intensification (FACASI) project started implementation in four countries namely Ethiopia, Kenya, Tanzania and Zimbabwe. The overall goal of the FACASI project was described as “to improve access to mechanisation, reduce labour drudgery, and minimize biomass trade-offs in Eastern and Southern Africa, through accelerated delivery and adoption of two-wheeled tractor (2WT)-based technologies by smallholders” (CIMMYT, 2013, p. 4). The business model for this technology is illustrated in Figure 2.1 below:

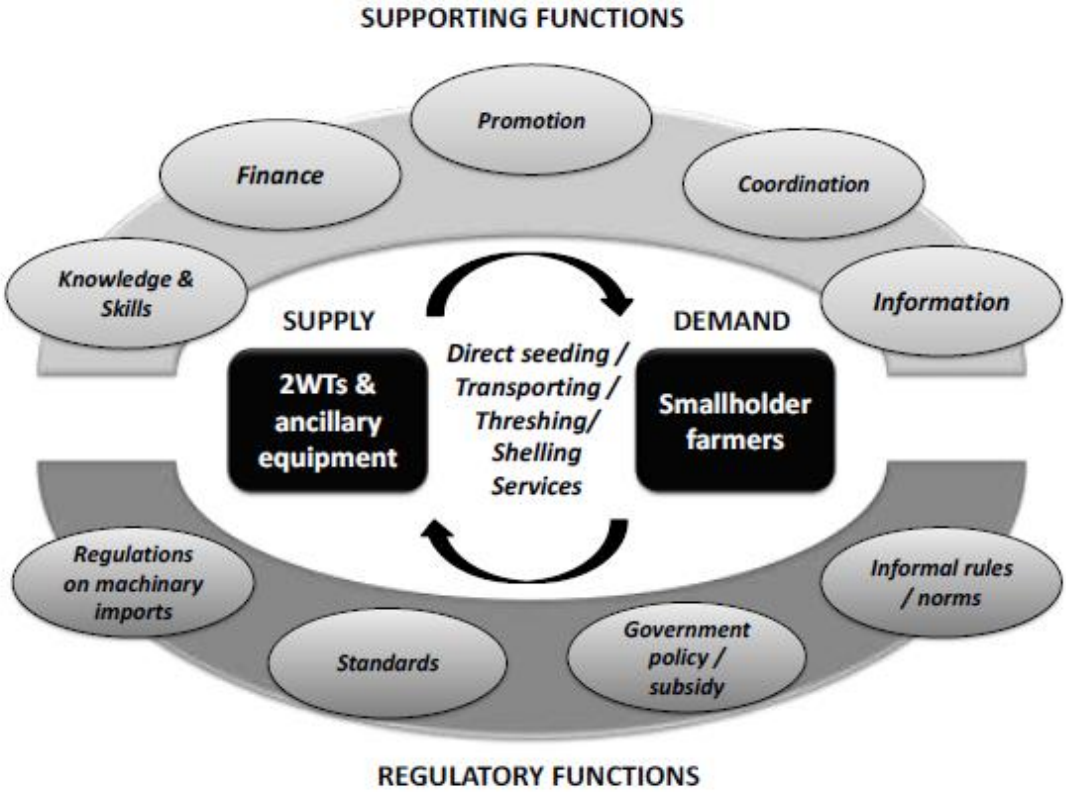


Figure 2.1: *Components of a generic two-wheel tractor (2WT)-based technology business model for small-scale farming (adopted from CIMMYT, 2013, p. 7)*

According to CIMMYT, the argument for mechanisation of conservation agriculture is based mainly on economic and socio-cultural factors which include decline in draught power due to decreased draught livestock numbers, decline in human labour and the collapse of most tractor hire schemes. The human labour drudgery resulting from low mechanisation has been linked to gender-disparities affecting women disproportionately through such practices as "weeding, threshing, shelling and transport by head-loading" (CIMMYT, 2013, p. 7). However, a balance between indigenous knowledge practices and innovations versus reducing labour drudgery needs to be struck, in a similar way to which the balance between increased farm power supply versus reduced power demand has been recognised.

The development of various cultural practices to harvest and conserve rainwater are a testimony to the high-dependence on rain-fed agriculture that exists in southern Africa and worldwide, and the poor availability and access to irrigation for small-scale farmers. The Zimbabwean irrigation development situation was described as follows by Manzungu (2001),

> *Irrigation*, which could go a long way in alleviating the aridity problem, *does not hold much promise*. Large-scale commercial farms account for 84% of the total irrigated area, parastatal

> schemes for 9%, and the smallholder farms for 7%. Expansion of the sub-sector, which entirely depends on government financial support, looks bleak. (p. 102, emphasis mine)

The naming and distribution of farm typologies obviously changed soon after the publication of the above with the land reform programme (with small-scale farmers now accounting for over 70%), but functional dams and irrigation systems are reported to have declined. Economic policy analysis research has recommended a focus on rehabilitation of ageing or deteriorating dams than new developments (World Bank, 2012) as desired by the Comprehensive Agricultural Policy Framework and Zim Asset. However, elsewhere research has recommended that in RWH&C designs, irrigation should not be seen as separate but integrated into the system (Oweis et al., 2004; Denison et al., 2011). Accompanying sustainability in irrigation is efficiency (Backeberg, 2014).

2.4.3 Cultures of praxis in locally-adaptive seed crop production, seed saving and exchange in southern Africa

While sorghum and millet are better suited to areas with variable climate such as low or erratic rainfall and high temperatures than maize, maize has a historical competitive advantage giving higher yields in many years in drought-prone areas including in acidic soils (FAO, n.d.). This is because maize was favoured with more research, improved varieties and technology and greater extension support for higher productivity than small grains (ibid.). The culture of growing maize as a substitute for the traditional small grain staples grew out of complex political (discussed earlier under policy) and social conditions during the colonial era in southern Africa (Palmer, 1977; Beach, 1983). Drought events of 1992, 1995, 2003 and beyond in southern Africa prompted many governments, NGOs and farmers to reconsider the value of neglected crop staples such as millets and sorghum realising the poor performance of the preferred maize crop (UNEP, 2006; SADC, 2008). Meanwhile, innovative farmers, agro-ecological farmers, and some farmers considered poor were still growing these small grains each season, including drought tolerant and climate adaptive pulses such as Bambara nuts, cow peas, pigeon peas and cucurbits among others (Chisi, 2003). Despite variety development, adoption rates are however low (Chisi, 2015). WWF-SA (2010) noted that

> Indigenous African food crops, such as millet and sorghum, have lost their status. Concerted efforts need to be made to ensure that these hardy crops are not lost to agriculture forever. A fatal element in the runaway loss of our genetic wealth is the fact that it is not evident to the public when one looks at the bread shelves or the meat counter. (p. 16)

However, locally-adaptive food crops varieties keep gaining importance in production, consumption and marketing with the ever increasing climate change impacts (SADC, 2013a; 2015c).

2.4.3.1 Cultures of praxis in locally-adaptive seed crop production, seed saving and exchange in South Africa

According to the South African Department of Agriculture, Forestry and Fisheries (DAFF, 2013) there is a diversity of indigenous grains (cereals and pulses) and vegetables that are still grown in different parts of South Africa that make a significant contribution to industry and household food security. DAFF (2013) defines indigenous grain crops as "any crop yielding starch and protein enriched seeds suitable for food" (p. 1) and identifies pearl millet (Limpopo, KwaZulu-Natal and the Free State provinces) and grain sorghum (Limpopo, KwaZulu-Natal, Free State, North West, Northern Cape, Eastern Cape and Gauteng provinces) among the grain crops and their main production centres. DAFF (ibid.) noted that there are challenges with the indigenous food sector that include fragmentation of the sector, wild occurrence and harvesting, and trade limited to local informal markets. Also "production and consumption have declined; and there is limited and undocumented information owing to the minimal (or lack of) research that has been conducted" (ibid., p. 1). Shava (1999) reported similar trends of decline in use noting that wild and indigenous planted plants were stigmatised as food for the poor, sources of disease and primitive. More recently in an ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) study, Orr, Mwema, Gierend and Nedumaran (2016) reported persistent preferences to maize

> Large areas of South Africa are classified as dry or moist semi-arid, making them ideal for sorghum and millets. However, *farmers in these zones prefer to plant maize rather than sorghum and millets, because of food preferences*. (p. 7, emphasis mine)

However, interest and value in locally-adaptive seed crops was noted to be growing in government, NGOs and research institutes due to their climate change adaptation properties (DAFF, 2013). From a United Nations-sponsored case study in South Africa, Ziervogel, Bharwani and Downing (2006) reported that poor farmers generally had greater crop mix (diversity) and other strategies that allowed them to adapt better to climate variability especially when they know the forecast whereby they respond to the performance of the rainfall season. "With a below normal forecast they do not give up on market crops, but either wait for the rain before planting, or plant half their seed initially and wait for the rain to plant the rest" (ibid., p. 299).

Recognising the concern in the loss of plant genetic diversity due to genetic erosion, the South African national Department of Agriculture established a National Plant Genetic Resource Centre in 1996 that does seed testing, regeneration and storage among other things in line with the SADC Plant Genetic Resources Centre of which it became a member in 1995. The Centre coordinates all activities related to conservation and sustainable use of seed resources for food and agriculture in the country. Pilot community seed banks were started in Limpopo and Eastern Cape Provinces in Vhembe and Joe Gqabi Districts respectively (SPGRC, 2017; Tjikana, Maluleke, Mokoena, Vernooy & Sthapit, 2016). There

are small pockets of seed saving groups and community seed banks in South Africa and these are growing due to the efforts of advocacy groups and organisations such as Zingisa Educational project, South African Food Sovereignty Campaign, and African Centre for Biodiversity among others. The next sub-section discusses the counter-culture of GMO praxis in South Africa.

2.4.3.2 Culture of GMO praxis in South African agriculture and smallholder food production

South Africa's main staple production is dominated by genetically modified (GM) varieties whose production is marred in controversies and power relations regarding uncertain health risk, access to alternatives and appropriateness for smallholder farmers' rain-fed contexts (Fischer, Berg & Mutengwa, 2015). South Africa led the rest of Africa by conducting its first field trials on GMO crops in 1989 (Wolson, 2007). In 1998 the country planted its first GM maize namely MON810 an insect-resistant variety developed by Monsanto, and in 2002 it grew its first soya. Since then South Africa has become the eighth largest producer of GMO crops in the world (WWF-SA, 2010). The MON810 GM maize variety has been shown to have failed farmers (African Centre for Biosafety, 2011; Fischer et al., 2015). Monsanto has so far released three GM crops in South Africa which include GM white maize, GM yellow maize (together accounting for over 80% of cultivated maize) and more than 90% GM soya bean (African Centre for Biodiversity, 2016b).

Pannar's non-GM hybrid maize variety called SC701 appears to be popular with some government departments of agriculture (extension services) in South Africa, for example in KwaZulu-Natal and Eastern Cape provinces where it is promoted among smallholder farmers. A study by the KwaZulu-Natal Department of Agriculture in collaboration with the University of KwaZulu-Natal supported this variety by providing attributes for an 'ideal' hybrid that included sweet taste, long shelf life and large ears (Qwabe, Derera & Tongoona, 2013).

Despite its usual 'neutrality' as an inter-governmental body, FAO has been caught up in the politics of knowledge regarding GM food production praxis (FAO, 2010b), resulting in major criticism and the risk of international incidents violating national sovereignty (La Via Campesina, 2010). Perhaps the key message of contention was FAO's assertion at a conference on food that biotechnology had much potential but was not having a significant impact yet in the lives of people in poor countries, and "according to FAO, biotechnological innovations can be of significant assistance in doubling food production by the year 2050 and in addressing the uncertainties of climate change" (FAO, 2010b). La Via Campesina's (2010) reaction was straightforward, and indicated unhappiness with absence of farmer invitation and accreditation to the conference,

> We take it as an act of aggression, as a profound lack of respect, and as an affront, that the [FAO] has decided to meet in Mexico with governments and the private sector, under the false argument that 'biotechnology can benefit peasants in poor countries'. (no page)

While most of the other countries in southern Africa have avoided GM seed as a risk to their local seed systems, some among them such as Swaziland and Zimbabwe have benefitted from South African GM grain imports during periods of food crisis especially when drought strikes (Masinjila, 2017). However seed security assessments have shown that grain imports during droughts may be reduced through locally-adaptive seed (FAO, 2016). The Academy of Science of South Africa (ASSAf, 2010) has contended that South Africa "is a role model for the rest of Africa. South Africa is seen as the hub of agricultural biotechnology for Africa" (p. xviii) and therefore promotes it regionally.

2.4.3.3 Cultures of praxis in locally-adaptive seed crop production, seed saving and exchange in Zimbabwe

The traditional seed saving culture in Zimbabwe has been used as a model by NGOs supporting small-scale farmers' local seed, food and water security systems. NGOs that have been involved include Africare, Catholic Relief Services, Chimanimani Ecological Land Use Community Trust (CELUCT), Community Technology Development Trust (CTDT), Environment Africa, Wildlife and Environment Zimbabwe, ITDG (now Practical Action) and Participatory Ecological Land Use Management (PELUM) among others (Progressio, 2009; African Centre for Biosafety, 2015b). NGOs such as Environment Development Activities (ENDA) Zimbabwe have in the past worked with communities and government to store diverse locally-adaptive seed varieties at local and national levels, which received recognition by the regional seed bank (SPGRC, 2016). The seed saving programmes led by NGOs became so successful in the 1990s that government decided to also get involved in promoting seed saving and seed fairs through voucher systems in 1999 (Progressio, 2009). NGO support of seed saving has, however, been erratic over the years due to poor funding and conflicts with government that came to a head in 2007/2008 towards a heavily contested national election that saw NGOs being temporarily stopped from servicing rural areas; and command agriculture and farm mechanisation schemes taking over (Solidarity Peace Trust, 2006; Mabhena, 2013; Pindula, 2017). This situation points to the need for alternative ways of learning to adapt to water scarcity through seed systems (Vernooy, Bessette, Rudebjer & Otieno, 2016).

The Department of Agricultural Technical Extension (AGRITEX) has adopted the culture of seed fairs since the 1990s and organises these annually from ward to provincial levels culminating with a national event to promote seed saving and exchange. African Centre for Biosafety (2015b) noted that the Zimbabwe's Plant Breeder's Rights Act allows "some level of saving, exchanging, donation and sale of farm-saved seed/propagating material" (p. 54) which supports seed saving cultures. Seed saving

however has often been placed at risk by disaster risk unpreparedness when the macro-economy is depressed and worsened by climate change and drought when multinational seed corporations are allowed to take over government dominated seed input subsidies (ibid.).

Studies have revealed that farmers in Zimbabwean rural areas have various seed preferences, that is local and commercial open pollinated varieties (OPVs) or commercial hybrids due to ambivalent influences they receive from different sources including extension services, NGOs, seed outlets and the Grain Marketing Board (GMB) (Pesanayi, 2008; Progressio, 2009). With national parastatals and private seed outlets succumbing to economic pressures, such international seed producers as ICRISAT and national research stations (e.g. the Matopos) have gained importance as OPV seed sources accessible to NGOs and farmer organisations. A study by Progressio (2009) revealed that farmers often bought hybrid seed (crossed for certain desired traits from two selected parent plants) from trade stores but the gains are not always sustained. This is because "hybrid plants have uniform features including maturity and height. … often high yielding" which is good for the market and household, "but if replanted they will not produce uniform plants, and the yield will reduce by about 50 per cent" (p. 11). Replanting of saved seed is a culture that is part of the traditional seed systems of rural farmers and is linked to adaptation to low incomes with potential to increase incomes through consistent and networked production to meet demand in competitive market economies. It is threatened by worsening poverty and climate change that lead to eating of seed, delayed land preparation and planting (ibid.). A tension between small grains and maize praxis persists as the latter was particularly promoted by the colonial government's extension services as the right crop for recognised 'master farmers' and good for the market (Keyter, 1978) such that it is the preferred staple. These were maize varieties different from the varieties already adapted to the local climate which local farmers already had in their villages. Figure 2.2 illustrates how the vicious cycle of poverty was experienced in certain typical Zimbabwean communities, and how seed assistance interventions can reduce poverty.

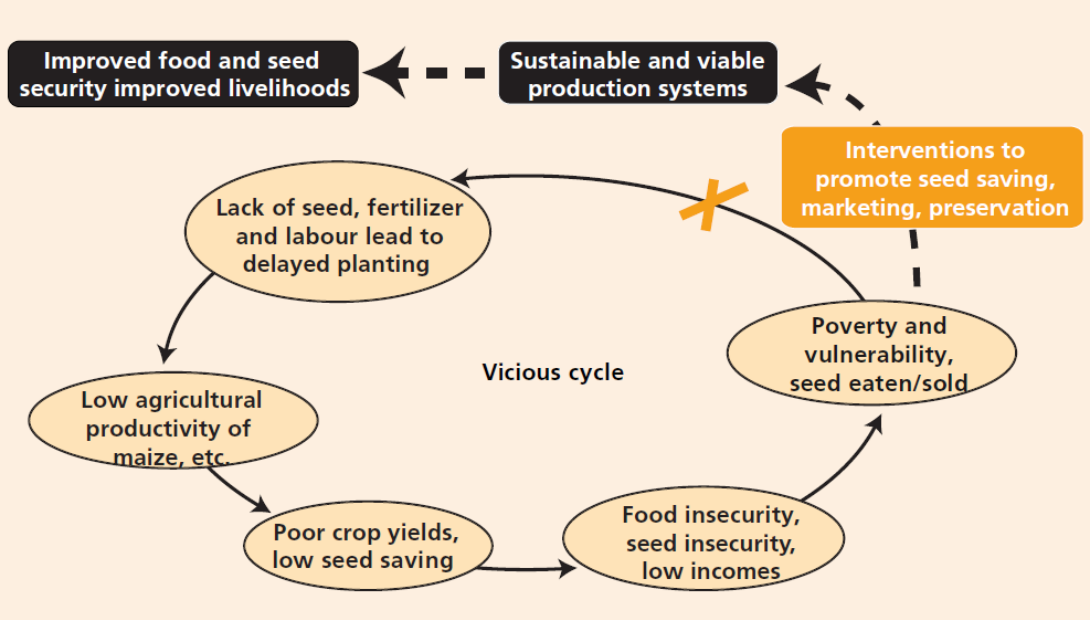


Figure 2.2: *The cycle of poverty and vulnerability and possible seed interventions (adopted from Progressio, 2009, p. 11)*

Figure 2.2 illustrates a problem precipitated by the absence of locally-adaptive seed systems and how it can be solved through seed saving and marketing interventions. However the analysis is incomplete without factoring in the role of agricultural water security which is a limiting factor in most Zimbabwean rural farming areas even if seed and soil fertility are in place. This is because of climate change and frequent droughts in the country. Seed security needs to be treated systemically together with water security just like the need to integrate agricultural disciplines in interventions including development work, extension education and training (Kroma, 2003; Padgham, 2009) and farming practice. For such integrated seed, water, practice, policy, academic and social processes to happen, there is need for well-informed farmer-led advocacy.

One such organisation that emerged in Zimbabwe out of policy-practice processes is the Zimbabwe Smallholder Organic Farmers Forum (ZIMSOFF). ZIMSOFF is a small-scale farmers' organisation that emerged from a small-scale farmers' convergence of the East and Southern African Farmers' Forum (ESAFF) in a parallel event at the World Summit on Sustainable Development in 2002 organised by PELUM (Terra Madre Foundation, 2017). According to ZIMSOFF (2016),

> The aim was that farmers should be at the forefront of driving awareness-raising and policy change towards a transition to Agroecology. In 2012 ZIMSOFF joined La Via Campesina and in 2013 became the host for its international secretariat. (p. 2)

ZIMSOFF, recognising the threat of industrial agriculture and its well-funded campaigns in Africa, has a revitalised mission of influencing policies at national and institutional levels and public awareness towards agro-ecology with farmers' rights and contexts at the forefront. Through this

mission, one of ZIMSOFF's strategic objectives is "to enhance/increase smallholder farmers' voice to influence policy reform towards community seed sovereignty" (p. 7). This mission is designed to influence what the organisation sees as barriers in mind-sets towards agricultural development. These include the approach and practice of academia to agricultural education such as in "*agricultural colleges* the *overriding emphasis* is on the green revolution/industrial agriculture" (p. 11, my emphasis). A shift from industrial agriculture to Agroecology is gaining international support (Frison & Jacobs, 2016). Other barriers targeted by the mission are the weakness of political expediency and agricultural industry's greed. In its current strategic planning, ZIMSOFF continues to recognise the potential of agricultural colleges and the efforts they are making to include agricultural biodiversity in the curriculum; the discussion of agricultural education praxis will be made in subsection 2.4.4.3. ZIMSOFF has therefore planned activities to work with other stakeholders to mainstream spread of agroecology such as to "develop MOUs and plan of action with *strategic allies* e.g. … *Agricultural Colleges*" (p. 13, my emphasis), PELUM-Zimbabwe and Zimbabwe Land and Agrarian Network (ZiLAN) and the Zimbabwe Organic Producers and Promoters Association (ZOPPA). The cultures and responses of agricultural education and training praxis are discussed below.

2.4.4 Cultures of agricultural education and farmer training praxis: Silenced and privileged voices

The cultures of agricultural education and farmer training in Africa are characterised by the inescapable bifurcated or dualistic agricultural landscapes as the independent countries emerged from colonialism (McIntyre et al., 2009). The stronger arm in this dualism, large-scale conventional agriculture, tends to dominate the education and training discourse with the excuse of economic growth, competitive advantage and trade. According to two independent reports by FAO and the World Bank, it is therefore a discourse of the economically more powerful and the dominant ruling class, with smallholder farmers' voices loud by their absence symbolised by their embodied contexts and knowledge practices (World Bank, 2007; McIntyre et al., 2009). The seminal report by McIntyre et al. (2009) pointed out pedagogical absences,

> Agricultural Hands-on training for students is minimal, work placements are limited … and no country offers job placements services to graduating students ... Work placements are essential, not a luxury, for Africa. They expose students to actual problems of production, processing, and marketing. They connect classroom teaching with the real world. (p. 34)

This absence of practical work is compounded by an earlier observation by Hall (1995) that

> In some cases, the extension workers have more to learn from farmers than to teach to them, but unfortunately they're not learning. *No one is taught at university to listen to farmers*, or attempt to understand their priorities or problems or to explore their potential. (p. 33, emphasis mine)

The above problem points to both extension workers and agricultural university extension education with the latter as the source of the problem that becomes systemic along the relational knowledge chain. Agricultural learning in the university lecture rooms is therefore incomplete at graduation and needs to continue in the field. While the statement regarding farmers not being listened to may sound far-fetched and perhaps there may be a distinction between universities and agricultural diploma colleges, there is corroboration of similar ideas by McIntyre et al. (2009, citing Leach; and IDS), that

> The history of the last sixty years may be read in part as a history of struggle to get the voices of the poor, of women and other marginalized people heard in the arenas where science and technology decisions are made. (p. 66)

The above claim from agricultural education writers agrees with Freire's (2005b) proposal for a "practice of freedom" that allows for the voices of the students and teachers to be heard democratically. This is posited against what Mocombe (2004) describes as an

> … antidialogical pedagogy in which the teacher's knowledge is taught to the student and becomes their (practical) consciousness. The latter case … (which characterizes the mechanism of the oppressor), is totalitarian, and simply attempts to indoctrinate (in order to reproduce the dominant social order) rather than liberate, whereas the former, dialogical pedagogy, allows the oppressed to remain a transformative agent within their historical material conditions. (p. 25)

It appears then that interventions need to be formative in order to ensure that voices are diverse, and that they are projected, heard and listened to, and by the right people in social learning contexts (Leeuwis & Pyburn, 2002; Borsari, 1999; Wallace, Mulhall, & Taylor, 1996). This implies effort and time for relationship building rather than transmission. The next section re-views the culture of Agricultural Education and Training in South Africa with respect to small-scale farmers' voices.

2.4.4.1 Historicised culture of agricultural education and training (AET) in South Africa

The history of agricultural education and training (AET) praxis in South Africa is characterised by a dualistic system based on racial disparity hatched during the Apartheid era (Paterson, 2004; South Africa. DAFF, 2008a). Paterson (2004) chronicles the development of agricultural education in South Africa and noted that there was a deliberate separation of AET provision between Whites and Blacks. The White learners were more privileged with regard to opportunities, substantive agricultural content and exposure to agricultural science and research. Paterson (ibid.) noted that this segregation began during the Cape Colony government at the turn of the twentieth century whereby an industrial education curriculum for Blacks, deliberately devoid of technical skills and focussed on manual labour, was designed. Its aim was to develop African labourers who could not compete with their White compatriots for trades and artisanships.

> Accordingly, Africans would be taught the manual skills appropriate to their colonial agricultural context. Such training was calculated to improve the 'industriousness' or work capacity of Africans rather than to give them access to appropriate technical skills. (ibid., p. 94)

Paterson (2004) argued that this scenario was a result of deliberate socially engineered curriculum design and that "the material circumstances of most ordinary mission schools constrained learning and teaching opportunities" (p. 94). While the Department of Education was responsible for school curricula, the Native Affairs Department had both an interest and later an influence on agricultural schooling practice empowered by the Native Trust and Land Act of 1936 (see section 2.3.2.1 on policy). For example, the Local Native Commissioner had power to determine what school funds could be allocated. He could even overturn local council resolutions to allocate funds to purchase books for learners by diverting them to buy garden tools instead thereby advancing the Native Affairs Department's policies (ibid.).

Paterson (2004) described this conflict of motives as "the agricultural intent and value of schooling was contested between African communities and the colonial departments" (p. 87) noting racially divisive statements regarding separated models of schools. He also noted that most rural mission primary schools were also informed by the same racially undermining notion of the role of Africans in colonial society and had no problem in advancing an acculturation education as long as they received funding. The meaning of these actions for education is that African Blacks subjected to this acculturation associated agricultural education with manual labour, and this contributes to the general dislike of agriculture by youths in South Africa today (Bryceson & Jamal, 1997) and the absence of agriculture as a subject in the South African primary school curriculum (it only appears later in Grade 9) (Pesanayi, Khitsâne & Mashozhera, 2016). The importance of agriculture then was seen in the inclusion of agricultural skilling in the theological curricula at the South African native College (later University of Fort Hare) and Lovedale mission in the early twentieth century, and this had downstream effects as African theologians would often supervise mission schools.

Up to the democratic turn in 1994, institutions providing AET were identified in two groups, namely so-called 'historically black' and 'historically white'. They were separated by their distinct roles. For Agricultural Colleges, the 'historically black' institution's role was to "train extension officers, nature conservation and home economics officers" (South Africa. DAFF, 2008b, p. 8) while the latter's role was to "train future farmers and farm managers" (ibid.). The universities were training extension officers for the public and private sectors in both cases. However, they reflected a similar disparity in that the historically black institutions had limited post-graduate studies while the historically-white emphasised research and were strong on post-graduate studies. These disparities are also reflected in

the other AET providers such as agricultural high schools offering agricultural subjects, and technikons.

2.4.4.2 Contemporary AET praxis in South Africa and the persistence of legacy

The impacts of an inherited dualistic AET system have persisted in the post-democracy period. This dualism is reflected in roles and functions (in terms of the served target group) assumed by the AET organisations and their human resource output. The dualistic AET landscape is perceived to have negative impacts requiring policy and practice interventions and shifts (van Rooyen, 1998; The Presidency, 2008; ASSAf, 2017). This AET set-up exacerbates the capability deprivation and lack of knowledge of alternatives to agricultural water and locally-adaptive seed persisting in the small-scale farming systems. An evaluation of the South African agricultural curriculum which found issues of inappropriateness and misalignment of the agricultural curricula in schools, colleges and universities with Agriculture Department Policy (South Africa. DAFF, 2008a citing Worth) noted,

> Despite policy changes to develop a single integrated extension service (serving both the commercial and emerging/small-holder farming sectors) most educational institutions offering agricultural programmes *still have commercial agriculture as their primary focus*. *Issues related to small-holder farming, food security, rural livelihoods and sustainable agriculture hardly feature* in the agricultural curricula. (p. 171, emphasis mine)

The absence of focus on developing smallholder farmers and food security amounts to a capability depravation that is in direct contrast with national development policies. Drawing on Armatya Sen's capabilities approach, the South African NDP uses a transformative approach to change that relies on enhanced capabilities and an active citizenry with a "focus on what people are able to do" (South Africa, DP, 2012, p. 477). The need to work collaboratively and historically that resonates with my conceptual framework (see section 1.8) is underscored below,

> Alongside hard work and effort, capabilities and the opportunities that flow from development enable individuals to live the lives to which they aspire. A developmental state builds the capabilities of people to improve their own lives, while intervening to correct historical inequalities. Neither government nor the market can develop the necessary capabilities on their own. (ibid., p. 27)

The NDP strongly commits to a framework to adopt a minimum standard of living by South African society whereby "of these capabilities, *education and skills*, and the opportunity to work are the elements where South Africa most needs to make progress" (ibid., p. 38, my emphasis). This indicates the important role that agricultural education is expected to play in national transformation through transforming its curriculum content and approaches. Paterson (2004) reported that

> The place of agricultural curriculum forms in South African education is a *highly emotive one*. This is because 'agriculture' or 'gardening' activities undertaken by African pupils are *associated with impoverished curricula* under colonialism and apartheid. (p. 93, emphasis mine)

There is a conflict of motive in democratic South Africa and the rest of post-colonial Africa regarding the place of the agricultural curriculum contributing to national development goals and local development needs versus perception of education as a vehicle to move youths "out of the rural situation into a world of more opportunities" (Hartshorne cited by Paterson, 2004, p. 93). Kroma (2003) reported that curriculum transformation and revision processes "occur in *highly contested and politically nuanced* contexts that call for thoughtful considerations … involves acts of power that require *careful negotiation with stakeholders*" (p. 361, my emphasis). This means that the process of transformation and decolonisation of curricula is not a simple reversal of the ills of the colonial period but involves critical thinking, social learning and an immanent critique of prevailing socio-economic development models with respect to local contexts (Kroma, 2003). In light of these arguments, it is important to reflect on the impacts of agricultural policy reforms in democratic South Africa on the agricultural education and training curriculum.

In 2008 the South African Department of Agriculture commissioned an evaluation of the national AET landscape that found a number of contradictions in AET work regarding curriculum response to farmer contexts and sustainable agricultural water absences (South Africa. DAFF, 2008a). One of the AET evaluation objectives to this effect was:

> To what extent is the AET curricula aligned to the urgent challenges facing the agricultural sector (including issues such as sustainable agriculture and land care; *household food security* and *water harvesting*; *rural wealth creation*). (ibid., p. 5, emphasis mine)

Water harvesting for food security and rural economic development was identified as an urgent challenge by the evaluation, noting that the Minister of Agriculture repeatedly highlighted it and that it has been in widespread use in North Africa, "but is not a method that is yet entrenched in agricultural thinking in South Africa" (ibid., p. 42). The evaluation recommended inclusion of rainwater harvesting in the curricula of High Schools, FET colleges, Universities of Technology and other universities. In its recommendations, the evaluation report specifically reported that

> The SAQA accredited courses already provide a broad outline within which the discussion of Water Harvesting can easily be accommodated. (p. 108) … [and] … *All Universities* can pay more attention to the comprehensive *incorporation of* modules on food security, *water harvesting* and rural wealth creation within Agricultural and Social Science qualifications. (p. 114, emphasis mine)

In committing Agricultural Training Institutes (ATIs) to training farmers and agricultural officers, the South African training policy for ATIs (South Africa. DAFF, 2012b) expects training programmes to be "coordinated in such a way that they assist previously disadvantaged farmers *to overcome obstacles to their development into commercial farmers*" (p. 3). As discussed above, sustainable agricultural water is one of the main obstacles.

According to the norms and standards for the ATIs of South Africa (South Africa. DAFF, 2011), ATIs are mandated to

> Offer *a range of AET qualifications* at NQF levels 1-7; Conduct relevant applied research; ... giving attention to the *transformation agenda* by …*aligning curricula* to the human resource development needs *as identified by public and private sector stakeholders* in the agricultural sector; *Developing strategic partnerships* with relevant stakeholders and service providers … Function as centres of excellence within its respective agro-ecological zone. (pp. 8-9, emphasis mine)

From the above mandate, it is clear that agricultural colleges and ATIs are expected to respond to socio-ecological needs and these would include linkages and in some agro-ecological zones, the issues of drought, climate change and water security for food security.

The South African national Department of Agriculture in collaboration with the Netherlands Government introduced a Competency-Based Learning (CBL) project[15] to help agricultural colleges to comply with the national norms and standards for the ATIs. Eight agricultural colleges in South Africa were involved in the CBL project introduced from 2012 to 2015 (Chaminuka, Lalendle, Nompozolo, Viljoen, Ceballos-Müller & Brouwers, 2016). Each college had all its academics meeting with other college academics to assess and work around the better methods of agricultural training. The aim was to harmonise the college offerings and also to have a standard formula for the programmes offered by all the colleges in South Africa. CBL is a learning strategy that is centred on developing a curriculum that emphasises the type of product (job profile) the institution wants to produce. The content, assessment and application of the curriculum are solely based on the competency. CBL encourages interaction that is based on interactive learning methods which give the students equal ground to research the lesson beforehand. It encourages student-centred approaches of learning. The teachers' role is to coach and facilitate learning and comprehension of materials.

The CBL farmer profile had a number of learning lines including animal and crop production, soil science, business management, engineering and innovation capacity. Some of the specific competencies related to collaborative co-engaged learning under innovation capacity were to "manage group dynamics and *be able to function in a variety of groups* and environments; … play an *active role (collaborative)* in development initiatives" (Chaminuka et al., 2016, p. 21, my emphasis). In soil science, learners were expected to understand water and climate assessments, and implement sustainable agricultural practices with regard to tillage and soil fertility. In engineering, learners were

[15] At the conclusion of this thesis Agricultural Colleges in South Africa were transitioning into Agricultural Training Institutes in line with the Norms and Standards of Agricultural Training Institutes (South Africa. DAFF, 2011). Fort Cox College of Agriculture and Forestry became the first one to attain this status through the TACATI – [Transformation of Agricultural Colleges to Agricultural Training Institutes] project in June 2016.

expected to "select appropriate tillage practices, understand basic irrigation planning and installation, do basic design of drainage systems" (ibid., p. 12). These selected competencies can lead to emergence of sustainable agricultural water improvement. The link between the CBL process and expansive learning can be found in the CBL description as

> A learning-by-doing process that *requires all stakeholders to work together* and be *committed* to seeing the process right through to its logical end. … a *dynamic process* that requires adaptation to the changing environment and priorities. (ibid., p. 22)

In 2014 the South African government published a Green Paper on the proposed National Agricultural Training Institutes Bill inviting public comments, one of the aims of which was to promote agricultural education and training quality, with the output to

> Restructure and Transform Agricultural Colleges and programmes into Agricultural Training Institutes and programmes to respond better to the human resources, economic, and development needs of the Republic... (p. 5)

The Norms and Standards for the ATIs is the instrument expected for achieving partnerships with universities in the accreditation of qualifications and educational quality standards. The CBL process and the norms and standards do not spell out water for food explicitly but give clear direction towards its improvement, in line with the explicit praxis in the policies and strategies as discussed earlier.

The Agricultural Sector Education and Training Authority (AgriSETA) is a body under the South African Department of Higher Education and Training that oversees accredited training in the agricultural sector in specified areas and programmes. It achieves this by providing grants and bursaries for Learnerships, Skills Programmes, Adult Education and Training, tertiary studies and in-service training. To ensure education and training quality AgriSETA accredits training providers in the sector and monitors the quality of the training they provide. Many agricultural colleges deliver AgriSETA accredited training courses to farmers on demand by farmers themselves, the Department of Agriculture, Department of Social Development or other bodies to improve skills in rural areas (AgriSETA, 2016).

Recently the Academy of Science of South Africa (ASSAf, 2017) published a 'consensus report' highlighting the importance of the agricultural education and training (AET) sector in meeting the United Nations Sustainable Development Goals (SDGs). The report notes that the AET sector is a fragmented system in that Agricultural Colleges fall under the Department of Agriculture, Fisheries and Forestry while Vocational Colleges and Universities are under the Department of Higher Education and Training and AgriSETA accredited training is biased towards commercial farming, thus fuelling the historical bifurcation of agriculture and marginalisation of informal and smallholder farming. The past 15 years have seen the production of increasingly fewer agricultural science teachers

while only 20% of school-exiting (matriculation) students write Agricultural Science, making agriculture a shrinking subject. This implies that the pathways for agricultural learning from lower grade to higher education are at risk (see also Pesanayi et al., 2016). In addition, the ASSAF report notes with concern the lack of adequate practical teaching and learning facilities and practical agriculture teaching ability in schools. In acknowledging the role of agriculture in the water-energy-food nexus, the report recommends a study on "articulation pathways and curriculum innovation ... to demonstrate practically how a fully articulated system which leverages ICT innovations and a multidisciplinary conceptualisation of agriculture could be designed" (p. 26). The ASSAf (2017) report proposes stronger linkages in a farmer-centred knowledge triangle linking education with research and extension as follows:

> Within this knowledge triangle, the roles of each of the actors are *intersectional*, and *extend beyond the actions of what each actor does in isolation*. The role of researchers is to design curricula for discovery learning which enable farmers and extension workers to *engage in conscious learning*. Researchers also partner with farmers, specialists and extension workers to develop new ideas and technologies. Extension workers focus on helping farmers learn to become experts on their own farms and to become researchers in their own right and help farmers cultivate capacity to learn through deliberate efforts and a facilitated learning agenda. In this process, farmers build capacity to command the factors influencing the sustainability of their livelihoods; *they acquire the sense of equal partnership in the learning process* and build their own capacities to learn. (p. 64, emphasis mine)

The above-mentioned study, however, does not provide guidance on the mediating processes or methodologies needed to put this in place. In the above citation, I emphasise the importance of intersectional work, the strength of the whole compared with its parts, engagement in conscious learning and partnerships of equality that are hallmarks of the CHAT and boundary-crossing approaches (see section 1.8.4 and Chapter 3) that I use in this study. This gives value to networking platforms (see SADC, 2008, section 2.3.1.2) that value farmers such as illustrated in Figure 2.3 below.

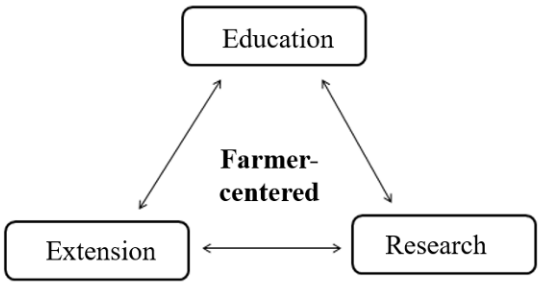


***Figure 2.3**: Agricultural knowledge triangle with farmer at the centre (adopted from ASSAf, 2017, p. 64)*

The ASSAf (2017) study proposes an agricultural knowledge triangle for innovation in the agro-food value chain that pays attention to the linkages in the research-teaching-extension nexus and places the

farmer at the centre. I argue that this study contributes to the broader study by ASSAF (2017) because it tackles transformative agency pathways akin to what Cussins (1992) and Engeström (2003) called "cognitive trails" (see Chapter 3). It does this by tracking how co-engaged learning and use of various conceptual tools and artefacts including ICTs paved the way for transformative agency pathways in agricultural colleges' curriculum innovation actions (see Chapter 6), thus providing methodological and process guidance for realising the above idealisation of intersectionality proposed by ASSAF (2017). According to Stetsenko (2016), a transformative world is possible when premised on the ethos of solidarity and equality;

> Teaching-learning appears as an important pathway to developing one's identity, and each act of learning is transformative... Yet *this is possible when knowledge and facts are authored by the learners* in their *relevance to themselves* … The learners' identities are posited to be reliant on … their own transformative agency that realizes and brings about changes to these practices" (p. 337, emphasis in original).

Stetsenko, in this quote, was arguing for transformative learning and identity development springing from willful agency and relevance. The culture of AET praxis in Zimbabwe is discussed below.

2.4.4.3 Culture of agricultural education and training praxis in Zimbabwe

Agricultural education and training praxis in Zimbabwe, like in South Africa, is closely linked to the culture of agricultural practice and its historical development from the sedentary stage into colonisation, independence and post-independence eras. These historical stages are punctuated by various factors such as politics of control by succeeding powers (traditional, colonial, UDI and independence authorities) and the impact of national policies discussed in the policy section. Informal agricultural training among the local Africans took place mostly as a form of apprenticeship as children learnt from their parents or other adults. Formal agricultural education in Zimbabwe can be traced back to the mid-1920s with the establishment of mission stations which trained native agricultural demonstrators. These mission stations included Mount Selinda in Chipinge, Domboshawa and other training institutions. Like in the South African case study, two agricultural systems and extension services existed in colonial Zimbabwe, one for the white settler commercial farmers and the other for the indigenous black Africans. The former, mostly full-time businessmen were largely serviced by private extension services, private agricultural colleges, a powerful Commercial Farmers Union and Research Stations. The latter rural-dwelling (peasant) farmers had varied experiences from demonstrators experimenting with them using top-down techniques to extension workers living among them and using transmission and training and visiting to participatory extension approach and facilitation methods (Kramer, 1997; Ponniah, Puskur, Workneh & Hoekstra, 2008).

From 1999 to date (2016), the agricultural system has been totally transformed by the agrarian reform in particular the fast-track land redistribution programme which saw most White large-scale commercial farmers being forced to vacate their farms. This created a new Black large-scale commercial farming class that has increasingly sought services of the government extension workers.

Närman (1991) provided a fairly comprehensive analysis of 'Education, training and agricultural development in Zimbabwe' for the period covering the early 1970s to the early 1990s from a UNESCO and conventional agriculture perspective. The Zimbabwean case study will best be understood from a historical perspective through to the current situation with regard to small-scale farming, farmer innovation, and agricultural extension education.

Formal agricultural vocational education in Zimbabwe was established by the then British Colony of Rhodesia in 1926 when the government appointed Emory Alvord[16], an American missionary as agriculturalist for the instruction of natives (Reid, 1977; Wolmer & Scoones, 2000). Alvord's efforts to train farmers started as a voluntary individual endeavour in 1920 at Mount Silinda School in Chipinga, whose reputation came to the attention of the Chief Agriculturalist and the Chief Native Commissioner (Kramer, 1997, p. 169). The first agricultural training institutes in Zimbabwe for technicians and farmers were established at Domboshawa in Chinamora communal lands in Mashonaland Central and at Tsholotsho in Matabeleland North near Bulawayo and enrolled their first demonstrator trainees in 1924. They were established as technical or "industrial training schools whose primary task it would be to *educate the Africans* in order that they could then be *self-sufficient in their own areas*" (Kramer, 1997, p. 165, my emphasis). The first trainees completed their training in 1927 and in the same year pioneered the official beginning of demonstrators' work in the reserves. The intention for training demonstrators was to offer very practically-oriented training in field operations and care of stock, which was reinforced by lectures on the basic science of the subjects taken so that "on completion of their training, [the demonstrators would] be drafted to the Native Reserves to instruct the local populations on *modern methods of agriculture*" (ibid., p. 166, emphasis mine). This work included demonstration of various farming techniques on four acres of land given to each demonstrator.

The success of agricultural instruction of the indigenous Black people on modern farming methods was mixed, with an initial success followed by failures due to a number of problems and contradictions in perceptions within government, policies and their impacts and from suspicions by Black farmers

[16] Alvord's individual efforts are believed to be a response to a report by the Committee of Enquiry into African Affairs in the then Southern Rhodesia which recommended the establishment by government of central institutions in reserves where teaching may be given by expert instructors.

that demonstrators were government political agents. Agricultural education was introduced during the colonial period in primary and secondary schools initially as part of nature study, as practical work, then as part of environmental and agricultural sciences. Formal post-school agricultural training took place initially at Gwebi and Chibero Colleges of Agriculture that initially catered for White students only and then at other colleges including Mlezu, Rio Tinto and Esigodini among others, starting with certificate qualifications and later with diplomas. Historically, the Department of Agricultural Education and Farmer Training operated

> as a branch under the Ministry of Agriculture for years since the 1950s. It was elevated to departmental level in 2004 when its span of control was expanded from the traditional seven to 14 agricultural colleges. (Zimbabwe. MAMID. Department of Agricultural Education and Farmer Training, 2015)

After independence, the new government of Zimbabwe restructured the Ministry of Agriculture, creating a home for AET. At national level, Agricultural Education and Farmer Training operates as a department under the auspices of the Ministry of Agriculture, Mechanisation and Irrigation Development (MAMID). The Department currently oversees 14 colleges, seven of which are being run in conjunction with the Ministry of Youth Development, Indigenisation and Empowerment in the training of students at certificate level under an apprentice programme which is fully funded by government. This became necessary in order for the Department to meet with the increased demand of personnel by the Department of AGRITEX after the inception of the land reform programme. The aim of AET is to produce agricultural graduates capable of delivering agricultural support services in practical farming, research, extension and farmer training, with core functions of agricultural education and farmer training. The mission of the Department of Agricultural Education and Farmer Training is "to provide adequate technical training in the science and practice of agriculture at certificate, diploma and higher national diploma levels and also farmers and other clientele involved in agriculture" (Zimbabwe. MAMID. Agricultural Education and Farmer Training, n.d.).

The main sections where agricultural education is conducted are Agricultural Engineering, Animal Production, Crop Production, Farm and Agribusiness and Farmer Training. Kushinga Phikelela National Farmer Training Centre trains farmers primarily, but all the colleges have Farmer Training as one of the sections whose function is mainly to develop farmers' skills in specific areas of training need. Kushinga Phikelela has a unique agribusiness entrepreneurship course that allows students to develop a business plan, implement it and get assessed on the results of their marketing and income generation that other colleges and universities could learn from.

2.4.4.4 The response of Zimbabwean Agricultural Education Colleges to Environmental Education

A key milestone in integrating environmental sustainability in Zimbabwean agricultural colleges took place in 2009 with the introduction of two environmental education modules. These modules were

'Environmental Management in Agricultural Landscapes' and 'Reclamation of Degraded Landscapes' (Mugabe, 2009). This was preceded by a 2008 study carried out by the University of Zimbabwe's Institute of Environmental Studies which observed that,

> At all colleges there was consensus that environmental education should be an important component of the agricultural diploma curriculum. Most principals and lecturers bemoaned the extensive land degradation in areas surrounding their colleges and emphasized that urgent action needs to be taken to avert further degradation. (ibid., p. 1).

Environmental Education has been taught using various strategies in the agricultural colleges since 2009 to date (2018) and has enhanced community outreach and engagement with practical environmentally-sustainable agricultural practices. These strategies include dedicated lecturers teaching environmental education in some colleges, while in others nearly all lecturers from the four disciplines and farmer training are involved.

2.4.4.5 Articulation of agricultural education in the schools with agricultural colleges

The Zimbabwean school system has had an agricultural curriculum at primary and secondary school levels from pre-independence to the post-independence period in various grade levels and post-primary schooling. At independence in 1980, the new Government introduced education with production from the experience of the revolutionary leaders whilst in exile, which was however short-lived (Mashingaidze, 1997). One of the findings of a Presidential review of education and training carried out in 1988-1992 was that,

> There was unanimity in the call to make the primary curriculum practical. … The respondents suggested that more emphasis should be given to the teaching of practical subjects such as computers, agriculture, gardening, cooking … Some felt that the concept of Education with Production popularised in the early 1980s should be revisited with the view to adopting it. (Zimbabwe, 1999, p. 291)

In 2013 the Government of Zimbabwe reintroduced agriculture in primary schools as a four year course from grade 4 to grade 7 (Zimbabwe. Ministry of Education, Sport, Arts and Culture, 2012). This was partly a response to the need to strengthen vocational and technical education as recommended by the 1992 Presidential Commission of Inquiry into Education and Training and in recognition that Zimbabwe's economy is agri-based. Strengthening the teaching, learning and practice of agriculture in the school system is one thing while integrating sustainability into it is another. It is therefore noteworthy that the new Grade 4-7 agriculture syllabus mentioned above has objectives that foster sustainable production, agri-business, community participation, developing positive attitudes towards agriculture, environmental awareness and responsibility, and developing innovativeness. The Grade 5 syllabus in particular contains a section on water harvesting (ibid.). The presence of rainwater

harvesting in the primary school curriculum shows it importance at a national level and is a challenge to tertiary education.

2.4.5 Cultures of agricultural extension praxis

Extension praxis can be described as what extension officers and workers do informed by prevailing extension theory, ideology or command. The concept of extension is based on the philosophy of diffusing expert knowledge from its source of concentration usually researched to places where it is absent (Kroma, 2003). However, over the years extension praxis has realised that knowledge is distributed and extension needs to accommodate other knowledges, but this does not always happen in praxis (Hall, 1995). Kroma (2003) argued that extension practitioners,

> … need to develop new capacities in adult learning that entail a fundamental philosophical shift from traditional normative notions of extension-client relationships to ones that embrace the agency and knowledge abilities of farmers. (p. 354)

Agricultural extension has undergone many radical changes in methodology which have been influenced mainly by the extension trainers' and researchers' perceptions of the extension agent's client, the farmer, and also by extension failures. These perceptions are wide ranging. From one end of extension praxis, extension agents see farmers as irrational objects of behaviour change needing guidance in order for them to make rational decisions geared towards technology adoption (Röling, 1990; Kramer, 1997; Düvel, 2000; Worth, 2008). On the other end, there are participatory extension approaches involving farmers from conceptualising and planning to assessment of farming (Anandajayasekeram, 1996; Moyo & Hagman, 2000; Ponniah et al., 2008). Universities, research stations, agricultural colleges, extension and rural development organisations have contributed to these perceptions. However, problems still exist in extension training curricula and extension policies that manifest themselves in extension service failures as seen in the type of advice given to farmers on agricultural water and seed-based value chain inputs. The 'experts' from these organisations in many ways had to learn from mistakes and humbling experiences that their knowledge practices were not superior to those of the farmers (Ponniah et al., 2008). Easterly (2013) called such exercise of power in unbalanced power-knowledge relationships, a 'tyranny of experts' and argued for social justice and respect for diverse knowledges and contexts of livelihoods.

2.4.5.1 Culture of extension praxis in South Africa

There are two agricultural extension streams in South Africa, one private servicing the large-scale commercial farmers and the other, the public extension system that is driven by government and servicing the smallholder farmers (Greenberg, 2013). The South African public extension system operates within a government mandate that functions according to specific programmes along commodity lines supported with conditions, and aimed at ensuring national food security and

commercialisation. Examples include the Cropping Programme that promotes GM maize (formerly MFPP, see section 2.3.2.4) and the Siyazondla Programme (literally meaning 'we are feeding ourselves') (Kroll, Beary, Segantin, Rudolph & Manjengwa-Hungwe, 2012; Phezisa, 2016). These top down programmes have a bearing on farmer choices and social justice. Top down extension approaches with social engineering have been criticised as bordering on institutional dysfunction for various reasons (ibid.; Worth, 2008; Davis & Terblanche, 2016). This has implications for the participation and commitment of extension workers in formative intervention processes aimed at improving sustainable water for food. Yet according to South Africa. DAFF (2005), participatory extension approaches are recommended by Government. The extent of partcipation will be explored.

According to Backeberg and Sanewe (2010), the agricultural extension service had a policy of "targeting group projects rather than individual or household initiatives... to enable government programmes to reach more people simultaneously" (p.10) a few years before the democratic dispensation which began in 1994. This group approach was carried forward into the democracy and still dominates current extension and advisory approaches in South Africa. According to the Department of Agriculture (South Africa. DAFF, 2012a),

> Government has identified cooperatives as one of the central pivots to reduce poverty, unemployment and high levels of inequality and to accelerate empowerment and development for the benefit of previously disadvantaged majority. (p. 2)

It is the South African government's belief that accelerated development of previously disadvantaged people is needed fast, and that massification through such approaches as cooperatives and commodity groups helps to reach out more widely and democratically. At provincial level in the Eastern Cape the cooperative groups approach was hailed by the Member of the Executive (MEC) for Agriculture; "the department with the assistance of the National Department of Agriculture is in the process of *implementing the commodity group development strategy*" (Eastern Cape Department of Agriculture, 2003, p. 3, emphasis mine). This action was described as a measurable output to facilitate joint planning, cooperation, collaboration and consultation fora with farmers through "the formation of consultation forums with the stakeholders (commodity groups, study groups and other advisory structures)" (ibid., p. 22). This action also points to the need for effective learning fora for farmers.

A close connection between extension, research and teaching was described by the ASSAF (2017) report. The report noted that "linkages in research–teaching–extension nexus are poor, and there is a need for better coordination" (p. 63) in order to improve extension and education praxis across this 'knowledge triangle'. The report proposed a 'farmer-centred' model of the latter, referred to above (ASSAF, p. 64). Challenges contributing to the poor linkages included "*lack* of skills and *contextual understanding* on the part of each of the actors on how to engage effectively with farmers" (Christoplos

in ASSAF, 2017, p. 64, emphasis mine). The teaching aspect was discussed under Agricultural Education in section 2.4.4.

2.4.6 Cultures of agricultural learning systems in tension

The review of small-scale farming practice, agricultural education and extension in sections 2.4.3, 2.4.4 and 2.4.5 above have shown that these agricultural systems are co-existing in a state of tension. Traditional agri-cultural values around local non-formal and informal seed systems, organic fertilisers and land management and tenure continue to be important for food security, especially of the majority of the world's people, and Africa's people in particular, who depend on the land and cultures of smallholder farming that emerge from co-existence and co-dependence values for their livelihoods (Wekundah, 2012; FAO, 2015). This is despite the technicist solutions being spread by globalisation in the supposed quest to feed an exponentially growing human population using industrial agriculture based mainly on commodification values. Despite making some steps to reduce world hunger, these solutions are facing numerous problems such as inability to actually feed the world population, failure to deal with cultural causes of hunger such as access to agricultural water, and unintended consequences such as water pollution from increased agro-chemicals (Pinstrup-Andersen, 2002). Agricultural learning systems have been implicated. The connecting points across agricultural learning systems have been rather silent in Millennium Development Goals reporting which tended to be more goal-oriented than systemic thus losing the opportunity to demonstrate the link between poverty reduction with environmental integrity on one hand and between training systems, extension and farming on the other (United Nations, 2015). The new Sustainable Development Goals (SDGs) therefore inject a new hope of making explicit the connections needed in making development policies more holistic and useful for food security and social-ecological justice in agricultural learning systems (ICSU, ISSC, 2015). The next section reviews how the changes in technology and socio-economic conditions have contributed to creation of boundaries between agricultural learning systems.

2.5 IMPACTS OF CHANGING TECHNOLOGY, ECONOMIC, SOCIAL AND ENVIRONMENTAL LANDSCAPES ON THE CULTURE OF AGRICULTURAL PRAXIS

The impacts of changing technology, economic, social and environmental landscapes on the culture of agricultural praxis are often related and some of them have been discussed previously as will be shown in the cross-references. However, for the sake of brevity, it is essential to pinpoint some of the individual impacts of these changes in order to understand where the generative mechanisms lie.

2.5.1 Impacts of changing technology on the culture of agriculture

As has been discussed earlier, technology in agriculture such as mechanisation, use of agro-chemicals and the gene revolution (see sections 2.3.1.1 and 2.3.2.4) have been applauded for increasing production, but this has come with heavy impacts of polluting soil and water bodies, and emissions from soil tillage and fossil fuels (African Centre for Biodiversity, 2016). The literature cited demonstrated that technology has had ambivalent influences on the culture of agriculture, some positive such as improving water supply and reducing labour drudgery in tillage, and some negative such as GM seed cited above.

A real life example of the negative impacts of unsustainable technology and socio-economic practices (and the possibility of reversing them) is perhaps provided by Cuba. Cuba reached its 'peak oil' (exhaustion of fossil oils) prematurely in 1990 due to cuts in Soviet oil supplies with the collapse of the USSR in 1991. Cuba was thus 'forced' to choose an oil-free, low input agricultural approach which made it self-sufficient in food production during its prematurely-induced peak oil and real energy crisis. The Cuban experience is believed to have provided a much-needed example for the rest of the world, modelling what would be the best ways to work with a low oil scenario such as organic, low input and locally-focussed small-scale farming (Heinberg, 2003). However, highly industrialised societies such as the USA and Europe have continued to consume increasingly higher fossil energy despite a USA peak oil and Middle East political crisis in 1970 followed by an energy crisis throughout the 1970s and early 1980s (ibid.; Shiva, 2008a). Calls for energy conservation, changes in lifestyles and investments in alternative energy during the era of President Jimmy Carter (USA Government, 1980) were forgotten when new oil reserves were discovered in Alaska and the North Sea, and populist presidents such as Ronald Reagan and others introduced new policies re-fuelling high oil consumption, with continuities into the present, despite efforts to curb this under climate change policies.

2.5.2 Impacts of globalising economic models on the cultures of agriculture

The economics of world trade in globalising economic models indicate that export-oriented trade has a negative impact on local production and therefore livelihoods, especially in developing nations (Shiva, 2005; Raworth, 2017). The impact of WTO policies on the culture of small-scale agriculture was discussed earlier (section 2.4.1). Here, I provide an illustrative example of these impacts in the developing world. Shiva (2002) argued against the economics of trade liberalisation by observing that

> It is little wonder that Indian activists, peoples movements and some politicians are calling for the reintroduction of *import controls*. ... This democratic demand would prevent famine. Yet nowhere in his article does Amartya Sen identify *the destruction of livelihoods and incomes of the small rural producers as the reason for increased endemic hunger, and indeed famine*, in India. On the contrary, Sen recommends further trade liberalization and increased exports as the solution to hunger in the Third World. *Yet export-oriented agriculture robs the poor of their land, their water and their livelihoods*. There is an inverse relation between increasing

> agricultural exports and declining food consumption locally and nationally. When countries grow flowers and vegetables for exports, they also sow the seeds of hunger. (p. 6, emphasis mine)

Of concern in the citation above is the competition in national investments on small-scale rural farming versus on export-oriented farming that compromises livelihoods as governments favour big producers in resource (such as water) allocations through their policies which trump commodification value over other value (e.g. co-exchange sustainability and livelihood oriented value).

2.6 TOWARDS SUSTAINABILITY IN AGRICULTURAL LEARNING SYSTEMS

The move towards sustainability by agricultural learning systems has been slow due to the strong economic-political forces of increasing commodification (Shiva, 2002) overpowering the other sustainability dimensions or 'pillars' of environment and social, but this is gradually shifting thanks to environmental and social justice movements, increased understanding of the diverse responses required to respond to climate change, and education (FAO, 2016). Moving beyond farming practices, smallholders' adaptation to climate change risks will be critical in order for food security to be realised. The sheer number of smallholder farm families in developing countries – some 475 million – justifies a specific focus on the threat posed by climate change to their livelihoods and the urgent need to transform those livelihoods along sustainable pathways. According to FAO it will be difficult, if not impossible, to eradicate hunger without resorting to agro-biodiversity measures (FAO, 2016, p. 12).

In recent years, changes in agricultural practices have been witnessed in some moves towards sustainability. These are shown by consideration of environmental health and the agro-ecosystems support base with the rise of climate adaptive agriculture (African Centre for Biodiversity, 2014a; 2014b), emergence of fair trade value chains, water recycling and rainwater harvesting and conservation innovations. Such moves have been seen in farmer grassroots movements such as Via Campesina, networks such as the Alliance for Food Sovereignty in Africa (AFSA) and African Biodiversity Network (ABN) , some civil society group activities (Pesanayi, 2008), and sometimes at formal organisational and national scales. The Zamorano pan-American agricultural college case in South America provides a case for a whole-institution change towards sustainability (Andrews, 2004). At national scale, Cuba adopted low-fossil fuel input in its agriculture as the nation moved to organic farming (Morgan, 2006). Cuba's unprecedented shift from the largest per capita consumer of fertilisers to one of the lowest was forced by a premature 'peak oil' crisis called the 'special period' precipitated by the end of subsidised Soviet support in 1990 (ibid.). In southern Africa, such initiatives as the Participatory-Ecological Land-Use Management Association (PELUM) have continued to support sustainable agriculture capacity.

On FAO's engagement with smallholder and family farmers' organisations, Wolfenson (2013) noted that the basis is the need for

> a transition to a sustainable agricultural system, grounded in an ecosystem approach, which includes increased adoption of agro-ecological practices, especially those developed by smallholders and family farmers (FAO, 2012) and ii) a fundamental change in governance systems which requires all actors involved to progressively shape agriculture, forestry and fisheries systems towards environmentally friendly and social inclusive systems. This includes determining who will be involved and how they will participate. (p. 12)

On transformative curriculum shift towards sustainability, Wals (2010) proposed innovation in co-engaged social learning involving multiple stakeholders, as is discussed further below.

2.6.1 Transformational changes across agricultural education, extension and research and their relational processes: Towards collective learning

The key educational question perhaps is what has caused some of these changes to be embraced, and what will make such changes of an impactful scale, possible and sustainable. FAO has had the privilege of hosting indigenous farming conferences where an ever-present 'remnant' of agro-ecological farming champions have raised their concerns and clarified their unequivocal visions for sustainable agriculture. According to Hainzelin (2014)

> … *systems need to suit the reality of smallholders and family farmers*, reduce dependence on fossil fuels and negative impacts on society and the environment by imitating nature and learning from local agro-ecological knowledge. "Performance" in agriculture requires new definitions. The *local context should be awarded greater importance: a shift from "ready-to-use" to "custom-made" cropping systems* places the producers at the centre of local innovation systems, to *combine technologies and traditional knowledge.* (p. 2)

The thinking in the citation above calls for hybridisation of science and traditional knowledge in ways that connect with small-scale farmers' local contexts and realities. This thinking was echoed recently by Blackie (2016) who called upon universities to reach out to poor students and thereby

> … build on the new approaches in agricultural thinking where universities are leaders in a new innovation system to which all contribute knowledge and which relies on the efficient transfer of information throughout the system in a non-hierarchical manner. (p. 3)

The respect of diverse knowledges rather than privileging one form of knowledge construction in agriculture is a key move towards sustainability in agricultural teaching, learning, research, extension and practice that needs further exploration. Such research therefore needs to also examine different ways of looking at what constitutes performance, quality and relevance across agricultural learning systems. Earlier, researchers such as Leeuwis and Van den Ban (2004) found that social learning, organisation building and conflict resolution were new skills needed by extension workers in order to deal with divergent interests, different actor perspectives and conflicts in collective learning processes.

They went on to propose that extension practice and thinking needed re-thinking because "…most of the innovations needed in present day agriculture have collective dimensions (i.e. they require new forms of interaction, organisation and agreement between multiple actors)" (p. 11).

The discussion above demonstrates a shift towards co-engaged learning for the 'common good' as suggested by 'collective' and 'new forms of interaction' between 'multiple actors' outlined in the citation above. This common good is difficult to define collectively since there are divergent interests; hence the object of co-engagement is contested and probably constantly changing. Some parties may find such forums meant for collective learning at variance with the achievement of their pre-determined agendas and may thus be absent from such co-engagements choosing to exert their influence by other means, or buy-out other interests (Easterly, 2013). A process of active solidarity building or commoning (Lotz-Sisitka, 2017) may thus be needed in collective learning processes to reclaim the commons such as common spaces for farming which may be violated by laws undermining OPV seed and privileging GM varieties.

Regarding transformation in extension there have been huge shifts in both South Africa and Zimbabwe from the Training and Visit method to Participatory Extension Approaches and Farmer Field Schools. However despite the policy and praxis shifts, inadequate funding has kept the public extension systems operating below the desired standards (Anderson, 2007; Worth, 2008). The theories behind these approaches have been discussed extensively in the literature and shall not be engaged with here. However, I will discuss the farmer field schools approach as it has significance to this study.

2.6.1.1 Farmer field schools

According to Braun and Duveskog (2008), the farmer field school approach was demand-driven and deliberately citizen-led as it *"emerged out of* a concrete, immediate problem" (p. 6). The context was the 1980s when farmers in Indonesia, their production and the environment were at high risk due to considerable abuse of agro-chemicals "promoted aggressively by the private industry and government" (ibid., p. 6). Pest species were becoming resistant and, in some cases, resurgent. What was called for was a large-scale decentralised programme of education for farmers. The farmers made their own plans and decisions and through experimentation and application, they grew into agro-ecological experts in their contexts of work, produced better yields and managed their socio-ecological spaces well with reduced risk to their subsistence and business operations (Dilts, 2001).

The UN Special Rapporteur on the Right to Food reported that farmer field schools had made a significant impact in reducing quantities of chemical pesticide use, improving yields and to stimulate continued learning in well organised groupings due to training and education based on agro-ecological

farming cultures (De Schutter, 2010). These results were based on studies carried out in Asia, East and southern Africa and Cuba. Both South Africa and Zimbabwe have implemented farmer field school approaches in selected pilot areas with results showing the value of engagement of farmers in a dedicated farmer-centred learning process that de-centres extension or NGO support (Hughes & Venema, 2005).

2.7 EMERGENCE OF SUSTAINABILITY PRACTICES IN AGRICULTURAL LEARNING SYSTEMS

A number of sustainability practices have started to emerge in South Africa and Zimbabwe's agricultural learning systems that connect agricultural education with small-scale farming contexts and extension praxis. In the South African ATI system, the competency-based learning project helped the agricultural colleges to define the job profile of their product as they transition to become ATIs. This process has motivated the agricultural colleges to reflect on the contexts of small-scale farmers and the relevance of their curricula to the intended profiles (Chaminuka et al., 2016). ATIs participating in the Competency Based Learning Community of Learning and Action (COLA[17]) of the TACATI process agreed to producing a competent farmer whose job profile was defined as "a competent farmer should be able to plan, organise and control resources (farm, natural, human, economic) in a sustainable manner and maximize profit taking into account, applicable social contexts" (p. 19).

The focus on the farmer is a drive towards sustainability with respect to paying attention to the farmer's context of farming. This orientation is supported by the ASSAf (2017) report that recognises the challenges presented by climate change and "the declining accessibility to quality water sources, the impact of unsustainable food production practices…" (p. 19). The report noted that the agricultural value chain connects agriculture to at least 11 of the 17 UN Sustainable Development Goals (SDGs) and that "more than any other sector, agriculture is the common thread which holds the 17 SDGs together" (ibid., p. 49).

In the Zimbabwean AET system, the emergence of environmental education as sustainability practice was discussed in section 2.4.4.4. In addition, the Zimbabwe Agricultural Education and Farmer Training system has started integrating the ideas of organisations advocating for agro-ecology, small grains and rainwater harvesting in smallholder farming through its Principal's Council meetings and

[17] "COLAs were an innovation of the project, to facilitate collaboration by multiple stakeholders towards multiple objectives. They were demand driven and addressed felt needs by taking the responsibility to address a specific challenge/problem related to the transformation process at the colleges. In addition, they facilitated joint learning by bringing together good practices and shared interests of those who chose to participate" (Chaminuka et al., 2016).

curriculum reviews (Zimbabwe. MAMID. Department of Agricultural Education and Farmer Training, 2015). The Council of Principals is an important decision making body for curriculum development in the Zimbabwean AET system and meets regularly with external stakeholders.

2.8 ENGAGEMENT WITH LEARNING IN AND ACROSS BOUNDARIES (BOUNDARY-CROSSING)

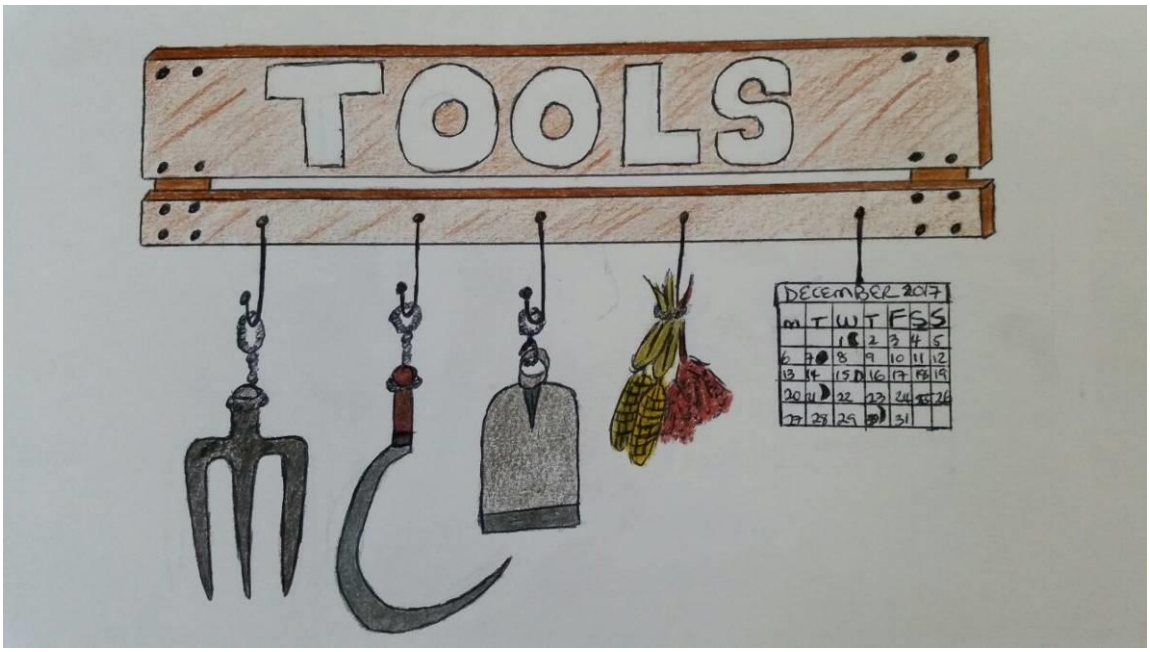
In order for sustainable agricultural water praxis to emerge effectively across boundaries of agricultural learning systems, there is a need for social learning processes (Leeuwis & Pyburn, 2002) that facilitate collaborative engagement with the common object of agricultural water relevant for small-scale farming contexts (Mukute, 2010; Engeström, 2016; Pesanayi, 2016b). The current discontinuities that exist across agricultural learning systems in southern Arica have not been corrected by ordinary technical interventions such as World Bank structural adjustment programmes, trade liberalisation or national policies that have tended to disregard social justice and individual freedoms (Easterly, 2013; de Sousa Santos, 2005). This signals the need for different forms of intervention, which will be further elaborated across this study.

2.9 CONCLUSION

This chapter has revealed arguments that the sustainability of small-scale agricultural production and human consumption lie in the balance of cultures of agriculture and constitute social justice in water access for food production and sustainability in seed security. The chapter has revealed dynamics of the contradiction that exists in cultures of agriculture and associated praxis between historical and smallholder farming histories and practices that reflect the value of co-existence and sustainability, and wider dominant political and economic forces shaping agricultural policy and praxis that are more reflective of commodification value. In surfacing this as a contradiction, this chapter does not suggest an oppositionalising of co-existence and sustainability value vs commodification value, rather it begins to argue for the need for dialectical engagements which will be taken up further in the thesis via the dialectically constituted expansive learning processes that are the focus of this study. The chapter has shown that there are strong economic and political forces acting against small-scale farming practices and these are directly and indirectly promoted by agricultural education and extension systems. Yet, small-scale farming systems have an important role to play in the food security of rural African societies, which are still in the majority despite increasing rural to urban drift. From nutritional, health, food safety and environmental points of view, the diversity of seed, grain and vegetable foods presented by traditional small-scale farming systems is also important for the sustainability of agricultural production and consumption. The efficacy of this diversity also provides an opportunity

for local and indigenous farming knowledge systems to blend with (rather than be replaced by) modern scientific knowledge. This chapter has thus laid a foundation for examining the contestations that exist between fixed and shifting knowledge practices affecting small-scale farming activities. It has been shown that the battlefields occur in agricultural college or university curricula, in extension advice, in market forces that pressure farmers and in inputs that farmers can or fail to access. It therefore appears likely that the resolution of agricultural water and seed input problems can be explored at and possibly across the boundaries of the work of agricultural college lecturers, farmers and extension officers learning collectively. Chapter 3 therefore critically examines and discusses theories and a methodology that may enable such boundary-crossing learning to take place.

CHAPTER 3
GENERATIVE THEORY AND METHODOLOGY FOR BOUNDARY-CROSSING EXPANSIVE LEARNING RESEARCH



3.1 INTRODUCTION

This chapter discusses major theoretical ideas used to frame this study and the methodological design resonating with these theories, linking these with the objectives of understanding boundary crossing emergence and transformative agency within and across agricultural learning systems. I sought a theoretical framework that would help me to conceptualise, understand and explain collective learning across different organisations, entities and their cultural practices within networked contexts. I shall discuss my choice of cultural-historical activity theory (CHAT) for this study as main substantive theoretical framework from the field of cultural psychology and the learning sciences, its learning-oriented formative interventionist developmental work research (DWR) methodology (increasingly also referred to as Change Laboratories (CL)), and critical realism as an 'under-labouring' meta-theoretical explanatory tool, offering depth ontological perspective for emancipatory engagement.

As introduced briefly in Chapter 1, theory is a big idea that helps us to understand the world and our interactions with it, and hence this chapter advances those ideas in framing our understanding of activity and reality. Howell (2013) explained theory as a derivative of the word *theoria* (meaning behold or view) and sharing the same root as 'theatre' (which is providing reflections on society and

the world). Hence, he argued that "theory involves a way of viewing and reflecting on the world and in this way it is different from knowledge of how the world is (reality or truth)" (ibid., p. 19). Critical realism, created by Ram Roy Bhaskar, is concerned with issues of human emancipation and ontological explanation (Bhaskar, 2008a, b; Bhaskar, 2009). I found meta-theoretical tools from critical realism useful in exploring the complexities and generative mechanisms embedded in the expanding historicised object of agricultural water and the climate-adaptive seed systems it potentially enables across the interacting activity systems and mediated learning processes of interest (see section 3.2.2.8). Developmental Work Research or Change Laboratory Methodology (CL) as discussed later, derives its learning-centred formative interventionist tools from Cultural Historical Activity Theory, which is a substantive post-Vygotskian theory from the field of cultural psychology and the learning sciences (Engeström & Miettinen, 1999). The methodology enables tracking and shaping of the object of activity by subjects in interacting activity systems and researchers collaborating with them through boundary-crossing change laboratory workshops and expansive learning cycles.

3.2 INTRODUCING CULTURAL-HISTORICAL ACTIVITY THEORY (CHAT)

This section describes Cultural Historical Activity Theory (CHAT) as it relates to the exploration and understanding of boundary-crossing learning and the possibility of transformative change through formative intervention in socio-ecological contexts. According to Daniels et al. (2010), CHAT can be seen as a theoretical lens developed to aid understanding of the relationship between the human mind (thoughts and feelings) and activity (doings) and for analysing the same. CHAT belongs to a body of sociocultural approaches in the field of cultural psychology and the learning sciences that "emphasize the interdependence of social and individual approaches in the co-construction of knowledge… [which] were first systematized by Vygotsky and his collaborators" (John-Steiner & Mahn, 1996, p. 191). According to Vygotsky, human consciousness emerges from human activity that is mediated by artefacts (Daniels et al., 2010). Roth and LaCroix (2012) defined CHAT as "a cross-disciplinary framework for studying how humans purposefully transform natural and social reality, including themselves, via activity as an ongoing culturally and historically situated, materially and socially mediated process" (p. 1). This study was designed to facilitate the working together of people from different but related contexts, disciplines and sectors to purposefully transform their constraining situations, thus making CHAT a relevant framework. In using CHAT, the history and social experiences of individual agricultural actors was considered as it is believed to shape the dynamics of consciousness (Vygotsky, 1978) and therefore influence learning and change. Kaptelinin and Nardi (2006), drawing on Leont'ev (1978), reported that central to CHAT are three main notions, firstly that humans act together as an action-based communicating collective, in which secondly, they make use

of and adapt diverse tools for learning and communicating. Thirdly, in so doing they work within a community for meaning making, learning, communicating, and doing collectively.

3.2.1 Elaborating CHAT: Basic principles

The usefulness of this theory in examining learning and agency across systems with divergent and convergent ideas and approaches is embedded in its five basic principles, the foundation of which is recognising the *activity system as the prime unit of analysis* (Engeström, 1987; Rogoff 1995; Yudin, as cited in Elkonin, 2014, p. 2057). Secondly, the principle of *multi-voicedness* of activity systems is a key emancipatory factor as explained in detail below. *Historicity* is the third principle, while the fourth principle is the central role of *contradictions* as sources of change and development. The fifth principle declares the prospect of *expansive transformations* in activity systems.

In summarising **activity systems** the first principle is that "a collective, artifact-mediated and object-oriented activity system, seen in its network relations to other activity systems, is taken as the **prime unit of analysis**" (Engeström, 2001, p. 136, emphasis mine). Activity systems are superior to individual and group actions that are directed by prior set goals, and are thus considered secondary units of analysis, comprehensible only in the context of whole activity systems (see Figure 3.3).

The second principle recognises that since an activity system is composed of a subject and a diverse community, it means that various points of view, interests and customs exist, and the participants may convey diverse positions through the division of labour they contribute to the activity. They also bring different histories. The mediation artifacts and rules of activity system also carry embedded multi-layered history, and this history is escalated when one considers networks such as interacting agricultural learning activity systems. Engeström contended that for any formative intervention efforts to succeed, it will thus require active listening, internal negotiation and translation among other actions that respect **multi-voicedness** (Engeström, 2001).

Historicity in CHAT is understood as the process of identifying earlier cycles of activity systems, as the latter "get transformed over lengthy periods of time" (Engeström, 2001, p. 136). This means that the only way to understand the problems and possibilities of activity systems is against their own historical developments. It follows that sustainable water for food effort in agricultural learning systems should be analysed against the history of its local organisation and against the wider global history of agricultural water concepts, practices and tools engaged and accrued in the local activity.
The central role of **contradictions as sources of or opportunities for transformative change and development** (Putnam, 1986) is a key principle forming the basis for formative intervention. Contradictions are dialectical and have their roots in a socio-historical context whose analysis can

provide deeper explanation of phenomena (Engeström, 1987; Engeström, 2001). **Contradictions** are deep-seated structural tensions shaped by generative mechanisms that may not be visible to the naked eye and are historical (Engeström, 1987). Virkkunen and Kuutti (2000) describe contradictions as "fundamental tensions and misalignments in the structure that typically manifest themselves as problems, ruptures, and breakdowns in the functioning of the activity system" (p. 302). From a critical realist perspective the conceptualisation of contradictions is much the same as can be deduced from Norrie (2010) who saw them as "structural causes and generative mechanisms that render the actual and events present and observable" (p. 8). [The nature of contradictions is discussed in detail later in this chapter.] CHAT principles together with the possibility of expansive transformations in activity systems (Engeström, 2009b) are explained in the discussion of developmental work research methodology in this chapter. These principles are coherent with the concepts of causality, dialectics and absenting absences that are offered by dialectical critical realist philosophy as will be discussed later in this chapter.

3.2.2 Why CHAT?

In social science research, there has been the question of a lack of theoretical development compared to natural science, leading to the need for "theory discovery, development and meta-theorising" (Howell, 2013, p. 19). CHAT was found appropriate in this study because it offers tools for conceptualising developmental agricultural learning systems and their interactions as units of analysis, i.e. interacting activity systems. I was working with multiple agricultural actors in interaction with each other. CHAT provided a way of describing the interactions, not only between the subject of an activity system and other elements such as the mediating tools used to work on their object of activity, and how this object develops historically and interacts with objects of related activity systems to form boundary objects, but also between activity systems. As shown in the previous chapter, agricultural learning development in post-colonial states is rich in experiences and complex forms of historical capital that shape contradictions, and that can provide means for unpacking the politics of knowledge, exploring the evolution of tools and rules, and understanding changes in division of labour among actors and relationships between subjects in different activity systems. Research is minimal on collaborative learning that shows the interaction between learning and development in advancing sustainability and social justice in agricultural learning contexts; the area is as yet virtually unexplored (exceptions here are the work of Seppänen, 2004; Mukute, 2010; Baloi, 2017) and CHAT helped me to contribute to this space.

CHAT also connects well with the participatory decision-making and action research needs of agricultural water in southern Africa (SADC, 2006; WRC, 2014). Backeberg and Sanewe (2010) noted that in participatory action research

> ... *people are actively involved* in conducting a systematic assessment of a social phenomenon by *identifying a specific problem* for the *purpose of solving it*. It is an educational process because *researcher and participants together* analyze and learn about the causes of and possible solutions to the problem addressed. It is an action-oriented activity since *findings are implemented in the form of practical solutions*. (p. 6, emphasis mine)

The co-engaged processes alluded to above are systematically deployed in the CHAT approach. In the CHAT tradition of expansive learning, the process of identifying a problem and agreeing on a common object of activity as a joint motive is a highly engaged process, together with the iterative process of joint solution modelling and implementation (Engeström, 1996). Backeberg and Sanewe's (2010) concern with the power relations between disadvantaged groups (small-scale farmers) and more powerful individuals is addressed through the multi-voiced nature of CHAT and the emancipatory tools provided by CHAT and critical realism (see theoretical discussion in this chapter). In addition, the dialectic of $Power_1$ – $Power_2$ (Bhaskar, 2008a) discussed later in this chapter (see sections 3.7.7 and 3.7.7.1) presents a developmental way of looking at power relations in a different way that develops transformative agency in the so-called powerless.

3.2.2.1 Activity Theory and Cultural-Historical Activity Theory tradition: Origins and historical development

Activity theory emerged out of work in cultural psychology as an approach to explore the connection between mind and activity, and has found application in many other social science disciplines and their interplays. Kaptelinin and Nardi (2006) have described its aim as "to understand individual human beings, as well as the social entities they compose, in their natural everyday life circumstances, through analysis of the genesis, structure, and processes of their activities" (p. 31). To understand the role and application of activity theory, it is essential to trace its tri-level historical origins and development firstly in classical German philosophy, namely in the ideological thoughts and writings of Karl Marx and Friedrich Engels.

From here, the ideas of activity phenomena were taken up by the Soviet cultural-historical school of psychology led by Lev S. Vygotsky (1896-1934), Alexei N. Leont'ev (1904-1979) and Alexander R. Luria (1902-1977) in the 1920s and 1930s (Engeström, 1999a; Van Oers, Wardekker, Elbers, & Van der Veer, 2008). Yrjö Engeström and colleagues at the Centre for Research on Activity, Development and Learning (CRADLE) at the University of Helsinki, Finland made further developments in this field from the late 1970s onwards. This study used Cultural-Historical Activity Theory (CHAT) following the work of Engeström (1987, 1999a, 2016) and colleagues, firstly to frame agricultural learning systems as complex activity systems that they are, with various subjects working on their objects through mediating tools. I then used Engeström's third generation CHAT (Engeström,

1987) to surface ambivalences, tensions and contradictions with a formative interventionist goal to resolve them across boundaries otherwise separating the interacting activity systems. Engeström and Sannino (2011) however caution the untheorised use of the concept of contradiction; hence, its conceptualisation and manifestations are discussed in this thesis.

3.2.2.2 Activity theory: A reflection on its pedestals of Marxist thought

Activity theory is considered as a model of artefact-mediated and object-oriented action that is also socially mediated as meaning-making is considered a joint collective activity (Vygotsky, 1978). The philosophical transformation inherent in activity theory was a Marxist concern that reality was conceived only in the form of the object (a materialistic view), but not as sensuous human activity or practice, i.e. subjectively. Despite being neither a philosopher nor an educator, Karl Marx's political contributions in shaping socialism have found sustained space in educational foundations. In this respect, learning is seen as a process leading to self-emancipation. This perspective is based on the subject-object premise that sees humans as creators of the social conditions that produce them. On this basis, Marx's (1867 [Eng., 1887]) premise is that socio-historical processes determine practice, and that human emancipation is a collective revolutionary practical activity. Daniels (2008) observed unique 21st century circumstances that challenge conceptions of learning and need recognition when interpreting and applying Vygotsky's ideas of the early 20th century,

> These challenges are themselves mediated and shaped by the culturally and historically specific understandings of learning that have been developed and are available at specific moments in time and space. (p. 3)

The literature shows that Marx's involvement with the conceptualisation of activity stems from the influence of Hegelian dialectical thinking. The latter saw development as methodological advances from one notion to another through negation, i.e. "development by the union of opposites" (Seligman, 1901, p. 619; Stern, 2012). The notion of the absolute idea or system in Hegelian dialectics appears to have become a schism developing into an Achilles heel of Hegel's ideas (O'Malley, 1970). [Stern (2012) problematised this and I will also discuss it briefly in Chapter 8]. What is important here is that the Bhaskarian dialectic, not unlike that of Ilenykov which Engeström draws on, adds to social sciences the capability of "functioning as agencies of human self-emancipation" (Bhaskar, 1993, p. 2) via situated emergence of agency via dialectical activity transformations (i.e. not only via discourse).

In *Das Kapital,* Marx (1867 [Engl., 1906]) introduced the *idea of contradictions* in capitalist society as social production by production class versus the nature of private appropriation of surplus by the ruling class (primary contradiction of exploitation) and the contradiction between use value and exchange value. This idea is taken forward in cultural-historical activity theory (see section 3.2.2.7).

Marx (ibid.) saw no difference in the master-slave relations of serfdom and ruler-producer relations of modern capitalism that flashed a red light as follows:

> The economic structure of capitalist society has grown out of the economic structure of feudal society. ...The immediate producer, the labourer, could only dispose of his own person after he had ceased to be attached to the soil and ceased to be the slave … of another. … Hence, the historical movement which changes the producers into wage-workers, *appears, on the one hand, as their emancipation from serfdom* ... But, on the other hand, *these new freedmen became sellers of themselves only after they had been robbed of all their own means of production*... And the history of this, their expropriation, is written in the annals of mankind in letters of blood and fire. (p. 508, emphasis mine)

In fact, the history of expropriation is being perpetuated in today's globalising neoliberal economy (de Sousa Santos, 2005), which Marx foresaw nearly one and half centuries ago. Now expropriation has extended to the earth's sustaining systems in addition to human labour (Moore, 2015). From an emancipatory educational approach, Freire (1998) in his view of education as ideological concurred with Marx on the need for struggle and emancipation against expropriation's social injustices;

> I don't believe that women and men of the world … conscious of their dignity … will not want to reflect on the sense of foreboding that is now universal in this perverse era of neoliberal philosophy. … Even before I ever read Marx I had made his words my own. (p. 114)

As shall be seen in the further development of activity theory in this section, the project of emancipatory learning was taken forward by Engeström (2008a) who strongly rejected the caging of people in imposed categories as a form of symbolic violence. This is because official, unchallenged epistemologies reduce possibilities for human development. He insisted that "such closed 'stabilization knowledge' (Engeström, 2007) is commonly the result of exclusively empirical generalisations taught in schools as authorised 'correct knowledge'" (Davydov in Engeström, 2008a, p. 11). It compares well with the misdescription of being as knowledge that Bhaskar (2008b) called the epistemic fallacy (see section 3.7.3).

3.2.2.3 Development of the idea of mediated action and activity theory

Borrowing from Marx's ideas, Vygotsky (1934/1986) observed a state of crisis in the psychology of education which he attributed to the separation of "atomistic and functional modes of analysis . . . [that] treated psychic processes in isolation" (p. 1) from the personal needs and wishes of the person. He, building from Marx and Engels (1970), therefore called for holistic and inseparable integration of mind and culture in explaining practical human labour as object-oriented activity. In this formulation of psychology, the idea was to find a method that enabled examination of the organism and the environment as a single unit of analysis as individuals learn to engage in shared activities (Stetsenko, 2005). According to Yamagata-Lynch (2010), Vygotsky proposed that "the organism and the

environment were parts of a complex system that co-created consciousness through human participation in activities. He was interested in identifying methods that would objectively study and explain human activities" (p. 15). Vygotsky's recognition of the vital relationship between the individual's mental processes and his/her interaction with socio-cultural, historical and institutional contexts crystallised in the concept of mediated action (Yamagata-Lynch, 2010).

Vygotsky's mediation triangle

Mediated action is the subject / individual with mediating artifacts (tools or signs) and is represented in Vygotsky's basic mediated action triangle (Vygotsky, 1931/ 1978; Cole & Engeström, 1993). This is formulated diagrammatically in Figure 3.1.

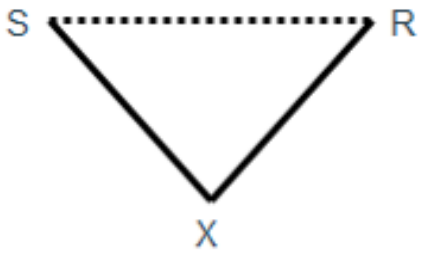


Figure 3.1*: Vygotsky's original formulation of mediated action (after Vygotsky, 1931/ 1978, p. 40)*

In this 'first generation activity theory' Vygotsky proposed that human activity represented by the now more complex association between the stimulus (S) and the response (R) is (also) culturally-mediated by a cultural sign (X). In this way, he founded cultural-historical psychology. Vygotsky highlighted the significance of mediation tools in the subject-object interaction, thereby initiating a shift in focus from behaviourist psychology to activity. A journey back in Russian history reveals some influences to activity theory from the political changes taking place then. In the aftermath of the 1917 Bolshevik Revolution against the imperial Tsars and an economically-classed society, there was a new social demand by a euphoric population with people-led democratic ideas for a new psychology to replace the overthrown bourgeoisie. This gave way to the birth of Marxist cultural-historical psychology underpinned by the concept of activity as foundation for emancipation. What remained unclear though is the nature of this kind of activity. This issue was resolved by Luria and Leont'ev when they elaborately integrated social, cultural, and historical aspects into an explanation of how the human mind functions (Stetsenko, 2003). Luria and Leont'ev, together with Vygotsky, were co-founders of cultural-historical psychology whose basic principles are cultural mediation, historical development and practical activity, in a socio-genesis of learning that leads development.

Luria's studies on indigenous people brought to the fore the field of multiculturalism which sheds further light on developments of cultural-historical activity theory (Eilam, 2003; Cole, 2005; Toomela, 2014). Notably, most of these Soviet inspired cultural-historical psychology ideas could not be openly implemented in the larger Russian society as they clashed with the contradictory realities facing the Lenin and Stalinist-led communist leadership. Hence they could also not reach the wider world stage beyond Russian borders during this time and many decades after, especially during the turbulent Stalinist era until the 1960s (Daniels, 2005; Yamagata-Lynch, 2010).

Mediation

Wertsch (2007), writing on mediation in the Vygotskian tradition, agreed with Vygotsky regarding the centrality of mediation in human activity leading to human consciousness. Such mediation is linked with the use of "psychological tools" or "signs" such that

> Instead of acting in a direct, unmediated way in the social and physical world, our contact with the world is indirect or mediated by signs. This means that understanding the emergence and the definition of higher mental processes must be grounded in the notion of mediation. (p. 178)

Wertsch therefore foregrounded mediation in learning processes such that co-construction of knowledge in social interaction leads to appropriation and internalisation of the cultural tools required for performing a new or more advanced task in a new activity. Wertsch (2007) also made a distinction between explicit (overt and intentional stimulation) and implicit mediation. In the latter, mediating signs "are part of a pre-existing, independent stream of communicative action that becomes integrated with other forms of goal-directed behaviour" (ibid., p. 183). In this study, this means that a mediating role can be performed by each of the interacting subjects in the normal course of their activity, and that it can also be expanded by formative interaction with more knowledgeable peers. It can be planned as expansive learning interactions, on one hand, and can also be catalytic along emergent, everyday expansive learning cycles. These two forms of mediation (implicit and explicit) can also co-exist and intersect in expansive learning.

In the agricultural learning contexts of this study, the concept and processes of mediation were applied to the interaction among agricultural actors as co-mediators in boundary-crossing change laboratory workshops and out of these settings. In so doing, the cultural contexts of smallholder farmers' historicised practices was given primacy as a reference point, while all activity systems were considered equally important. Other researchers in the post-Vygotskian scholarly tradition support these views on mediation. According to John-Steiner and Mahn (1996), sociocultural approaches are "…based on the concept that human activities take place in cultural contexts, are mediated by language and other symbol systems, and can best be understood when they are investigated in their historical

development" (p. 191). To get a first-hand grasp of the BCCLW method I had the privilege of undergoing training at CRADLE (see Appendices 3.5A and B).

According to Daniels (2015), the concept of mediation makes it possible for humans to transform their world with external cultural tools as they act upon or are acted on by socio-cultural and historical factors, rather than being subjugated by or within cultural systems. Similarly, Elkonin (2014) argued that mediated activity thus involves "the valuation of your own behaviour through cultural forms – signs" (p. 2058) whereby "the social and the individual mutually shape each other" (Daniels, 2015, p. 34).

3.2.2.4 Elaboration of concepts of activity systems

Having scoped the origins and development of activity theory, it is now time to discuss an understanding of some key concepts used in activity theory, namely activity, action, subject and object. *Activity* has been described as a purposeful and developing interaction of the subject with the world, a process in which mutual transformations between the poles of "subject-object" are accomplished (Leont'ev as cited in Kaptelinin & Nardi, 2006, p. 31). Object-oriented activity has also been referred to as *practice* (Miettinen, 2005). According to Leont'ev (1978/2009), the distinction between human activities and actions is that the former are composed of basic components that realise them, being the actions. "We regard action as the process that corresponds to the notion of the result which must be achieved, that is, the process which obeys a conscious goal. Just as the concept of motive is correlative with the concept of activity, so the concept of goal is correlative with that of action" (ibid., p. 6). Using Leont'ev's words, the relationship between activities and actions is illustrated as follows for a person's food procurement activity:

> Let us assume that a person's activity is stimulated by food, this is its motive. However, in order to satisfy the need for food he must perform actions that are not directly aimed at obtaining food. For example, one of his goals may be the making of trapping gear. Whether he himself will later use the gear he makes or pass it on to other participants in the hunt and receive part of the common catch or kill, in either case his motive and goal do not directly coincide, except in particular cases. (Leont'ev, 1978/2009, p. 7)

The **object** of an activity is the reason why individuals and groups of people choose to take part in an activity, and therefore it holds together the other elements of an activity system, and has a complex and contradictory nature (Kaptelinin, 2005; Hyysalo, 2005; Miettinen, 2005). Leont'ev (1978) proposed that "the object of an activity is its true motive" (p. 62) rather than the organic needs of an individual as traditionally conceptualised in psychology. **Mediating artifacts** are material tools and cognitive instruments, or signs. They include "social others and artifacts that can act as resources for the subject in the activity" (Yamagata-Lynch, 2010, p. 2). According to the Oxford Living Dictionaries (undated), 'artifacts' (or artefacts) are objects shaped by human workmanship, typically those with

historical or archaeological interest. In this study, the terms ‘artifact’ and ‘artefact’ are used interchangeably as the spellings occur in these two variations in the literature.

Using activity theory, an activity system, such as the learning activity system of water and seed activity, becomes the unit of analysis in studying human mediated activity among a community of (agricultural) actors who have a common object of activity of water and seed provisioning.

3.2.2.5 Second generation activity theory

Alexei Leont’ev (1978/2009), through his developmental psychology work, is credited with connecting the subject, object and mediating tools to the rules, community and division of labour in it although he did not demonstrate how these connections worked (Engeström, 1987). Leont’ev integrated mediation by other human beings into the activity triangle by distinguishing collective activity from individual actions as discussed earlier. He also re-modelled the emergence of division of labour as a central historical process using his famous example of the “primeval collective hunt” (Leont’ev, 1981, pp. 210-213). Engeström (1987) developed these ideas further to formulate second-generation activity theory (see Figure 3.2).

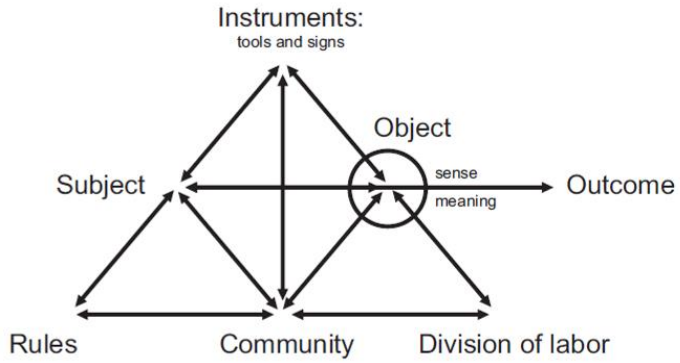


***Figure 3.2**: Second-generation activity theory (Engeström, 1987)*

According to Engeström (2015b), working with or developing theory requires careful modelling that is step-wise beginning with delineation and identification of the object of inquiry in problem identification or object constitution (p. 201). The process has tacit and implicit dimensions linking theory and everyday problem-solving of the subject. The next step is construction of a model. The subject is not a solitary figure in this whole process as depicted by the process of transition from the abstract to the concrete in Marxist thinking, but is connected to a community as shown in Figure 3.2 whereby there is collective rather than individual activity, which is the third step in the proposed theoretical thinking process (ibid., p. 203). The shift to collective activity as opposed to individual activity as a unit of analysis is culturally-relevant for African smallholder farming systems where the

culture of *ilima* (IsiXhosa and IsiZulu) and *humwe* (ChiShona) typify traditional collective farming activity. These collective cultural practices are discussed in Chapters 6 and 7.

At this point, towards discussion of second generation activity theory, it is worth noting that the ideas of cultural-historical psychology and activity theory became so connected that their fusion is known as cultural-historical activity theory (CHAT, in short) (Roth & Lee, 2007). In the second generation of CHAT, there is an addition of the lower triangle which includes three more elements, namely the rules, the community and division of labour which are discussed below, together with the outcome of activity (Leont'ev, 1978/2009; Engeström, 1987; Yamagata-Lynch, 2010). The community is the social cluster, of which the subject is part, in his/her engagement in a particular activity. The subjects in the **community** share tasks among its members in a manner referred to as **division of labour**. The activity takes place as these elements interact under certain formal and informal governing principles regulating the way the community can work, known as the **rules**. The **outcome** is the end result of an activity towards which an organisation, a group, a network or a society is working towards. For an activity system to be, there must be a shared purpose of some sort which defines the nature or object of the activity.

3.2.2.6 Three analytical levels of activity theory

According to Leont'ev (1978), activity theory differentiates three levels of analysis which are activity, action and operation. The first level (activities) is carried out by a community and is oriented towards an object or motive. This level is used to build activity systems. Actions are carried out by individuals or a group of people as the second level within an activity and are said to be goal-oriented. The third level is described as conditioned operations carried out by a routinised human or machine. These levels of activity are dialectically related as illustrated in Figure 3.3, and offer additional theoretical lenses for cultural-historical activity theory.

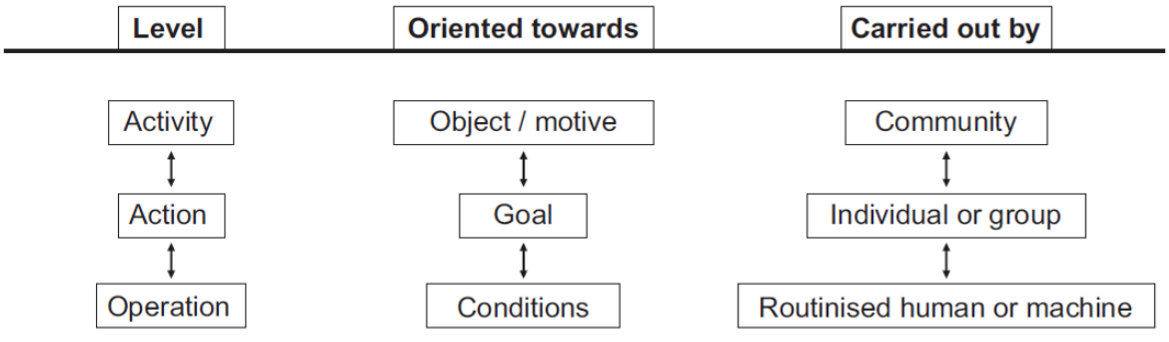


Figure 3.3: *Three levels of activity (after Leont'ev, 1978, pp. 66-67)*

Activity, action and operation have a dialectical relationship. This is illustrated as follows by Virkkunen and Newnham (2013, p. 37):

> The joint activity is realized through individuals' actions but individuals' actions also form the joint activity. In the same way the objective of the action determines what operations are needed, but on the other hand, the available operations affect what kind of objectives can be set and reached.

In the case of collective activity, success of the activity depends on coordination, which is one of the mechanisms of boundary-crossing described by Akkerman and Bakker (2011). Ideas of co-engaged learning as transaction and actioning of new emergent ideas (Östman & Öhman, 2010) and meaning-making are useful in understanding boundary learning in interacting activity systems, as shall be described in the next section on third generation activity theory. Roth (undated) also observed that in CHAT, "the rudiments for orientating and attributing meaning, emotionality and needs, and communication and social structures" are seen as emergent (p. 16).

3.2.3 Identifying, conceptualising, and theorising contradictions and their manifestations

The analysis of activity systems through following the object of activity in formative interventionist research depends largely on identifying contradictions that interrupt or cause discontinuities in the smooth flow of work, and resolving them dialogically and dialectically. This section endeavours to conceptualise and theorise contradictions in order to avoid trivialising or reducing them as has been observed in much organisational change research (Engeström & Sannino, 2011). In the CHAT tradition, the concept of contradiction is derived from Marxist dialectics as discussed in Karl Marx's classical work *Das Kapital* (Marx, 1990), whereby it typically denotes an opposition or incompatibility inherently existing within an object or proposition. The contradicting forces define each other's existence, for example, vast wealth and ownership of capital coexist alongside, and are contrary to, extreme poverty, dependence and deprivation.

According to Engeström and Sannino (2011), contradictions have deep, contextual socio-historical roots and by nature "cannot be observed directly; *they can only be identified through their manifestations*" (p. 369, emphasis mine). This means we can observe what the effects of contradictions show us in text, speech, language or artefacts, but we can only understand the phenomena fully when we historicise these manifestations and work out their generative mechanisms (Norrie, 2010). Engeström and Sannino (2011) went on to define and characterise four kinds of manifestations of contradictions which could be effectively found in the data namely "dilemmas, conflicts, critical conflicts, and double binds" (ibid., p. 373). As contradiction is a foundational philosophical concept with socio-historical rooting, the caution is that these manifestations should not be equated with the contradictions but need rigorous theorisation and conceptualisation. In their paper, Engeström and Sannino (2011) proposed and demonstrated how these discursive manifestations could be collectively used as a framework for analysing sequences of change efforts. In so doing, they explained

development as "historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p. 137). Engeström (2016) further conceptualised development as

> qualitative transformations... driven by an expansive reconceptualization of the object and motive of the entire activity. …such transformations are both initiated and implemented in daily work actions, in deviations from the prescribed course of actions and in mundane innovations. (p. 221)

The process of analysing contradictions is like 'peeling an onion', a metaphor coined by Engeström and Sannino (2011) and illustrated in Figure 3.4.

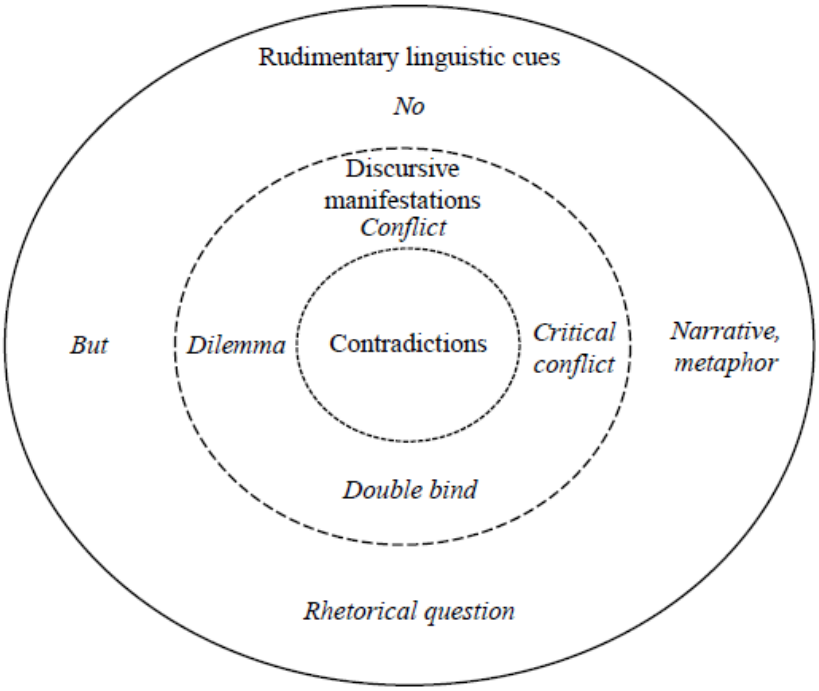


Figure 3.4: *Metaphoric onion methodological tool for analysing contradictions and their manifestations (adapted from Engeström & Sannino, 2011, p. 375)*

The metaphoric 'onion' diagram in Figure 3.4 shows progression in analysing discourse data from finding basic linguistic cues in simple ('but', 'no', ...) expressions, narratives, metaphors and rhetorical questions, leading to finding potential discursive manifestations of contradictions named above. This process is essential because contradictions are not always obvious in discourse. Below, I discuss manifestations of contradictions to guide how I searched for and analysed them (see Chapters 4 and 5).

3.2.3.1 Manifestations of contradictions in 'dilemmas'

Engeström and Sannino (2011) conceptualised dilemmas as everyday occurrences in thought processes and practices. Rather than individual mental agonies of decision-makers, they perceived a dilemma as "an expression or exchange of incompatible evaluations, either between people or within the discourse

of a single person. It is commonly expressed in the form of hedges and hesitations..." (ibid., p. 373). Hedges are used by speakers or writers in the form of mitigating words, constructions or sounds used to distance oneself from propositions made or lessen the impact of an utterance such as politeness or softening the blow (Prokofieva & Hirschberg, 2014). Dilemmas were mainly surfaced in Chapters 4 and 5.

3.2.3.2 'Conflicts' as manifestations of contradictions

Conflicts can be characterised by serious disagreements or arguments between people, especially over a protracted period, such that one's actions negatively affect another's behaviour through interference, obstruction or otherwise. They can be based on beliefs, interests, needs or facts. Disagreements can be verbalised through oppositions with such expressions as "no" signaling potential or actual conflict. Argument, resistance and criticism are also forms of conflict. Examples of how I encountered and worked with conflicts are found in Chapters 4-7. Deliberative conflict resolution becomes a process of compromise, submission or intervention by a third party.

3.2.3.3 'Critical Conflicts' as manifestations of contradictions

Engeström and Sannino (2011) viewed "critical conflicts" as situations where people feel silenced, violated or guilty and in the face of inner doubts that are not solvable by the individual alone; they regress into action paralysis. "The discursive working out of critical conflicts involves personal, emotionally and morally charged accounts that have narrative structure and frequently employ strong metaphors" (ibid, p. 374). This study found at least two critical conflicts in two of the cases (see Chapter 4).

3.2.3.4 'Double-binds' as manifestations of contradictions

The theory of double-bind emerged from multidisciplinary research on interpersonal relationships or relational practice that brought together work from various fields including anthropology, biology, psychiatry and ecological and systems epistemologies (Bateson, Jackson, Haley & Weakland, 1956). Double-bind has been defined by the online Oxford Living Dictionaries (undated*)* as

> A situation in which a person is confronted with two irreconcilable demands or a choice between two undesirable courses of action: (e.g.) *students are caught in a double-bind between unemployment and cuts in education.*

In double-bind situations, people and organisations struggle to move forward because they fail to find a way out of contradicting conjunctions they encounter as reinforcing cycles in their contexts, and typically individuals are unable to find solutions on their own without engaging with others (Engeström & Sannino, 2011). Bateson (1972) clarified a shift in the object of study from the

individual's mind to the relationships they are in as the sources of unsustainable positions that are manifested through patterns of communication between two or more individuals. In the relationship, Engeström (1978) explained that the double-bind is located in the spatio-temporal dimensions of interaction. The ideas of double-bind have found application in inter-organisational relationships through this re-focus on communication in relationships, which is where the boundary-crossing interest of this study lies (see Chapters 6 and 7).

3.2.3.5 The ubiquitous and latent nature of primary contradictions in capitalist commodities: Use versus exchange value and a possible reinterpretation

In explaining the historical nature and development of contradictions, Engeström (2011) described the primary contradiction of capitalism as existing in every commodity (see section 3.2.2.2). The dual nature of use value versus exchange value in the primary contradiction can be understood by examining the instruments of the smallholder farmer activity system. They comprise seed and soil fertility inputs which are essential for successful crop and horticulture production (use value), but they are also commodities produced by the market for sale to gain profit (exchange value). Farmers, extension advisers and agricultural educators encounter this contradiction in their work choices.

Bonneau (2013) further underscored the importance of manifestations of contradictions by explaining the essentially economic nature of the primary contradiction. He demonstrated that the latter is based on the conflict between "the use value of the product or service, which exists to meet needs and its exchange value, i.e., its commercial potential" (ibid., p. 9). He further argued that "the primary contradiction has a latent form, with the result that it is impossible to have direct access to it in our empirical study. Therefore, *we must approach it via its manifestations in the discourse and actions* of the players involved" (p. 9, emphasis mine). This is the argument for tackling contradictions through their discursive manifestations in this study; for clarity of identification and description, and for theoretical precedence. A possible shift in the conception of the primary contradiction due to the different socio-economic context of this study that is not classical capitalist (as in Marx and Engeström's contexts) is surfaced and discussed in this study (see Chapters 2, 4, 5 and 8).

3.2.3.6 Secondary contradictions

Engeström (1987) characterised secondary contradictions as occurring between two elements (or corners) of an activity system for example between the object and its mediating tools as illustrated in Figure 3.5.

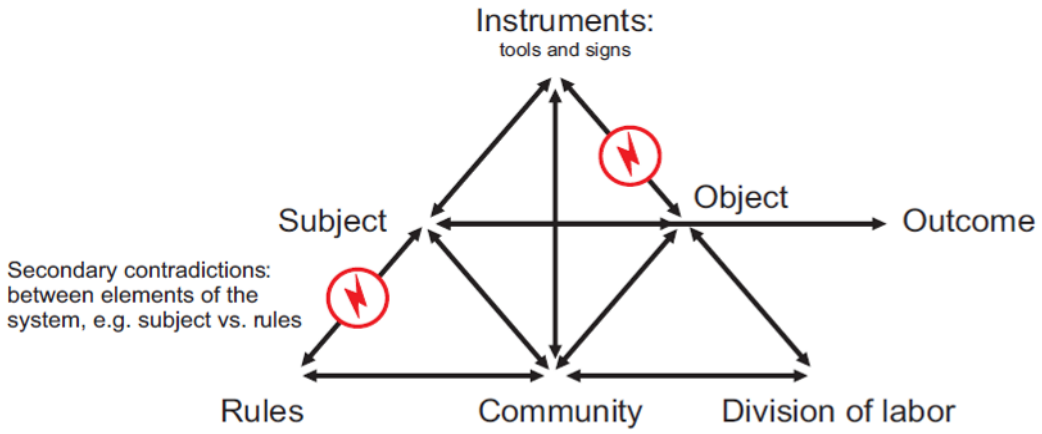


Figure 3.5: *Secondary contradictions illustrated between subject and rules and object and instruments (adapted from Engeström, 1987)*

A typical example of a secondary contradiction provided by Engeström (1987) is whereby the division of labour has a rigid hierarchical structure that lags behind and prevents the possibilities opened by new advanced instruments. This can happen in formal organisations such as agricultural colleges.

3.2.3.7 Tertiary contradictions

A tertiary contradiction is a conflict of motive that emerges in a central activity between a dominant motive and a culturally more advanced motive (Engeström, 1987). This is illustrated as a level 3 contradiction in Figure 3.6. Engeström (ibid.) illustrated this level of contradiction using an example from the school and home contexts of pupils.

> The tertiary contradiction appears when representatives of culture (e.g. teachers) introduce the object and motive of a culturally more advanced form of the central activity into the dominant form of the central activity. For example, the primary school pupil goes to school in order to play with his mates (the dominant motive), but the parents and the teacher try to make him study seriously (the culturally more advanced motive). The culturally more advanced object and motive may also be actively sought by the subjects of the central activity themselves. (ibid., p. 103)

In the citation above, a culturally more advanced motive is mediated using tools introduced by another person in the subject's community or is pursued by the subject. It can be both. Tertiary contradictions are potentially significant in smallholder farming, agricultural education and extension service, the central activities of interest in their interacting (boundary-crossing learning) contexts in this study. The dominant motives can respectively be adaptive rain-fed farming for subsistence production, irrigation systems for commercial production and extension advice on what is considered 'appropriate' farming systems suited to the agro-ecological region respectively. From a praxis perspective, the culturally more advanced form of the activity, what Engeström (1991) interrogates as 'which way is up', is a formative interventionist project of expansive transformation with no predetermined result. The idea of the 'culturally more advanced' motive thus appears to be value laden and therefore raises some

social justice questions (see Chapters 6 and 7). Mukute (2010) questioned the construction of what counts as 'culturally more advanced' from a substantially counter-hegemonic and cognitive justice discourse perspective where, for example, GM-monoculture is seen to be culturally more advanced in 'mainstream' agriculture but may not be so. Similar questions emerge in this study regarding the water and seed objects, as introduced in Chapter 2.

3.2.3.8 Quaternary contradictions

Quaternary contradictions emerge between the central activity and its 'neighbour' activities with which it is linked. Engeström (1987) identified five types of 'neighbour' activities. The first four are those embedding the object and outcomes of the central activity (object-activities), and those producing the instruments, the subject and the rules, respectively. The fifth type of 'neighbour activities' are "central activities which are in some other way, for a longer or shorter period, connected or related to the given central activity, potentially hybridizing each other through their exchanges" (ibid., p. 103). Figure 3.6 shows the four levels of contradiction discussed above.

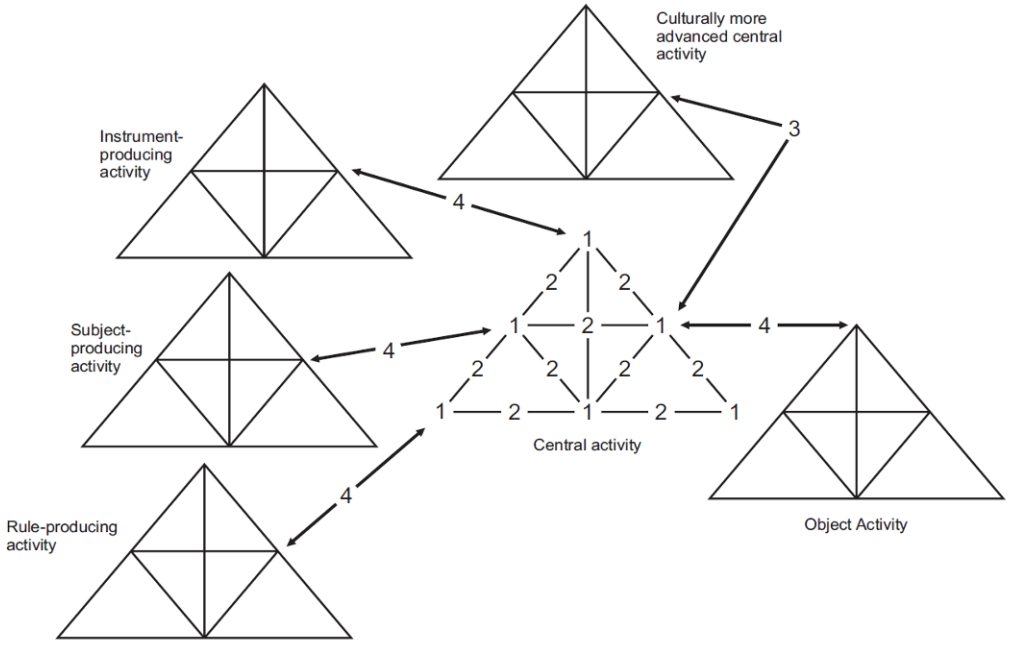


Figure 3.6: *The four levels of contradictions in activity systems (Engeström, 1987)*

In Figure 3.6 number 1 refers to primary contradictions within the elements, while secondary, tertiary and quaternary contradictions correspond respectively to numbers 2, 3 and 4.

3.2.3.9 Third generation activity theory and boundary-crossing in learning networks

Reflexively responding to critiques by Cole (1988) and others regarding the role of cultural diversity and dialogue between different perspectives, and extending Luria's ideas about multiculturalism,

Engeström (1987) developed third generation activity theory. In order for it to absent the absences observed in its criticism, third generation activity had to "develop conceptual tools to understand dialogue, multiple perspectives and voices, and networks of interacting activity systems" (ibid., p. 6). The latter entails the interaction between at least two activity systems to networks of activities through a jointly negotiated object. Figure 3.7 below shows the minimal unit of analysis in the third generation of activity.

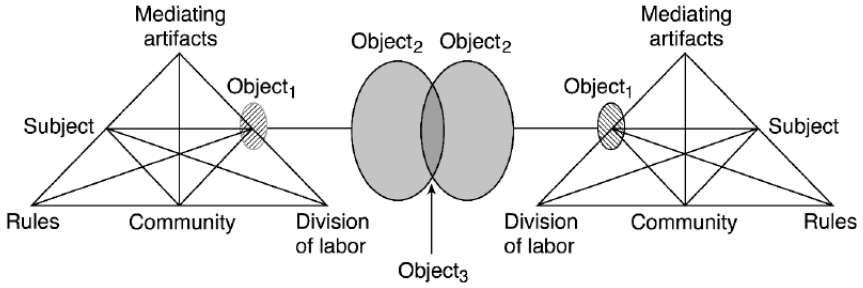


Figure 3.7: *Third generation activity: Two interacting activity systems as minimal unit of analysis and a potentially shared [boundary] object$_3$ (adapted from Engeström, 2001, p. 136)*

In Figure 3.7 a potentially shared or jointly constructed object between the interacting activity systems is shown at the centre of intersection. Engeström (2001) described the object as a "moving target, not reducible to conscious short-term goals" (p. 136). In his description Engeström (ibid.) provided the example of a patient in their different phases. Initially, the patient approaches the doctor as an unreflected, initial 'raw material state' (object$_1$). Then they are diagnosed and classified as a collectively constructed meaningful object (object$_2$). Eventually there is "a collaboratively constructed understanding of the patient's life situation and care plan" (ibid., p. 136), the potentially shared object (object$_3$). In practice, the interacting activity systems may be more than two depending on the nature and complexity of the study.

In this study the interest is in exploring potential expansive learning across multiple interacting activity systems, namely small-scale farming, agricultural education and extension activity systems. Participants from these activity systems were organised into one learning network in each country case, with the South African one activated by a training-of-trainers course enabled by a Water Research Commission Project (see Chapters 1 and 6) called Amanzi for Food (Lotz-Sisitka et al., 2016). Learning, potential development and changes in human activity and societal activity systems can be identified by the interactions shared among multiple interacting activity systems and formative interventions across their boundaries (Engeström, 1999b). Yamagata-Lynch (2010) suggests that researchers need a framework that they can use as a tool to aid in identifying boundaries between complex systems. "This boundary identification framework will guide the investigators' design, development, implementation, and analysis processes." (ibid., p. 24). This implies that in order to

investigate boundary-crossing learning, one needs a structure which conceptualises an activity system as a bounded system.

The idea of a bounded system can be traced to Smith's (1978) description of a case as a bounded system. Regarding a bounded system in human activity and social sciences, Stake (1994) stated that "it has working parts, it probably is purposive, even having a self. It is an integrated system. The parts do not have to be working well, the purposes may be irrational, but it is a system" (p. 236). Using these ideas and the cases in this study, I conceptualised the individual agricultural learning systems as bounded activity systems with potential or actual interaction as described in the next section. (This construction was then tested as I worked with research participants to construct their actual activity systems as described in Chapters 4 and 5).

3.2.3.10 Application of third generation CHAT to boundary-crossing learning in networked agricultural learning systems

As discussed earlier and throughout this thesis the key agricultural learning systems under study are agricultural education, extension and small-scale farming activity systems. It was assumed that diverse agri-business and socio-ecological motives and tools and their contradictions are embedded in these activity systems and across their interactions based on the literature review in Chapter 2. The contradictory forces manifested as tensions, dilemmas or otherwise were viewed as opportunities for collaborative learning, joint problem solving and agency. In seeking a theory, the study was concerned with a view of the world which presented agricultural practices in agricultural education, farming and extension as whole but interdependent systems. This is because these systems are complex in themselves, and they are designed to influence each other through their products, although not necessarily reciprocally as linear knowledge flows were presumed from experts to consumers as discussed in Chapter 2. In many ways, the agricultural learning systems have developed separately, unequally and in the process, developed boundaries between each other that often present barriers to joint learning as discussed in Chapter 2.

This pursuit stems from the desire to trace and study as much as possible the interactions between the components of these activity systems and the resulting learning for change and transformative agency. These components include the people working under and influencing certain structures (e.g. policies, curricula) in pursuit of livelihood and educational goals but with not so obvious transformational actions or solutions to follow to respond to emerging problems. Books, journals, assessment reports, policies and declarations are full of recommended actions in a usually technicist fashion of setting structural goals, but water scarcity, crop failure, hunger and extension failure persist in society

undershooting the targets (UNCTAD, 2014; UN, 2015; Malzbender & Earle, 2009). Related to these normalising approaches is the traditional problematic framework that Engeström (1999a) argued

> … separates the study of socio-economic structures from the study of individual behaviour and human agency... This traditional dualistic framework does not help to understand today's deep social transformations. (p. 19)

The above problem has to do with many causal mechanisms, including the failure of structures to respond to the development trajectory of meeting set goals without examining the historical and cultural mechanisms that give rise to problems in work (Virkkunen & Newnham, 2015). Normalisation in this case refers to social and educational processes or social engineering that constructs certain ideas and practices as the normal in such a way that they become natural and taken for granted in the everyday. It can contribute to fatalism that then takes away people's freedoms especially when it delinks processes in systems so that society does not see how certain actions or promises in one system impact on their livelihoods through destabilising other systems. Engeström (1999a, p. 19) argued "there is a need for an approach that can dialectically link the individual and the social structure".

In this study agricultural learning systems are the units of analysis and are described below:

Smallholder / Small-scale farming activity system:

Smallholder farming is an activity system made up of various actions such as connecting with other people, obtaining inputs (internally and/or externally) with the aim of producing food or cash crops and/or livestock for local consumption and/or sale using rainwater (the object). In so doing, it is learning while being guided or directed by certain norms, rules, regulations and /or values (see section 2.4.3). This learning is mediated by extension material demonstrations and by traditional conceptual tools such as winter ploughing and seed exchange or artefacts such as seeds and draught power. It is also an activity system facing poly crises including climate variability and change (nature's rules) and reduction by industrial farming systems that relegate it as romanticisation with the past and with unsound economies of scale (McIntyre et al., 2009). Extension services channel conventional industrial farming values to it sometimes disrupting smallholder farmers' own values, knowledge and livelihoods. This is the activity system of focus in this study because it is where the outcomes of agricultural education, research and extension play out in the lives of people dependent on the soil, seeds and water.

Agricultural education activity system:

Agricultural colleges and university agricultural faculties in South Africa and Zimbabwe have traditionally been producing and continue to produce extension workers / officers / advisors from formal education who eventually work directly with the smallholder farmers, train farmers upon

request and do outreach to smallholder farmers (see section 2.4.4). These people constitute their community in the activity. The lecturers (subjects) use various mediating artefacts such as curricula that are dominated by industrial agricultural approaches, values and technicist tools for teaching water and inputs to mediate learning as discussed in Chapter 2. They are guided by rules for curriculum development and change, structured examinations and timetables among others. Two key recent changes are that, in the South African case, the colleges are trying to conform with new extension norms (rules) that require extension officers to have degree level qualifications (South Africa. DAFF, 2011), while in the Zimbabwean case, the colleges still produce diploma level extension workers (see section 2.4.4.4 and Appendix 7.1).

Agricultural extension activity system:

The agricultural extension activity systems in both South Africa and Zimbabwe have their object as advising farmers (their main community members) primarily using mediation tools from conventional technicist agriculture acquired from their training and guided by rules from their government mandate (see section 2.4.5).

Complex interactions were formed between at least four activity systems (described above), that were connected through course-activated and interest group learning networks around sustainable agricultural water and seed saving in South Africa and Zimbabwe respectively and yet distributed in space (see section 3.2.3.9). Digital links through a very active and generative WhatsApp group and a website (www.amanziforfood.co.za) linked to a blog, Facebook, and community radio (Forte FM Station, at 88.2 MHz frequency) connected the South African group and generated boundary-crossing data.

3.3 THEORY AND MECHANISMS OF EXPANSIVE BOUNDARY-CROSSING LEARNING

This section of Chapter 3 discusses the theory shaping expansive learning (Engeström, 1987) and the potential learning mechanisms (Akkerman & Bakker, 1995) by which it can occur in boundary-crossing change laboratories (Engeström, Engeström & Vähäaho, 1999). While a section of Chapter 1 was devoted to introducing the context and justification of boundary-crossing learning, this section takes these discussions further by explicating the concept and potential of expansive boundary-crossing learning, and connecting with ideas of causality (Bhaskar, 2008a [1993]; Bhaskar & Norrie, 1998). These discussions start by exploring potential dialogical learning mechanisms across boundaries, and then probe expansive learning across these boundaries.

3.3.1 Potential dialogical learning mechanisms at and across boundaries

This section discusses four potential dialogical learning mechanisms that take place at the boundary of activity systems, namely (1) *identification,* (2) *coordination,* (3) *reflection* and (4) *transformation* (Akkerman & Bakker, 2011), with the aim of providing a framework for investigating similar mechanisms across agricultural learning systems (see Chapters 6 and 7). Akkerman and Bakker (2011)'s research scoped a number of research projects that reported some form of boundary-crossing among which were those that used third generation CHAT.

3.3.1.1 'Identification' as learning mechanism in boundary-crossing

The process of identification is said to take place when one practice is defined relative to another, hence it is also referred to as 'othering'. In this boundary-crossing learning mechanism a number of cultural identities become contested as individuals such as farmers and extension workers participate simultaneously in various institutionalised domains such as 'mandated' extension work and agricultural innovations with farmers. These "cultural contractions (of institutionalised domains)… are drawn into question… [such as] questioning of the core identity of each of the intersecting sites" (Akkerman & Bakker, 2011, p. 11). These researchers (ibid.) also found identification to entail a continuous redefinition and consequent shaping of boundaries, for example, between product sellers and buyers. This perspective has implications for agribusiness operators and farmers. The fundamental need to authenticate coexistence among actors involved was found to be very sensitive and political in most cases. In the case of a networking system, the review found that "individual actors from various organisations may successfully define their different identities as well as their shared identities on a network level based on the project activities of this network" (ibid., p. 12). They also found the learning potential of identification to exist in a relational sense whereby participants make sense of each other's different practices and related identities.

3.3.1.2 'Coordination' as learning mechanism in boundary-crossing

Akkerman and Bakker (2011) considered boundary objects as mediating artefacts that allow different practices to cooperate better in distributed work, with dialogical interaction among partners playing the role of maintaining flow of work. Although this may be a different way of conceptualising boundary objects from Engeström's (2011) boundary-crossing perspective, there is a relationship when a mediating artifact takes the role of a boundary object. Four processes of coordination were identified as the need for a communicative connection between diverse practices and connections which can be shared by a number of partners; entailing efforts of translation between different contexts; entailing boundary permeability through repeatedly crossing different practices; and routinisation in automation. The first three processes have potential application in this study where the potential learning is in overcoming the boundary by establishing continuity and "facilitating future and effortless movement between different sites" (Akkerman & Bakker, 2011, p. 13).

3.3.1.3 'Reflection' as learning mechanism in boundary-crossing

Reflection is described by Akkerman and Bakker (2011) as comprehension, formulation, depth analysis and explanation of differences in perspectives and practices, and thus enables new learning about one's own practices and those of others. Through reflection, one has the possibility to look at oneself through the eyes of others' worldviews. One of the boundaries created by separating agricultural learning systems is the immersion of practitioners or professionals in their 'silos'. Reflection has the potential to enable movement across these silo boundaries. Reflection is also said to make the knowledge and assumptions used in interpreting the object more explicit resulting in "an expanded set of perspectives … that informs future practice "in contrast to renewed sense of practices that identification focusses on (ibid., p. 15).

3.3.1.4 'Transformation' as a learning mechanism in boundary-crossing

Studies describing transformation have been shown to frequently explore the effects of interventions, leading to deep changes in practices or potentially creating new, so-called boundary practices. Similar to expansive learning, "studies that describe transformation processes consistently start with describing the *confrontation* with some lack or problem that forces the intersecting worlds to seriously reconsider their current practices and the interrelations" (Akkerman & Bakker, 2011, p. 15, emphasis in original). This lack or problem can be likened to absences (Bhaskar, 1993) and contradictions represented by tensions and conflicts (Engeström, 2011). Disruptions in the current flow of work, among other causes, are implicated in confrontation with boundaries, which can result in recognition of a shared problem space between actors.

From a CHAT perspective, transformation takes place though the multi-voiced negotiation of a motive for shared activity (that is the boundary object) between diverse interacting activity systems. In this case, transformation entails practices crossing boundaries and engaging creatively resulting in the emergence of a new and unfamiliar cultural form of a hybrid. For example, Engeström, Engeström and Kärkkäinen (1995) described how new mediating tools or artefacts from different activity systems can combine to form a new concept. In order to sustain boundary-crossing productivity these authors (ibid.) proposed that there is need for *continuous joint work at the boundary*. This implies investing in boundary learning. They demonstrate that this can be achieved by real dialogue and collaboration between agentive actors ('flesh and blood partners') in all intersecting activity systems through boundary-crossing laboratories. Not all interactions result in boundary-crossing, hence the failures of boundary-crossing and specifically boundary objects also need to be accounted for in order to complete boundary-crossing learning.

Wals, van der Hoeven and Blanken (2009) described transformation as a learning mechanism that can be achieved through facilitation of a social learning intervention between people otherwise separated by ideological, value or institutional differences. The common goal is dialogically determined through spaces accommodating contradictions and constructive dissonances. These spaces must provide a safe atmosphere that provides equal opportunity to express perspectives and ideas. The direction of the solution is initially largely uncertain. Transformative social learning has been described in a way that resonates with boundary-crossing learning when it is able to demonstrate change in understanding not only at individual level, but by situating change into wider social units and networks through social interactions and processes between actors (Reed et al., 2006).

I analysed transcripts of boundary-crossing change laboratory workshops (see sample in Appendix 6.4D) and interviews with participants from them to search for boundary learning (as ZPD) and boundary-crossing (as expansive learning) as will be seen in Chapters 6 and 7 using a template as shown in Table 3.1 below. The first column has codes that I used to mark text in transcript from boundary-crossing change laboratory workshops and interviews that corresponded to the category of boundary-crossing mechanisms that I had identified (second column). In the third column, I recorded citations from the text that provided evidence for the learning actions that I had identified.

Table 3.1: Template for analysing boundary-crossing and learning mechanisms

(Coding based on Akkerman & Bakker, 2011 and Engeström et al., 1995)

Code:	**Category**	**Key events or agentive moments**
I	**IDENTIFICATION** - **Othering**, - **Legitimating coexistence**	
R	**REFLECTION - Perspective making**	
R	**REFLECTION - Perspective taking** - Taking the perspective of the other	
C	**COORDINATION** - Information or knowledge structure provides **communicative connection** between diverse practices, - **Efforts of translation**, - **Increasing boundary permeability**	
T	**TRANSFORMATION** - **Confrontation** with absence / problem towards seriously reconsidering their current practices and the interrelations - **Recognising** shared problem space - **Hybridisation** / new third space - **Crystallisation** of what is created embedding it in practice so that it has real consequences - **Continuous joint work at the boundary**: - **Real dialogue and collaboration** between flesh-and-blood partners" at either side of the boundary: - **New boundary practice** (human activity)	
A	**Committing to actions**	

3.3.1.5 The potential role of emotion in enabling or constraining boundary-crossing learning

I would like to argue that since the above boundary-crossing learning mechanisms are all relational, emotion plays an important role in the success or failure of such mechanisms. Empathy, for example, appears to be a prerequisite for agricultural educators to be able to recognise the importance of alternative agricultural water suited to smallholder farmer contexts. They have to have the passion to seek solutions to the kinds of problems farmers face in context if it is not in the official curriculum. The same applies to extension officers. O'Hara (1997) considered empathy as "both construct and human activity … as a way of being in, belonging to and knowing the relational contexts in which human beings find ourselves situated" (p. 2). Expressions of the affective (experience or state of emotion) are therefore important to look out for as evidence of developing relational agency and vice versa, a factor "largely neglected in the field of agency research" (Gentsch & Synofzik, 2014, p. 1). **Relational agency** here is a specific form of transformative agency as the latter "seeks possibilities for collective change efforts. In this respect, the concept of transformative agency is close to the concept of the relational agency" (Haapasaari, Engeström & Kerosuo, 2016, p. 233).

3.3.2 Expansive learning and transformative change across boundaries

The importance of the dialogical learning mechanisms described above to this study is evident in the study's interest in exploring learning mechanisms and how they expansively develop. Engeström and Sannino (2010) have described expansive learning as boundary-crossing and network building, which are important ideas informing this study as its subjects are immersed in networks with varying cohesive and relational bonds. They pointed out the importance of viewing networks not as level ground but also as hierarchies and therefore having learning also involving a vertical movement and boundary-crossing between different levels of organisations. Engeström and Sannino (2010), citing Toiviainen, called this a 'partnership level' of learning.

3.4 DEVELOPMENTAL WORK RESEARCH (DWR) METHODOLOGY – PRECURSOR TO CHANGE LABORATORY WORKSHOPS

This section discusses the methodology that was used to conduct the study as well as the methods used to generate and analyse the data. As described in the theoretical account, a formative intervention case study methodology appealed to the intended research design and question. This is because of the two phases of data generation being firstly, documentary reviews, interviews and ethnographic data generation to understand historicity and what was going on with water for small-scale farming and agricultural education, training and extension, and secondly, the expansive response of agricultural education and extension in interactions with farmers to expand their object of activity. An underlying

feature of the research methodology – named developmental work research and later change laboratories in CHAT (see process description of this methodology below) – was to support the research participants to jointly seek solutions to identified problems and contradictions in their work. The latter is an axiological consideration, i.e. "examining positionings and tensions … [relating] to ethical considerations and our own philosophical viewpoints" (Dillon & Wals, 2006, p. 550), in this case involving participants as formative interventionist researchers of their own agricultural water issues, driven by the need for praxis as a contribution to the common good.

The discussion in this section starts by describing the connection of methodology with the theory and area of study, followed by a discussion of the epistemological, ontological and axiological underpinnings of DWR methodology. This then leads to methods used to select the cases and to generate the first phase of data (interviews, observations, photographs, video and document analysis), the second phase of data (expansive learning from boundary-crossing laboratory workshops) and to analyse the data. Towards the end of the expansive learning cycle, I interviewed a few lecturers and farmers regarding their fulfilment or lack of achievement of aspirations embedded in the boundary object.

3.4.1 Connecting methodology, theory and the study of boundary-crossing expansive learning as generative of sustainable farming innovations

This sub-section describes the connection between the methodology employed, the theoretical lenses harnessed and the boundary-crossing expansive learning resulting from this formative interventionist study. Dillon and Wals (2006) highlighted the importance of cautious use of language and a clearer articulation of methodology and its philosophical underpinnings. They argued for the need for researchers' reflexivity in selecting methodologies and associated methods, and stating positions and assumptions based on their vantage points. In his critique of activity theory as a methodological tool in cultural psychology, Toomela (2008) describes the connection between methodology, methods and theory in a way that nonetheless supports DWR, thus:

> Methodology can be understood as a bridge between the studied phenomenon and a theory about it. Methodology imposes fundamental constraint on a theory: we can learn about the phenomenon only as much as a method allows. If the method does not correspond to the studied phenomenon, nothing can be concluded on the basis of data collected with the method. (p. 291)

Boundary-crossing learning across farming, formal agricultural education and extension activity systems has hardly been reported in the literature, making it a little understood phenomenon despite farming failures under support of extension and training that point to its need. Such collective learning can lead to the explicit goal of re-designing of work praxis within and across these activity systems if the people in these activity systems are willing to engage in new ways that are collaborative and non-

oppressive. In theorising research approaches that can enable such boundary-crossing learning, Engeström (2000) pointed out that "activity theory is at its best in analyzing poorly understood processes of developmental transformations over time" (p. 308). Edwards (2011) argued that joint inter-professional activity can be mediated by common knowledge, implying that it is important to focus on building common knowledge across activity systems that can enhance relational agency and possibly transformation of activity.

3.4.2 Self-reflexivity in carrying out formative interventionist research

Much scientific research is premised in attempts to demonstrate sanitised interactions between the researcher and the research participants (or non-human research objects) in an effort to study how phenomena would take place under 'natural' conditions. It tries to eliminate the influence and contamination of reality and the research object by the researcher. Engeström (2015a) argued that this is a fallacy because firstly, all research inadvertently intervenes; secondly, internal and external interventions are going on nevertheless; and thirdly, "by intervening deliberately and methodically we generate knowledge about what is possible" (p. xv). The mere presence of a researcher among other individuals in groups of people is potentially disruptive. Formative interventionist research makes no attempt to have the researcher pretend not to be influential in the research process or outcome because the research participants are the interventionists in their work practice with the former collaborating as a formative interventionist-researcher.

The need for and viability of formative interventionist method versus social engineering

Building on Midgley's (2000) definition, Virkkunen and Newnham (2015, p. 3) defined an intervention as a "purposeful action by a human agent to support the redirection of on-going change" emanating from a particular plan and form. They distinguished between two main types of intervention using ideas informed by theory and precedence thereby determining the quality of the outcome. These are social engineering or planned change interventions and formative interventions. The former is accused of downplaying practitioners' expertise and agency, thus ignoring "the need for communication, negotiation and collaboration" (ibid., p. 6) and buy-in. The arguments will not be discussed here except to say that social engineering brings in pre-planned solutions which are assumed to stay constant when presented to practitioners who are expected to react mechanically to change impulses from the outside, while *formative* interventions embrace open-processes that are indeterminate at the start; they are co-defined over time, hence the importance of the prefix *formative.*

Engeström (2013) argued that "formative interventionist methodology, as embodied in the Change Laboratory, is *needed* and *viable*" (p. xv, my emphasis) for various reasons discussed later in section 3.6.5.1. I therefore made several plans to ensure multi-voiced representation in boundary-crossing

laboratories, providing relevant stimuli for those present to make their contributions as much as possible through talk and co-defined shared activity. I deliberated on who should be involved with organisers and pointed out omissions where I thought these had been made, which often happened when agricultural colleges were organising the initial workshops.

In describing the 'non-obtrusive' nature of interventionist research, Lotz-Sisitka (2014) argued that,

> The distinguishing character of this kind of research is *the need for the researcher to cross the border between the etic (outsider) and the emic (insider) perspectives – there and back again*. This shift between differing logics provides opportunities for new insights since the researcher wants to achieve solutions that work in the field and come back with evidence of theoretical significance. (Personal Communication, June 29, 2014, emphasis mine)

This argument provided the researcher with direction that more than actualises what Muchena (1990, p. 19) described in her proposition for a "confluent curriculum … (with) an emic-etic perspective" for Zimbabwe that integrates the affective and cognitive domains. She argued that this would provide the basis for co-generation of knowledge and co-engaged learning in agricultural extension education and farmer training. This study sought to understand the possibilities of integrating the knowledges across multi-levelled agricultural learning activity systems and examining their underlying values, assumptions and generative mechanisms. DWR in a boundary-crossing setting enabled collaborative generation of knowledge and mutual respect and integration of different knowledges. The latter processes were not easy due to perceptions carried in power-knowledge relationships, hence I was on the look-out for such exercises of power in interactions and balance of contributions to dialogues. However this concern was partly resolved expansively in novel ways that can be explained by the '$power_1$-$power_2$' model (Bhaskar, 1993) and interrogation of generative mechanisms, as described in Chapters 4 to 7.

Formative intervention on the other hand recognises the emergence of entire systemic change once a new solution is proposed or introduced. Such dynamics are not driven by abstract concepts but instead by collective voices in deliberation and articulation of concepts in practice. In this study I used a formative interventionist approach because of my research interest and the systemic needs of the research participants to collaboratively develop solutions to their agricultural water and seed security problems (see Chapters 6 and 7). My positioning in this process was to assist with keeping the process moving in a developmental direction determined by the participants' deliberations as a collaborating mediator (see section 3.4.2).

Ongoing self-reflexivity in the change laboratory processes

In my reflexive deliberations I had many internal conversations regarding the achievement of multi-voicedness. A question that bothered me right at the beginning was 'in what way could I as a researcher

be unknowingly preventing some participants from telling their side of the story effectively?' One way I thought this could happen was with my use of the English language among farmers who were more comfortable with isiXhosa, with some having a limited command of English. I requested one of the participants to be not only an interpreter but also a mediator of discussion in the training of trainers' course and hired an interpreter as a research assistant in the change laboratory sessions. I also expressed my challenge to the participants as an apology and demonstrated my progress in learning their language by trying it out with them through code switching and sometimes using the mines mixed language ('*isfalakaloko'*) upon advice from one of the participants, which was quite amusing for them and improved our relations. These moves were very useful for effective communication.

The boundary-crossing change laboratory sessions became like the pasture area for me reminiscent of my past experiences as a herd boy (see section 1.2.2). A return from the change laboratories saw me carrying a large amount of data made up of observations, video and audio recordings, ethnographic experiences, model solutions from participants in the 'mission field' and further questions on their feasibility. Some proposed new models which necessitated further discussion with institutional leaders and key informants. As I tried to make meaning of this data, it reminded me of the complex digestion process of the ruminants under my charge. Data became like cud, regurgitated from the long term memory for processing in moments of reflection. This was the nature of my reflexive 'indaba room', where I battled with my own mind, with data, with ethical dilemmas and had conversations with my supervisors. It was in these reflexive moments that I realised that my interventionist-researcher positioning as perceived by the interventionist-participants was that of a collaborating mediator. I also refer to myself as the main researcher (R1) in interview and change laboratory transcripts where other researchers were with me in a research team or event that I was leading.

3.4.3 Brief history and origins of developmental work research methodology

Developmental work research was developed by Yrjö Engeström (1991) in collaboration with practitioners in changing work contexts. Virkkunen and Newnham (2013) outlined a history of DWR emerging from a national Finnish in-service capacity development programme which connected an academic researcher Engeström with human resource practitioners. They discovered that instead of training individuals, it was more practical to develop work activities, which led to the emergence of a new approach in research and development called Developmental Work Research. Engeström's (1987) 'Learning by Expanding' dissertation created expansive learning theory which explained the theoretical foundations of DWR.

Further collaborative work using DWR exposed a number of temporal and other challenges in the methodology of merging research with the world of work practices which needed to be resolved. This

contributed to refinement and the birth of the Change Laboratory method for applying DWR, which was designed to work with new dialectics to meet the repertoire of challenges encountered. The Change Laboratory method was first used with normal work units supported by an interventionist, using ideas from CHAT of "re-mediation and dual stimulation" (Engeström, Virkkunen, Helle, Pihlaja & Poikela, 1997, p. 1). To cater for research and development in the collaboration, coordination and communication between more than one organisation, Boundary-Crossing Change Laboratories were developed to "study jointly the causes of ruptures in the coordination of their actions concerning their shared clients and develop new concepts to manage the collaboration" (Virkkunen & Newnham, 2015, p. 25). I worked with Boundary-Crossing Change Laboratories in this study, situated in learning networks as expansive learning activities.

3.4.4 Principles of developmental work research that I drew on

I used *developmental work research (DWR)* methodology to study the learning expansion process through *following the common (boundary) object of activity* (Engeström, Engeström & Kerosuo, 2003) across agricultural education, extension, agri-business support and small-scale farming activity systems. DWR is based on "the theoretical account of networks of activity systems found in 'third generation' activity theory … [used to] …*facilitate and understand the expansive learning* that takes place in and for interagency work" (Daniels & Warmington, 2007, p. 385, emphasis mine). I found the use of the Boundary-Crossing Change Laboratory based on DWR methodology useful to study inter-organisation learning and collaboration along an expansive learning framework. This was preceded by 'mirror data' generation using historical and ethnographic methods carried into a few Change Laboratory Workshops. 'Mirror data' refers to ethnographic and historical data, especially that which "demonstrates challenging and problematic aspects of the current activity" (Engeström, 2008b p. 17) which is reflected back to the participants generating it. Its purpose is to "stimulate involvement, analysis and collaborative design efforts among the participants" (Engeström, 2016, p. 64). Engeström (ibid.) argued that

> When practitioners face a mirror depicting their own disturbances, they often experience them as personal failures or even crises. Powerful and unpredictable cognitive, emotional and social dissonances are triggered. (p. 16)

This study sought to understand the learning emerging from the above dissonances. The ideal transformative change processes in expansive learning are described below.

3.4.4.1 Layers of transformative change

DWR has at least three layers of transformative change that take place during intervention processes, as shown in Figure 3.8 below.

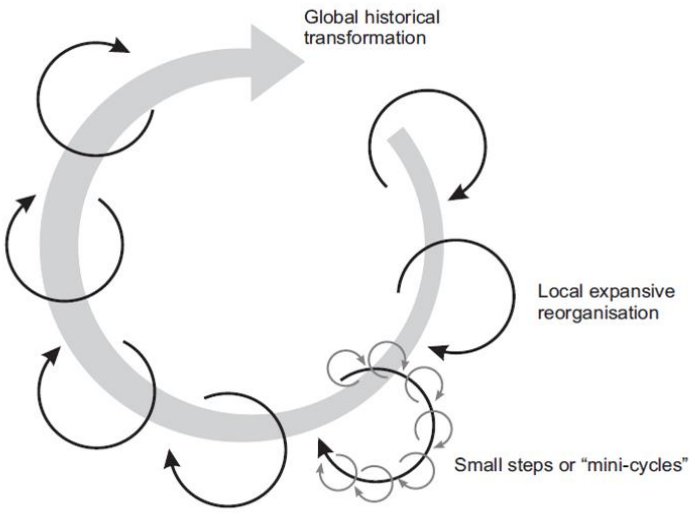


Figure 3.8: *Cycle of developmental work research (adapted from Engeström, 1996, pp. 131-143)*

The bigger loop represents the global historical cycle that ideally takes place in the activity as a whole, but which is made up of smaller expansive learning actions (local expansive re-organisation). The latter could be meetings or consultations by researcher-interventionists with senior people to clarify facts or discuss sensitive matters. These local actions could also entail internal meetings or other discursive deliberations to, for example, check compliance of processes or decisions about to be made with standing rules or the possibility of changing them. These smaller processes are described as 'mini-cycles' or small steps. Engeström (1987) cautioned though as to how to interpret and implement these cycles, indicating that small to intermediate phases and cycles that take from minutes to months (as opposed to longer cycles that take years) do not necessarily mean that expansion has occurred. They may just be isolated events, with the overall organisational cycle stagnating, which means that in researching, patterns of connecting events need to be traced and sought to determine expansive learning. He contended that,

> A large-scale expansive cycle of organizational transformation always includes smaller cycles of innovative learning. However, the appearance of small-scale cycles of innovative learning does not in itself guarantee that there is an expansive cycle going on. Miniature and intermediate cycles of innovative learning should thus be regarded as *potentially* expansive. ... The occurrence of a full-fledged expansive cycle is not common, and it typically requires long-term effort and deliberate interventions. (ibid., p. 13, emphasis in original)

The citation above demonstrates that formative interventionist research is an investment of time by the researcher-interventionist, and must recognise that working with people in just ways is also an investment of their time. I took these ideas as part of my reflexive deliberations and ethical protocol. Hence the investment had to be discursive with open and honest deliberation and worthwhile for the people involved by linking to their aspirations and development of capabilities. This would hopefully ensure that it was led by the owners of the intervention, with researchers making an effort to engage

and detach in innovative and timely ways. Part of this engagement included writing joint papers with those that needed to do so, especially the lecturers but also some farmers.

3.4.4.2 'Knotworking'

Engeström (2008b) described knotworking as "a movement of tying, untying, and retying together seemingly separate threads of activity" (p. 194) with no centre of control holding. The idea of a 'knot' derives from the symbolism of distributed and partially improvised collaborative performance "between otherwise loosely connected actors and activity systems" (ibid., p. 194). He described collaboration dynamics in knotworking as taking place "without rigid, predetermined rules or fixed central authority" (ibid., p. 20). The idea of knotworking was found potentially useful for connecting the loosely connected agricultural learning systems in tension described in section 2.4.6.

A type of co-engagement was identified by Engeström (2008b) where "collaboration between the partners is of vital importance, yet it takes shape without rigid, predetermined rules or a fixed central authority" (p. 20). Engeström (ibid.), borrowing from Raeithel and Fichtner, proposed "three developmental types of epistemological subject-object-subject relations: *coordination, cooperation and communication* … (and) the possible mechanisms of transition between them" (p. 50, emphasis in original) that would constitute boundary-crossing (see Chapter 6). Engeström (ibid.) also identified transformative agency potential amongst people in organisations working collectively thus,

> Employees' collective capacity to create organizational transformations and innovations is becoming a crucially important asset that gives a new, dynamic content to notions of collaborative work and social capital. ... such capacity is conceptualized as distributed agency or collective intentionality. (p. 199)

Work and learning across boundaries and within organisations is therefore interlinked. In this study, I was interested in collective action across organisations, which would affect collective agency and culture of activity within the group and also back in the organisations.

3.4.5 Obtaining research access, and mediating data generation tools and processes

My first step in generating data was to visit the research sites in South Africa and Zimbabwe based on literature and appointments to meet key informants and leaders, and then to work backwards iteratively to identify relevant documents. The consultation of documents clarified and revealed information that was not clear from interviews and observations and vice versa, while talking to more than one person had similar triangulation effects. In some cases, information was conflicting depending on the perspectives of the informers as discussed in Chapter 4. Research access to the South African case study was done at two levels, the higher organisational level at provincial and local municipality levels and at lower organisation and institutional levels such as agricultural colleges and extension offices.

Informed individual consent was also sought at both levels. For the South African case study the following research accesses were obtained: General access request (Appendix 1), the Nkonkobe Economic Development Agency (NEDA) (Appendix 2.1), the Agricultural Extension Services (Eastern Cape Provincial Department of Rural Development and Agrarian Reform) (Appendix 2.2) and Fort Cox College (Appendix 2.3). Appendix 3.1 provides a sample of signed informed consent forms. Appendix 3.2A and 3.2B present research access to Runde Rural District Council area in Zimbabwe and Zimbabwean Agricultural colleges repectively. The granting of research access was both quick and slow in the sense that verbal access was quick while written access took time. I listed my field engagements in Appendix 3.3A (for South African Case Study), and Appendix 3.3B (Zimbabwean Case Sudy). Appendix 3.4A and B provide examples of course materials analysed in the South African and Zimbabwean Case Studies respectively.

3.5 DATA GENERATION METHODS

In this study I used five research methods to generate data: document analysis, ethnographic field and activity observations, in-depth key informant interviews, focus group discussions and interviews and boundary-crossing change laboratory workshops, as described below. The purpose of this diversity of methods was to aid trustworthiness through 'triangulation' and comparison, as they have fundamentally convergent epistemological or ontological assumptions (Hammersley, 2008). This diversity of methods was designed to assist me as researcher to ensure reliability and to deal with the possibility of "socially desirable rather than honest responses" that may have emanated from interviews (ibid., p. 23). Both qualitative and quantitative data was generated, but most emphasis was on the former. This data was expected to provide insight into tensions and manifestations of contradictions (see Chapters 4 and 5) regarding the objects of agricultural water and seed and other elements of the activity systems involved, and across these activity systems.

The initial key questions designed to conceptualise the activity systems at play in an attempt to start answering the research questions were:

- Who are the users of water for agriculture?
- Where and how do small-scale farmers obtain their water for food? (sources and methods)
- What institutions are in place to improve small-scale farmers' water security? (the providers and their mandate, obligations, reciprocal expectations)
- What are the successes and challenges in water security for small-scale farmers from a socio-historical to a current context?
- Why are the problems persistent?

According to Kerosuo, Kajamaa and Engeström (2006),

> Practice-based approaches [such as cultural historical activity theory] conceive knowledge as sustained by symbols, technologies and relations ... However, knowledge is understood as an on-going social and contextual accomplishment that is constituted and reconstituted in day-to-day practices. (p. 2)

Accumulation of knowledge in symbols and relations can be found in documents, artefacts, interviews and observations. My first port of call in data generation was an iterative combination of document and artefact analysis combined with interviews and observations with the aim of identifying the objects of focus in the activity systems and tracing their historical development. I then conducted boundary-crossing change laboratory workshops within learning networks in phase 2 of data generation that were at times embedded in a training of trainers' course.

A full list of my field engagements is given in appendices 3.3A and 3.3B. I index coded the people that I interviewed or engaged with otherwise beginning with their identification (e.g. agricultural college lecturer, ACL), followed by the country (e.g. South Africa, SA or Zimbabwe, Z), and the number allocated to the specific person (e.g. 1, 2… etc.) as shown in Table 3.2 that follows.

Table 3.2: Index coding of research participants

Generic Index Code	Explanation of index code and example
ACLSAx	Agricultural college lecturer South Africa, number 1, 2 … e.g. ACLSA1
ACLZx	Agricultural college lecturer Zimbabwe, number 1, 2 … e.g. ACLZ3
ACMSAx	Agricultural college senior manager South Africa, number 1, 2 … e.g. ACMSA1
ACMZx	Agricultural college senior manager Zimbabwe, number 1, 2 … e.g. ACMZ1
ALCAWSA1	FGD #ALCAWSA1 Video Transcript September 24, 2014 (Agriculture Lecturers Curriculum Analysis)
UALSAx	University Agriculture Lecturer South Africa, number 1, 2 … e.g. UALSA2
UALZx	University Agriculture Lecturer Zimbabwe, number 1, 2 … e.g. UALZ2
EOSAx	Extension Officer South Africa, number 1, 2 … e.g. EOSA2
EOZx	Extension Officer Zimbabwe, number 1, 2 … e.g. EOZ1
FSAx	Small-scale rural farmer South Africa, number 1, 2 … e.g. FSA1
FZx	Small-scale rural farmer Zimbabwe number 1, 2 … e.g. FZ2
RI1	Main researcher-interventionist i.e. the author
RI2, RI3, …	Other supporting researcher-interventionists
RA	Research assistant
LEDAFSAx	Local Economic Development Agency facilitator South Africa, number 1, 2 …
INTPR	Interpreter

Agricultural college senior managers include principals and heads of departments. Documents were index coded with the letter D followed by the country code (SA or Z) and a series number, e.g. DSA1 for document from South Africa, number 1. A confidential CD/DVD contains lists of names of research participants and their index codes, documents analysed, signed informed consent forms,

media (video, audio and photo), and transcripts. Table 3.3 shows how the data files (audio and video) and the transcripts were named. Interviews have letter codes corresponding to generic codes of participants given in Table 3.2, so an interview with a farmer in South Africa would be interview #FSAx as shown in the first entry in Table 3.3. The index code also shows the type of file e.g. video or audio, and the date (month, day and year).

Table 3.3: Index coding of audio, video and transcript files

Generic file name	Explanation of index code and example
Interview #FSAx Audio, Month, Day, Year	Interview with a farmer (F) from South African case study (SA), farmer number x, recorded in an specified media (e.g. Audio) file in given month, day, and year
Interview #FSAx Audio Transcript, Month, Day, Year	Transcript of the above interview audio recording.
Paired Interview #ACLZx and 2, Video, Month, Day, Year	Paired interview with two agricultural college lecturers (ACL) from Zimbabwe case study (Z), number x and y, and 2, recorded in a video file in specified month, day, and year.
Change lab #BCCLWSAx, Group name, Video, Month, Day, Year	Boundary-crossing change laboratory workshop (BCCLW) held in South Africa (SA), number x, group name (optional e.g. learning network, LN) or Fort Cox College, FCC), video file, recorded on given date (e.g. … #BCCLWSA2, LN, Video …)
Change lab #BCCLWZx, Group name, Video transcript, Month, Day, Year	Boundary-crossing change laboratory workshop (BCCLW) held in Zimbabwe (Z), number x, group name (optional e.g. Ml for Mlezu or Ri for Rio Tinto College networks or LN for the wider learning network), video file, recorded on given date (e.g. … #BCCLWZ1, Ml, Video …)

All the audio and video files and the bulk of the transcript files are saved in a confidential digital video disc (DVD).

3.5.1 Document and artefact analysis

Finding documents was no easy task as most were neither readily available nor shared by organisations and persons visited and were not readily accessible on the internet. A combination of repeated visits and interviews led to gradual accessing of most documents. A variety of documents were analysed which included agriculture college prospectuses, curricula and courses, extension services and farmers plans, assessment reports and project reports from extension work and local authorities farmer development programme reports. Some cultural mediating artefacts relevant to agricultural water and local seed-based value chains, collective learning and networking were also identified and analysed to historicise the objects and activity systems in their socio-cultural contexts. The table below summarises the documents and artefacts which were found and analysed.

Table 3.4: Summary of documents (D) and artefacts (A) found and analysed

Type of document or artefact	South Africa	Zimbabwe
Farmers' plans and records	• Farmers' records x2 (D) • Water User Association business plan x1 (D)	• Records of trainings in (Phiri) and look and learn visits (DAEFT) for RWH&C x2 (D)
Farmers' agricultural water mediating artefacts	• RWH&C and soil conservation structures and practices e.g. *gelesha* (A)	• RWH&C and soil conservation structures and practices e.g. deep contours (A)
Farmers' local seed-based value chain mediating artefacts	• Seed inputs and sourcing concepts (A) • Seed storage structures (A) • Crop production tools (A) • Grain and food processing tools (A)	• Seed inputs and sourcing concepts (A) • Seed storage structures (A) • Crop production tools (A) • Grain and food processing tools (A)
Agricultural college curricula	• Crop production programme x1 (D) • Animal production programme x1(D) • Engineering programme x1 (D) • Agribusiness programme x1 (D) • Farmer training programme x1 (D) • Soil and water conservation course x1 (D) • Agricultural College prospectuses 2014 – 2017 x4 (D)	• Crop production programme x1 (D) • Animal production programme x1 (D) • Engineering programme x1 (D) • Agribusiness programme x1 (D) • Farmer training programme x1 (D) • Soil and water conservation course x1 (D) • Environmental education modules x2 (D)
Extension services plans	• Provincial business plan 2017x1(D) • Cropping programme plans x1 (D) • Extension officers' performance plan x1 (D)	• AGRITEX training and extension plans x1 (D) • ZIMSOFF strategy x1 (D)
Local authority agricultural plans and programmes	• LED smallholder farmer development programme x1 (D) • NEDA strategy x1 (D)	• District agriculture and environment plan x1 (D)
TOTAL DOCUMENTS USED	18	13

The key questions discussed in the documents were which water and seed elements were included or excluded, how and why?; and in what way are dryland farmers considered? The information in these documents gave insight into the nature, history and culture of the activity systems and their elements. The results of the analyses of these documents are found in Chapters 4 and 5. I initially used the following analytical schema (Table 3.5a) which was later co-developed with participants who used a modified version (Table 3.5b) as part of course assignments in the South African case study.

Table 3.5a: Primary document analysis tool

Name of document:	e.g. Crop production syllabus ……				
Agricultural water elements represented (e.g. irrigation theory, SWC practicals, RWH&C practicals, etc.)	Rank	% content	Agricultural water elements excluded (i.e. are absent but which you wish were there, and reason)	Rank	% content

...					
Seed input elements included (e.g. commercial hybrid, GMO for food crops; locally based OPV seed inputs for crop production; etc.)			Seed input elements excluded (i.e. are absent but which you wish were there, and reason)		

In Table 3.5a, the 'rank' in the second column was used as a way of weighting the agricultural water or seed input elements in terms of the importance they were given in the curriculum documents, such as period of teaching / practical allocated, detail provided in the course outline and assessment credits given in the prospectus. The 'percentage' content in the third column was a fraction of the specified content (e.g. RWH&C) compared to the whole (e.g. agricultural water in general). These two variables in the fifth and sixth columns represent aspirations.

Table 3.5b: Curriculum documents analysis tool

Name of curriculum document/practice and year	General and topic/s overview, level of implementation	RWH&C content or issues (explicit)	RWH&C content (implied)	Comments

After working together with three agricultural college and one university agriculture lecturer in the South African case study using the template in Table 3.5a, it was agreed to modify it and use Table 3.5b, which the three college lecturers later used in carrying out Assignment One of the Amanzi for Food course. Table 3.5b demanded more qualitative analysis that lecturers found easier to work with while generating rigour. I worked with their input to generate data regarding curriculum content of RWH&C compared to other agricultural water aspects, as shown in Chapter 6. For the Zimbabwean case study I used the same templates (Tables 3.5a and 3.5b), but without the benefit of participants using them in an accredited assignment (see Chapter 7).

3.5.2 Field and activity participation, ethnography and observation

Direct participation and observation were employed to see, listen to and engage with farmers, agricultural educators and extension officers in order to understand how they used tools and artefacts to engage with their practices and doings of agricultural water and local seed-based value chains. Sites of participation and observation included gardens, homesteads, crop fields, demonstration sites and agricultural shows. Some of the observations of farmers' and lecturers' practices took place over an extended period of over two years at Lloyd Village, Matole Basin and Fort Cox College in South Africa, and at Mlezu and Rio Tinto Colleges in Zimbabwe. I visited the farmers and lecturers regularly on a monthly or two-monthly basis spending one to two days with them in their daily work routines with the aim of portraying events in their terms and with a focus on water for food issues as they emerged over time (Cohen, Manion & Morrison, 2007). Formative intervention change laboratories

(see section 3.5.6) were carried out during this period consistent with ethnographic inquiries (ibid.). I took photographs and where appropriate, videos of relevant activities, constructions, tools and artefacts, which I shared with participants and obtained real-time feedback forming a basis for reflection and joint meaning-making. I also took field notes to capture key issues related to the observations, pictures and videos which captured current learning and documented notes and brief narratives in a research journal.

The information from direct observation, photographs and video clips of work sessions also contributed to mirror data and ongoing learning and reflection data. Patton (2002) proposes that "to understand fully the complexities of many situations, direct participation in and observation of the phenomenon of interest may be the best research method" (p. 21). In saying so he also recognised the importance of qualitative data from what people say but also cautioning on the use of such data because of the limitations to learning it carries. Phases of data generation were iterative and built on each other. What I had planned was not always what I actually did as sometimes the venues, seating arrangements or weather were not practical for something planned, or instead of one interviewee there were two or a group, hence I had to be adaptive, while ensuring links between data sets for possible triangulation (Cohen et al., 2007). Data generation from interviews is discussed below.

3.5.3 Group interviews and focus groups

Group interviews are useful when conducted with a group of people who have worked together for some time, with the aim of understanding the view or collective response of the whole group as the unit of analysis rather than the individual member (Cohen et al., 2007). Seeking the collective response avoids marginalisation or blaming of individuals, collects a range of responses and ensures "where it is seen as important that everyone concerned is aware of what others in the group are saying" (Watts & Ebbutt in Cohen et al., 2007, p. 373). I carried out three group interviews at three study sites (Fort Cox College of Agriculture and Forestry and Lloyd Village garden in South Africa and Mlezu Agriculture College in Zimbabwe). The intention was to get a collective view of how the curricula were responding to issues of water for food at the colleges, and how a garden cooperative was dealing with water for food under a rain-fed farming system. These group interviews provided insight on issues that were followed up via in-depth key informant interviews and provided "mirror data" (see section 3.4.4) for the change laboratory workshops (Engeström, 1987). Focus groups are

> A form of group interview, though not in the sense of a backwards and forwards between interviewer and group. Rather, the reliance is on the interaction within the group who discuss a topic supplied by the researcher yielding a collective rather than an individual view. (Cohen et al., 2007, p. 376)

I conducted two focus group discussions in each of the training course modules in the South African case, and two focus groups in the Zimbabwean case (at the Mlezu and Rio Tinto College learning network sites). In the South African case, the first focus group was designed to engage small-scale farmers with agricultural lecturers and extension advisors in groups of five to six to get to understand each other's contexts while the second was used to co-generate new models of water for food activity in similar heterogeneous teams. In the Zimbabwean case, focus groups were designed for the same purposes with similar numbers.

3.5.4 In-depth key informant interviews

I identified and interviewed key informants to generate data on contexts of small-scale farming, extension and agricultural education with a specific focus on the history and current struggles with agricultural water. They led me to relevant documents (e.g. water user association business plans), artefacts (e.g. farm dams for watering livestock, broken fences, bush encroachment) and pointed me to key activities such as traditional ways of farming (e.g. *gelesha*), rainwater harvesting innovations and highlighted historical relational tensions. Key informant interviews (Cohen et. al, 2007) were thus conducted with farmers (two each at South African and Zimbabwean case study sites), agriculture college lecturers (two from one Agriculture college in Zimbabwe and two from one University in South Africa) and two principals, and the Agriculture education department (two officials). The rich data from the interviews was captured on audio tape. The information from the interviews provided elaborate information and manifestations of contradictions coming from the change laboratory workshops and further clarified data (see Chapters 6 and 7).

3.5.5 Categorisation of data generated from the activity systems

This section explains how data was initially categorised for purposes of making sense of it. These categories fed into deeper analysis and enabled thick descriptions to be made for explanatory power and critique. The initial categories were informed principally by the research objective and question, and also by sense-making ideas that emerged whilst I was still in the field listening to people, observing actions and artefacts and reflecting, which constituted preliminary data analysis (Patton, 2014). The categories were also guided by the meta-theory of CHAT whose second-generation activity system provides six networked systemic elements namely subject, object, mediation instruments / tools, rules, community and division of labour (Engeström, 1987). Table 3.6 is a summary of a more detailed categorisation in Appendix 3.4.

Table 3.6: Initial categorisation of data from the two country nested cases

Category	**Theoretical frame of networked systemic elemental categories (CHAT)**
History of smallholder farming, water for food, and water in the curriculum	Historicity

Smallholder rural farmers (gender and age disaggregated), **Agricultural Educators** in Agricultural college and university lecturers; **Extension Officers** and **Local Economic Development Facilitators**	Subject
Aspirations to improve their agricultural water	Object
Water and seed supply tools, **curricula**	Mediation instruments / artefacts / tools
Mandates, terms and conditions of government farmer support programmes, policy, curricula, Water Act, Norms	Rules
Farmers, agricultural lecturers/trainers, extension officers, LED officers, farmer innovators. Traditional ways of togetherness (*ilima* in isiXhosa / *kuvundukura* in ChiShona)	Community
Relational roles of above agricultural actors; reciprocity	Division of labour

The categorisations of the data in Table 3.6 helped me to plan my familiarisation to the practices and related actions of agricultural water and locally adaptive seed systems including their seed-based value chain inputs, and to develop the initial insights into the activity systems and their objects, as well as the shared object. This orienting task was made possible by reflecting on various aspects of the activity systems such as their local historical footprint leading to the current form of the activity. Also useful was considering the agricultural water and related seed-input objects and tools of the activity and their purpose and the current concrete problems and disturbances experienced in farmers', agricultural educators', extension officers' and local economic development agency facilitators' daily work, among others (Virkkunen & Newnham, 2015, pp. 70-71).

I used the categories in Table 3.6 to surface the contradictions in the data from within each activity system (see Chapters 4 and 5). The case descriptions in Chapters 4 and 5 will be used to introduce each activity system with a broader contextual background and then focus in detail on the contradictions emerging from the activity systems. As noted above, contradictions are a rich source of dialogical stimulation and are described here according to the cases and activity systems generating them in order to provide the context at organisational, institutional, individual and relational levels. Contradictions and tensions are first examined in the context of networked relationality to explore cultural affinity between the agricultural actors. In her study of the development of this learning network as a community of practice, Weaver (2016) with whom I shared the research space in the WRC-funded project, reported that rainwater harvesting became a shared domain as agricultural actors created common value of the practice as they interacted regularly in the learning network.

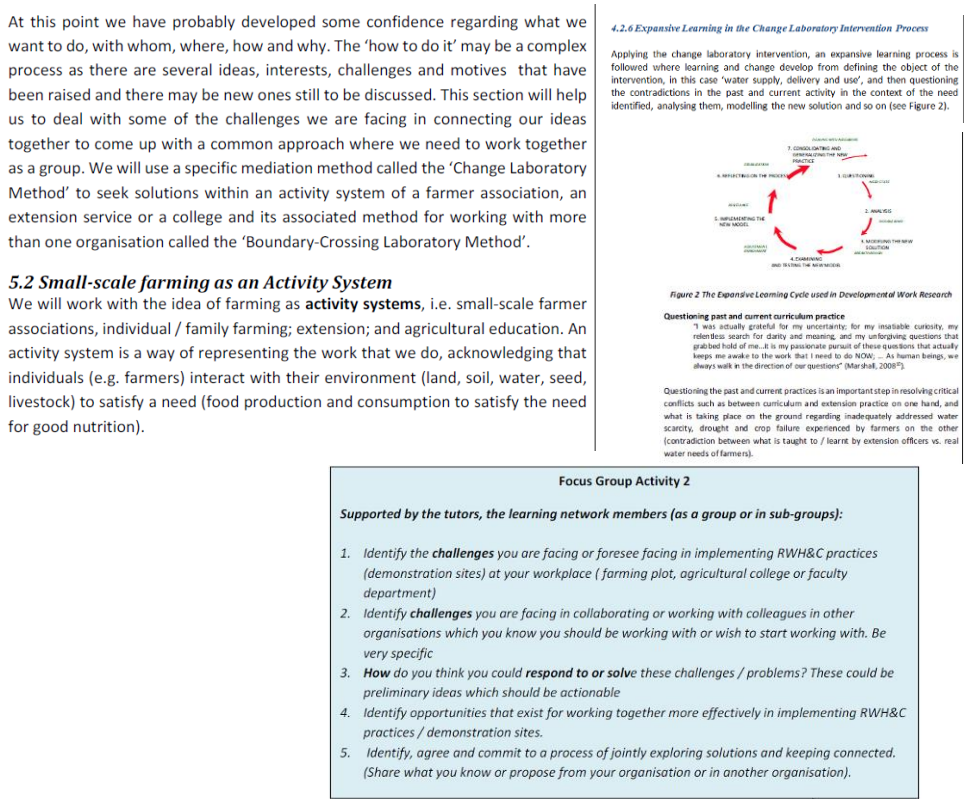
The organisations, their representatives and farmers participating in this study indicated from the outset during interviews and meetings that they were keen to form a learning network to continue the conversations around agricultural water and to participate in capacity building.

3.5.6 Observation and following the object in Change laboratory workshops (CLWs)

A change laboratory workshop is a formative intervention workshop (Warmington et al., 2005) that involves actors in an activity system or connected activity systems with boundary-crossing objects (Engeström, 2007; Engeström, 2008b). It is described materially as a space set aside for systematic reflection on past and present work practices (reflexive historicity) with a view to develop new human activity (how things might be) (Engeström et al. 1997; Virkkunen & Newnham, 2015). Participants work together in a structured and cyclical way to envision new activity in or across their organisations. CLWs were used to process data generated from interviews, focus group discussions and observations made at each study site and its related systemic components within learning networks formed by the participants (see Chapters 4 to 7). Mirror data made up of photographs, video clips and extracts from interviews was reflected to the participants in workshops designed for the learning networks that were organised as shown in Appendices 3.3A and 3.3B. This was followed up with dialogue mediated by the use of double stimulation tools designed to assist participants to co-engage in the resolution of contradictions in their joint work (see section 3.6.3 and Chapters 6 and 7). Participants drawn from different workplace contexts related to the activity systems participated in these workshops through collaborative dialogue and debate among themselves and with the researcher as participant observer and interventionist (Daniels, 2008; Engeström, 2007). I used the CLWs to identify common tensions and contradictions, and also to provide a forum to review social learning and activity systems research.

According to Virkkunen and Newnham (2015), it is good for the researcher-interventionist to gain a broad outlook to the activity, but they caution that "*the idea is not to get involved in high-level debates of the development and future of the activity*, but to focus on the current concrete problems in mastering its object" (p. 71, my emphasis). I used this caution by following the way the joint object was reconceptualised and developed by the learning network as a group and how especially agricultural educators and small-scale farmers reframed it and formed and implemented decisions regarding this joint object in their contexts (see Chapters 6 and 7).

In the South African case, learning network participants indicated in the first change laboratory that they desired to learn more about rainwater harvesting through a course. A training of trainers' course was then conducted as a new tool to facilitate collaborative expansive learning. A series of five change laboratory sessions was conducted within the five training of trainers' modular sessions from September 2014 to April 2015. The modules were designed for a 'changing practices course' with expansive learning in mind (Rhodes University, 2014).



At this point we have probably developed some confidence regarding what we want to do, with whom, where, how and why. The 'how to do it' may be a complex process as there are several ideas, interests, challenges and motives that have been raised and there may be new ones still to be discussed. This section will help us to deal with some of the challenges we are facing in connecting our ideas together to come up with a common approach where we need to work together as a group. We will use a specific mediation method called the 'Change Laboratory Method' to seek solutions within an activity system of a farmer association, an extension service or a college and its associated method for working with more than one organisation called the 'Boundary-Crossing Laboratory Method'.

5.2 Small-scale farming as an Activity System

We will work with the idea of farming as **activity systems**, i.e. small-scale farmer associations, individual / family farming; extension; and agricultural education. An activity system is a way of representing the work that we do, acknowledging that individuals (e.g. farmers) interact with their environment (land, soil, water, seed, livestock) to satisfy a need (food production and consumption to satisfy the need for good nutrition).

4.2.6 Expansive Learning in the Change Laboratory Intervention Process

Applying the change laboratory intervention, an expansive learning process is followed where learning and change develop from defining the object of the intervention, in this case 'water supply, delivery and use', and then questioning the contradictions in the past and current activity in the context of the need identified, analysing them, modelling the new solution and so on (see Figure 2).

Figure 2 The Expansive Learning Cycle used in Developmental Work Research

Questioning past and current curriculum practice

"I was actually grateful for my uncertainty; for my insatiable curiosity, my relentless search for clarity and meaning, and my unforgiving questions that grabbed hold of me...it is my passionate pursuit of these questions that actually keeps me awake to the work that I need to do NOW; ... As human beings, we always walk in the direction of our questions" (Marshall, 2008[p]).

Questioning the past and current practices is an important step in resolving critical conflicts such as between curriculum and extension practice on one hand, and what is taking place on the ground regarding inadequately addressed water scarcity, drought and crop failure experienced by farmers on the other (contradiction between what is taught to / learnt by extension officers vs. real water needs of farmers).

Focus Group Activity 2

Supported by the tutors, the learning network members (as a group or in sub-groups):

1. *Identify the **challenges** you are facing or foresee facing in implementing RWH&C practices (demonstration sites) at your workplace (farming plot, agricultural college or faculty department)*
2. *Identify **challenges** you are facing in collaborating or working with colleagues in other organisations which you know you should be working with or wish to start working with. Be very specific*
3. ***How** do you think you could **respond to or solv**e these challenges / problems? These could be preliminary ideas which should be actionable*
4. *Identify opportunities that exist for working together more effectively in implementing RWH&C practices / demonstration sites.*
5. *Identify, agree and commit to a process of jointly exploring solutions and keeping connected. (Share what you know or propose from your organisation or in another organisation).*

***Figure 3.9**: Left top and bottom: Extracts from pp. 11 and 13 of Module 3 Text of Amanzi for Food Training of Trainers' Course showing the way that the course supported change laboratories and expansive learning; Right top and bottom: Extract from Module 4 Text, p. 12*

In the training of trainers' course, it was difficult to avoid getting involved this way, so I designed focus group work sessions (see Chapter 6) where participants had high-level discussions on their own moderated by a chairperson from within their network. These sessions were video-taped in order to follow the detail of participants' interactions and participation in addition to documenting the discussions for later reflection. Virkkunen and Newnham's (2015) description of how to use mirror data in the change laboratory, "interview and ethnographic data functions best as mirror of the activity when it is presented as clips of video recordings" (p. 71) was not always feasible or culturally appropriate where in many cases it had the potential to cause discomfort or embarrassment to some people. I found it better to use photos (screen shots) of sections of video that summarised the message to be shared or photos and pictures of problems in joint objects.

In the training of trainers course sessions, I co-facilitated with the South African learning network, and in group activities and boundary-crossing laboratory sessions with both South African and Zimbabwean learning network participants, I had to follow iterations between the individual objects and joint objects of activity as the latter was important for the boundary-crossing and the former for the site based implementation. I was guided in this decision by Virkkunen and Newnham's (2015) assertion that

> The object of an activity typically exists *both as individual cases and as the set and amount of cases*. In the mirror that is produced for the practitioners, the object of the activity can be illuminated from both these perspectives but also from the perspective of different actors and their key actions. (p. 71, my emphasis)

This made sense for my two case studies because while the learning network was important for negotiating the joint object and generating common solutions, it was essential to explore each participant's institutional and mandate-based perspectives, while considering the interactional generative mechanisms.

3.5.6.1 Description of change laboratory settings

Change laboratory settings are traditionally located within the place of normal work activity (ibid.) but the space can be redesigned where participants from more than one workspace are brought together. Theoretically and symbolically, it is a space of focused mental and physical detachment from engaged work activity filtering out the noise of real life in order to experiment, analyse, re-imagine, design and model new innovation. Change laboratories are experimental so that plans for social action are not a given but should be treated as flexible and tentative until they perform as desired by the subjects under strict observation of their impact (Virkkunen & Newnham, 2015). The opposite commonplace idea of pre-determined solutions is typical of many 'development projects' led by 'experts' and imposed for the development of 'under-developed' others, sometimes under the mis-label of participation (Easterly, 2013).

The originators of the change laboratories set their innovation in a tradition of participation and emergence, with a number of forebearers whose ideas appear to have been ignored by normative positivist science. However, their line of thinking is based on principles of engagement and formative open processes, that are neither presumptuous nor impositional thus uplifting a non-hegemonic social justice agenda. The nuances in the approach to change laboratories even recommend a specific type of set-up and plan of the sitting space, the 'laboratory' as described in Figure 3.10 below.

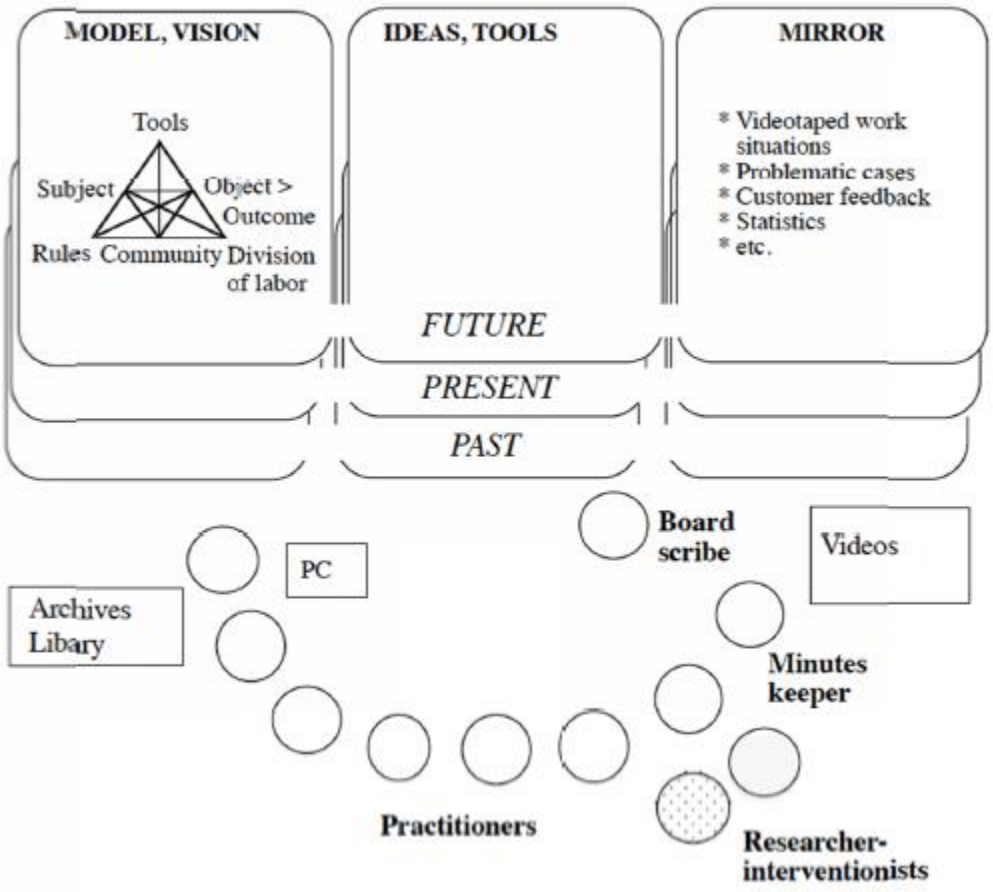


Figure 3.10: *Prototypic layout and instruments of the Change laboratory space [Adopted from Virkkunen et al. (2013, p. 16); after Engeström et al. (1997, p. 3)]*

The adaptation by Virkkunen et al. (2013) moves the layout beyond a single workspace and allows for practitioners rather than only workers, and for actors from different workspaces to be described appropriately in the co-engagements.

3.5.7 Expansive learning cycle

The expansive learning cycle was developed by Engeström (1987) in his expansive learning work with the third generation of activity. A cycle of expansive learning is a sequential connection between expansive learning actions. Specific kinds of actions enable the next set of actions to take place promptly. Engeström (2001) overlaid these sequential 'strategic learning actions' with corresponding (levels of) contradictions (see section 3.2.3) in the expansive learning cycle. According to Virkkunen and Newnham (2013), the learning actions sequence begin with (1) **questioning** where immanent critique and criticising of the historical and accepted practice and wisdom is done leading to its possible rejection or modification. Here the *primary contradiction* is examined as participants start shifting their gaze from defensive postures and fixed positions towards a determination to do something different and new. This is followed by (2) **analysis** of the situation in order to find out generative mechanisms. Two types of analyses are done, namely historical-genetic and actual-empirical analyses.

'Historical-genetic' analysis (Engeström, 2016) "seeks to explain the situation by tracing its origins and evolution" (p. 25) while 'actual-empirical' analysis "seeks to explain the situation by constructing a picture of its inner systemic relations" (ibid.). Questions may be asked such as: How did we work in the past (history)? What are our present troubles and contradictions? At this stage participants confront the double bind (see section 3.2.3.4) usually through a mediated process using double stimulation (see section 3.5.9); (3) **modelling the new solution** – creating a new model from newly found explanatory relationship in some clearly manifesting form. At this stage participants can ask the vision-seeking question: How do we want to work five years from now? Stage (4) **examining the new model**. Participants explore and plan for future changes they want to pursue, weighing the dynamics, challenges and potentials during the change laboratory session. Stage (5) **implementing the new model**. This is a process of putting into practice the first steps through doing, enriching and extending concepts e.g. of sustainable agricultural water in relational ways. Stage (6) **reflecting** on the process through critical analysis and assessment; and (7) **consolidating the new practice** sharing what was learnt, codifying the new practice, pursuing the new stable form of practice. Figure 3.11 shows the ideal-typical expansive learning cycle.

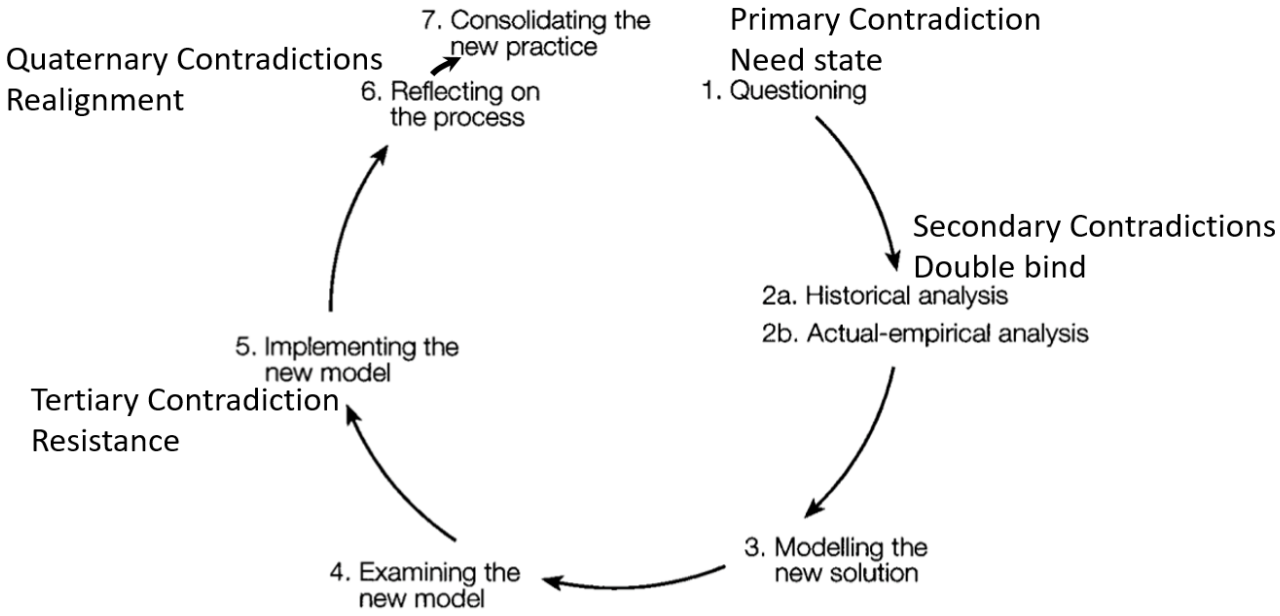


Figure 3.11: *The ideal-typical expansive cycle learning actions (adapted from Virkkunen & Newnham, 2013, p. 51), showing strategic learning actions and corresponding contradictions (Engeström, 2001, p. 152)*

When I was working with the learning networks and their nested cases in both South African and Zimbabwean case studies, the participants entered the cycle at different stages in the boundary-crossing change laboratory workshops. These are described below.

3.5.8 Boundary-crossing Change Laboratories: A tool for transforming co-engaged collaborative learning and coordinated work in learning networks

I applied change laboratory workshops in learning network contexts where agricultural actors were coming from significantly different fields of agricultural endeavour that brought in a boundary (crossing) element. In both the South African and Zimbabwean cases, there were smallholder farmers who were themselves heterogeneous in their practices, extension officers, agricultural college lecturers and local municipality economic development and environmental specialists. Their practices were separated by mandates, knowledge, power relations, practical needs and values that imposed cultural, philosophical, epistemological and ontological boundaries among others. According to Roth and Lee (2007),

> Boundary-crossing laboratories are similar to change laboratories in their joint focus on the identification of contradictions and trouble and in the design of new practices that practitioners find acceptable. When the change laboratory *involves practitioners from very different fields*, the work in a change laboratory takes on a new dimension. (p. 212, emphasis mine)

Virkkunen and Newnham (2013) reported that in the first boundary-crossing change laboratory workshop that was conducted by Yrjö Engeström and others in 1999 in a medical setting involving diverse practitioners including managers, doctors and nurses in a primary health centre and those in another organisation, a specialised hospital, their aim was to explore and resolve problems of coordination. Virkkunen and Newnham (2013) reported that the formative intervention resulted in a new model providing flexible planning and distributed care management of patients through a Care Agreement facilitating mutual negotiation and agreement of division of labour and responsibilities.

> The model is based on the idea of object-oriented *knotworking* in which the patient's "own doctor" in the primary health care, the involved specialists of specialized care, the patient, and members of patient's family meet to define the needs of care and in carrying out and following up the patient's health and care. (p. 25)

In boundary-crossing change laboratory workshops, one often finds the need to stimulate dialogue and learning. I used the principle and method of 'double stimulation' in this study.

3.5.9 Double stimulation

Double stimulation is a mediation approach and principle designed to stimulate the emergence and expansion of learning and volitional (or willful) action. As an experimental method, it has been used "to trace the structure of higher mental functions" (Hopwood, 2017, p. 24). Engeström (2009) pointed to "the developmental significance of double stimulation as essentially a mechanism of building agency and will" (p. 313). Sannino and Engeström (2015) argued that double stimulation is distinguished from the general notion of mediation by its *consideration of the conflict of motives and the aspect of volition or will*, a distinguishing feature from other psychological experiments. A classic

illustrative example is the 'waiting experiment' used by Vygotsky (1987) whereby a research participant left in a room by the research leader in anticipation of an experiment to begin experiences a non-event alone as time goes by. Sannino (2015a) developed a Vygotskian model of double stimulation derived from putting together various aspects of Vygotsky's work. Sannino, Engeström and Lemos (2016) described the waiting experiment procedure: "Facing a conflict and oscillating between the urge to leave and the commitment to stay, the subject is at first paralyzed" (ibid., p. 7). The authors described how the subject identifies an external artefact to help them resolve the conflict, to which he/she ascribes a sign to help them to set a new goal and execute it automatically when the sign is achieved.

> In double stimulation, the *first stimulus* is the problematic situation, which triggers a paralyzing conflict of motives. In trying to cope with the problem, the actors employ artifacts that serve the function of meaningful signs. These signs are *second stimuli* with the help of which the subjects can gain control of and transform the problematic situation. (Sannino et al., 2016, p. 8, emphasis in original)

I found the tools of double stimulation generating useful keys to unlock dissonance in deliberative situations along the expansive learning cycle, especially in moments where participants faced double-binds. I found it essential to prepare well for boundary-crossing change laboratory sessions by analysing contradictions carefully, noting contradictions emerging as first stimuli and identifying possible second stimuli in advance. This is because obviously I wanted to ensure that my research objectives and questions were addressed as each session progressed and I knew that the stakes were high with so many different agricultural actors with different objects of activity and positions. However, I quickly realised in moments of ethical reflexivity that "I" was wrong. My planning was very useful to help me to see where the sessions were going as deliberations proceeded. However situations that brought about dissonance and double-binds were not always the same as I had envisaged in my planning and hence the second stimulus had to be generated *in situ*. In many cases my planned second stimuli were modified by participants to better stimuli that helped them to analyse their situations and enable modelling of solutions. Hence, second stimuli were mostly co-constructed by participants and the researcher as joint formative interventionists. Table 3.7 below shows some of the second level stimuli that we employed in the BCCLWs. Sannino (2016) observed that double stimulation in collectives does not always work in the same way as in individual cases and may not always be useful. This caution was useful for my boundary-crossing change laboratory work.

Table 3.7: A sample of second stimuli employed for brokering in moments of dissonance in boundary-crossing change laboratory workshop (BCCLW) sessions

Some 'second stimuli' used in this study	How it was applied
Water Research Commission books on RWH&C	WRC books presenting a diversity of RWH&C practices at different scales were provided to each participant in the South African case study but to only selected participants in the Zimbabwean case study due to limited copies. A 'navigation tool' developed by Amanzi for Food team was an important access mechanism for this double stimulation tool, used to enable access to the materials for collective decision making by participants.
Cultural mediation triangle	In the South African case study, this was introduced in BCCLW number 4 as my way of interpreting their activity systems. In the Zimbabwe case, it was applied quite early in the first BCCLW. This helped participants to understand, and begin to work on a common object. See Figures 3.5, 3.6 and 3.7
Local traditional knowledge practice of conserving soil and harvesting water called *gelesha*	This practice was presented as a second stimulus in the second BCCLW of the IBLN in the South African case. With most participants being of Xhosa origin, it was expected that it was well known, but it proved to be a little known and disappearing heritage. However, it appealed to most participants who identified with it as an African example that works, and agricultural college lecturers welcomed it.
'WhatsApp' group connecting participants with smart phone capability	Participants in the South African case study modelled a social media platform under their name (Imvotho Bubomi learning network) to enhance dialogue in between meetings. The group generated much data regarding feedback of collaborations and actions and stimulated further action. At the same time, it excluded others with no smart phone capability, necessitating phone calls.
Existing demonstration plots (used as productive demonstration sites)	In the South African case study, RWH&C demonstration plots developed in Lloyd Village (farm ponds) and Fort Cox College (farm dam and mulching) were used to support expansive learning in Matole Basin, via developing these into boundary-crossing productive demonstration sites that all could contribute to allowing for co-learning and co-development of transformative RWH&C practice, expanding the common object of activity across individual activity systems. In the Zimbabwe case, farmer innovators freely provided their productive and functional water harvesting innovations to mediate learning of sustainable agricultural water.
Community radio agricultural programme	Participants in the South African case study modelled radio as a new tool for sharing their work widely. Live radio shows were designed to have diverse team formations that compelled farmers, agricultural college lecturers, extension officers and research technicians to co-engage more as they prepared to present and respond to viewers' questions (made on air, via telephone or Facebook) in a coordinated fashion.
Cultural artefacts that smallholder farmers identified with	Multi-coloured open pollinated varieties of seed maize were brought into workshops and courses by farmers to mediate the common object of seed saving and use of locally adaptive seed varieties in a desired food sovereignty paradigm
Newspaper articles	A newspaper article featuring small grains was used in a change laboratory workshop at Rio Tinto Agricultural College learning network in the Zimbabwean case study (see Chapter 7). It was used to consider the experiences of others in dryland areas of Zimbabwe regarding the possibilities of new activity with locally-adaptive seed varieties.

However, how these double stimulation tools are used matters in decision formation processes, as explained by Sannino (2015a). Sannino (2015a), who synthesised the Vygotskian model of double stimulation, observed that there is little justice done in contemporary double stimulation literature regarding its connection with conflicts of motives and yet this link provides "insights toward a model

of double stimulation as a mechanism of will formation" (p. 9), which in turn is important for the emergence of transformative agency and changed activity. She cited Vygotsky from his experiments involving children challenged with a complex selection to make a choice by casting a lot as follows;

> The complexity of motives and difficulty of choice, but particularly the presence of sharp emotional pleasant or repelling elements, resulted in a more frequent use of the die and, finally, when both series included extremely various motives which were difficult to compare… the natural selection was impeded and the child readily let the play of the die decide his fate. (Vygotsky cited in Sannino, 2015a or b, p. 9)

Of interest in the experiment cited above is the way in which the subject willingly turned to the use of the die, which illustrates the process of emergence of will.

Sannino (2015a) identified the process of double stimulation in decision-making involving two relatively independent apparatuses that reflect two corresponding stages in the emergence of volitional action. In *Apparatus 1* is found "the formation of a decision to act in a certain way by means of an auxiliary motive" (ibid., p. 9), whereby the fall of a die is given as an example of the latter. In forming a decision a person creates an instruction for themselves of how to act. Four sequenced phases describe the complex processes in Apparatus 1 and are summarised in Table 3.8 below. These phases are respectively (1) Conflict of stimuli; (2) Conflict of motives; (3) Conversion of one stimulus into an auxiliary motive; and (4) Closure. Apparatus 1 is formed by the clash or conflict between stimuli, e.g. from the waiting experiment "being asked to stay vs. having no purpose in empty room" (Hopwood, 2017, p. 24) shown in Table 3.8. The implementation of the decision formed in the first apparatus is a key component of *Apparatus 2*.

Table 3.8: Sannino's Vygotskian model of double stimulation (adapted from Sannino, 2015a in Hopwood, 2017, p. 2)

Phase	Detail	Example from waiting experiment
Apparatus 1: Decision forming	Comprises phases outlined below; at issue is choice of closure path	
1 – Conflict of stimuli	Demands or expectations that pull in opposite directions	Being asked to stay vs. having no purpose in empty room
2 – Conflict of motives	Activated by conflict of stimuli, subject at mercy of motives	Conforming to instruction to wait vs. wanting to leave
3 – Auxiliary motive	Conversion of stimulus to auxiliary motive, subject begins to control her behaviour	Deciding to use clock to make decision
4a – 'Real' conflict of stimuli	Occurrence of neutral stimulus confronting subject with signal and meaningful connection	Clock reaches particular time
4b – Closure of conditioned connection	Decision to act in particular way, subject makes decision based on occurrence of external stimulus	Participant decides to leave the experiment
Apparatus 2: Decision implementing	Activation of the conditioned connection	Participant leaves the experiment

The way this model was applied in this study can be found in Chapters 6 and 7.

3.5.10 The anatomy, nature and importance of the 'germ cell' in formative intervention

The 'germ cell' concept was introduced into Activity Theory by Vasily Davydov and further developed by Yjrö Engeström (2009). He defined it as the partial, simplest and smallest fundamental unit which has the characteristic properties of the whole system (Davydov, 1990). The 'germ cell' concept is derived from biological studies where it is defined as a cell at the embryo stage of development with the potential to develop into a reproductive cell (Lesch, Dokshin, Young, McCarrey & Page, 2013).

Examples of germ cells in literature include the spinning wheel in the Indian independence movement (Mohandas Gandhi, 1993) as a motive of self-reliance and a symbolic and physical instrument of nationalist emancipation (Yrjö Engeström, Personal Communication, March 2, 2015). According to Engeström,

> The charkha, or spinning wheel, was the physical embodiment and symbol of Gandhi's constructive program. It represents Swadeshi, self-sufficiency, and at the same time interdependence, because the wheel is at the center... It also embodied the dignity of labor, equality, unity… and finally independence, as British control of India was rooted in control of indigenous industries such as textiles. (ibid.)

Engeström, Nummijoki and Sannino (2012) described an embodied germ cell in a case of physical mobility in home-care that they identified as 'standing up from the chair'. In earlier writing, I (Pesanayi, 2016a) described how socio-cultural history is rich in germ cells relevant for sustainable agricultural water in Africa that are, on one hand, not utilised to their full potential (e.g. Zephaniah Phiri's water harvesting innovation). On the other hand, germ cells have at worst been destroyed by retrogressive forces (e.g. Sankara's self-reliant approach to food and garment production and consumption) or branded as communist with negative connotations (e.g. Nyerere's enacted vision of uniting capacity building ethos of the *Ujamaa,* Swahili for 'family-hood'). In this study, I conceptualised the germ cell as the partial, simplest and smallest fundamental unit which has the characteristic properties of the whole water-for-food system and used it as a second stimulus for learning, development and generative scaling of sustainable water for food (see Chapters 6 and 7).

3.6 DATA PROCESSING AND ANALYSIS

3.6.1 Transcription and member checking

In order to analyse the data generated from the methods discussed in section 3.5, interview transcriptions were done verbatim from audio and video material. Transcriptions of at least two of the participant groups were initially done by the researcher in order to revisit the 'live' conversations which for me began a process I saw as analytical mental mapping of data. The rest of the materials were then given to competent transcribers. Local language transcriptions were done by first language speakers of the respective languages, namely IsiXhosa and Chishona, and translated by a second

person or the transcriber with the researcher checking each translation. In some cases, unclear translations had to be taken back to original sources for clarification where possible. Such member checking was done on subsequent visits to farmers, extension workers and lecturers. Those participants with email addresses were sent transcripts in advance within a month of the interview, but they were not always able to review them in advance. Hence the researcher had to organise meetings with participants to go through the transcripts, with key areas of misunderstanding or inaudible feedback highlighted for clarification, correction, validation and update. The member checking process was very useful in ensuring that the record was correct, accurate and updated.

Apart from transcripts, the data record was also made up of field notes, reports of boundary-crossing change laboratory workshops, minutes of meetings and research journal entries, all of which were index coded for ease of access and management, as noted above.

3.6.2 Data analysis

According to Yamagata-Lynch (2010) care must be taken in data analysis to identify object-oriented activity and related actions, because

> Activity systems do not present themselves in observed data sets in a neat and organized manner. Once investigators begin their data analysis, they will find that their data set is *messy* and *complex*. Through an interpretive process, *investigators need to immerse themselves with the data* and *identify the multi-mediational activities their participants experienced*. … investigators have to parse their raw data into object-oriented activity and goal-directed action units. (p. 26, my emphasis)

The above implies that care and effort must be taken in fully understanding and analysing data in a cultural-historical context and that this data needs to be deconstructed into activity and action components. I found Virkkunen and Newnham (2013)'s advice useful regarding how to generate mirror data and what to look for: "mirror data should be collected of what the practitioners see as new and/or problematic in the object of the activity" (p. 71). The data generated in this study was analysed in four different phases and two different ways. The first phase of data analysis involved iteration between analysis of documents, individual and focus group interviews, and video footage with the aim of describing the dynamics of the activity systems and surfacing contradictions relevant for the study's focus on boundary-crossing learning. The second, third and fourth phases of analysis involved the analysis of data generated from training of trainers' workshops, boundary-crossing change laboratory workshops (BCCLWs) and follow-up meetings with managers of organisations or key informants to describe the boundary-crossing expansive learning that occurred and associated mediation processes relevant to the research questions as shown in Table 3.9 below.

Table 3.9: Phases of data analysis in this study

Phase of data analysis	What was done	Purpose
Phase 1: At the conclusion of the initial exploration phase	• Identified and analysed key documents for history of practices and indications of key object-oriented activity systems and related action units. • Analysed interviews, observations, documents and artefacts for the same.	To develop insight into the activity systems under study, identify possible objects, boundaries and to surface potential boundary-crossing tensions and contradictions as mirror data. Identify potential double binds.
Phase 2: During the boundary-crossing change laboratory workshops, Training of Trainers workshops, field visits and formative intervention meetings along the expansive learning cycle	• Presented mirror data • Observed and analysed talk, gestures, interactions and areas of difficulty • Participants intervened together with the formative researcher-interventionist to ensure multi-voicedness, power levelling and focus on common object. Some farmers tended to be quieter initially but picked up • Identified and consolidated insights into emerging boundary-crossing contradictions. • Evaluated workshops	To confirm and consolidate insights into contradictions, and identify any further double binds and contradictions emerging, clarify the collective ZPD and expansive transformations as boundary-crossing learning processes and possibilities. Co-develop double stimulation tools where relevant.
Phase 3: After and in between the boundary-crossing change laboratory workshops in each case (Note: Phase 2 and 3 were intertwined processes over a two-year period)	• Analysed interviews and observations • Analysed talk, gestures and interactions from video (and audio) material • Identified boundary-crossing contradictions • Identified germ cells, emerging transformative agency, and volitional action emerging from double stimulation tools	To develop in-depth insight into boundary-crossing learning processes, and develop potential double stimulation tools
Phase 4: Across all the cases	Analysed changed and unchanged practices, new tools generated and self-reflection. Final analysis of the expansive learning process looking at the outcome of boundary-crossing change laboratory workshops and meetings and identifying generative mechanisms. Reflection on the mediation processes involved.	• To identify and critically reflect on what changed and what did not, how it changed from a learning and mediation perspective and why it changed or not • To clarify new knowledge generated, generative mechanisms and boundary-crossing mediation processes found to be important for expansive learning

In the phase 1 analysis, one of the key objectives was to identify the nature of the agricultural water and / or seed system object and to trace its historical evolution. I did this by tracking how the object began as far back as possible, how and why it changed over time, and how it came to be what it currently was in terms of how agricultural water and seed system resources were being sourced, used or promoted by the various actors involved, or how these were being taught in the curriculum. I continued exploring this historicity together with participants in the change laboratory workshops in Phase 2 and 3 iterative analysis (see section 3.5.8) where there was a re-orchestration of multiple voices as various participants shared their different viewpoints and approaches. Engeström (1991) defined this perspective of historicity as "identifying the past cycles of the activity system" (p. 15). For this study, this meant understanding how farmers sourced and worked with agricultural water and / or seed systems in different historical periods, why they did so, and the changes that occurred with their water and seed availability and usage with respect to varying climate, resourcing and socio-political factors (see Chapter 6). In addition, I also sought to understand the agricultural college curricula's agricultural water and seed system content, how and what lecturers were teaching in relation to these objects, and why and how this approach and content related to small-scale farmers and agricultural extension workers (see Chapters 2, 6 and 7).

The above organisation of analysis into iterative phases of analysis helped me to plan for the unexpected and unknown, for example not all participants who were expected would come to boundary-crossing change laboratory sessions. In some cases, new information would emerge that introduced new contradictions that would need content experts who would not always be there. However, pre-planning helped to tackle what was possible and plan in advance for the emergent needs, while session evaluations informed next sessions. Analysis along the way was also useful in pointing out the need to have smaller meetings with key organisational managers, to reflect on the meaning of interactions with other important generative networks and to respond to the emerging need for knotworking.

In order to start answering my research questions, I followed both a formalised and non-formalised, logical way of reasoning, interpreting and drawing conclusions through inference and a variety of thought operations (Danermark, Ekstrom, Jakobsen & Karlsson, 2002). The "researcher's powers of abstraction, as well as imagination and creativity" (ibid., p. 79) are considered central in this whole process. This helped me to unpack the meaning of phenomena, what follows from them and the pre-existing conditions for their possibilities. I used abductive, deductive and retroductive modes of inference in this study. The abductive mode of inference starts from the rule describing the general pattern (ibid.) such as the unpredictability of rain-fed farming systems under climate variability and change. Using this mode of inference, "the conclusion provides new insight as an outcome of our

interpreting or explaining something" (p. 90) with the aid of the rule, noting that the insight is fallible. Abduction therefore enables understanding of an individual phenomenon in a new way by observing and interpreting it in a new set of ideas or conceptual framework.

I also made use of the deductive mode of inference in different ways such as to test whether conclusions I drew from arguments followed in a logically valid way from the premises given to back the conclusion. The strength of deduction is in providing rules and guidance for logical derivations. I used retroduction to examine the qualities needed for something to be possible, for example, what was needed for agricultural college curriculum change to be congruent with the water demands of small-scale farming. Danermark et al. (2002) claimed that retroductive reasoning "provides knowledge of transfactual conditions, structures and mechanisms that cannot be directly observed in the domain of the empirical" (p. 80). The transfactual is critical because it is lasting or permanent. It should be noted that one of the limitations of this study is the poor to no generalisation of results from a case study design. This limitation is lessened by thick descriptions (see section 3.5.5) that enable the reader to make informed decisions leading to action in other cases (Yin, 2013).

3.6.2.1 Identification and analysis of contradictions in work through activity systems

Bonneau (2013) reminded us of the economic nature of the primary contradiction according to Engeström, and advised that we can only access it via its manifestations (see section 3.2.2.5). Initially I tried to deduce the contradictions from the empirical data as I was processing mirror data from the raw data, but I realised that this alone may lead to misinterpretation as there may be generative mechanisms behind what I was seeing. Building on Phase 1 data analysis, I decided to interpret the manifestations of contradictions verbatim and brought them to participants for further clarification in change laboratory workshops where I continued to deepen my analysis of these contradictions and their generative implications for expansive learning via the Phase 2-3 iterative analysis work. Foot (2014) asserted that "the primary contradiction persists throughout even if attempts to resolve the other levels succeed temporarily, indicating that it also serves as a foundation for other levels of contradiction" (p. 22). Table 3.10 illustrates the latter, their corresponding characteristics and learning actions.

The links between levels of contradiction in Table 3.10 and corresponding learning actions helped me to follow the complex joint object at different stages and times. Engeström (1987) makes a distinction in the set of relations between learning operating in an expansive cycle and the contradictions emerging from activity system expansions. Figure 3.6 indicates the particular relationships existing between the different levels of contradictions and the particular learning actions taking place along the developing expansive cycle.

Table 3.10: Levels of contradictions and corresponding learning actions (adapted from Foot & Groleau in Foot, 2014)

Levels of Contradiction	Characteristics of Contradiction Levels	Corresponding Learning Action(s)
Primary	Occurs between the use value and exchange value of any corner of an activity system.	Questioning
Secondary	Develops between two corners of an activity system.	Analyzing Modeling
Tertiary	Arises when the object of a more developed activity is introduced into the central activity system.	Examining model Implementing model Evaluating process
Quaternary	Occurs between central activity and neighboring activities, triggered by tertiary contradiction.	Consolidating new practice Questioning

3.6.2.2 Use of historical data to identify contradictions

In order to identify contradictions I was guided by manifestations of contradictions (see sections 3.2.2.5 and 3.6.2.1) in past cycles of the learning activity of agricultural water and seed saving activity. Using mirror data reflected to my co-participants synthesised from interviews, focus group discussions and observations, we mapped discontinuities in work against time periods identified by participants and contextualised them within a national and global context of influence such as betterment policy in South Africa, and the Land Apportionment Act of 1930 in Zimbabwe (then Rhodesia). Discontinuities usually indicated boundaries between activity systems. The historical data comprised data and observations concerning historical changes in agricultural water and seed activity (such as rainfall patterns, water provisioning, seed sourcing, seed laws). Discontinuities in working with borehole water, for example, were manifested as a *critical conflict* in the object of water provisioning when a working engine was removed from a cooperative in the South African case study (see section 4.2.1.2). This water provisioning strategy could be traced back to the betterment policy during the apartheid period, and also linked to a period of dependence on high cost solutions during the early democracy period (mid- to late 1990s). Similarly historical data in the Zimbabean case study included an increasing valuing of sophisiticated irrigation systems in agricultural colleges and commercial farming during the colonial period (pre-1980), and the loss of rudimentary soil and water conservation measures such as mulching and winter ploughing, suppression of deep contours during the Rhodesian

UDI era (1965 to 1980), and the recognition and emergence of rainwater harvesting innovations as climate change heightened from the late 1990s. In Chapters 4 and 5 participants prioritised the manifestations of contradictions they wanted to work on.

3.6.2.3 Analysis of changed practices and the ZPD

In order to identify practice changes (boundary-crossings that emerged), I analysed collaborative modelling and expansion processes (i.e. from expansive learning cycle) of sustainable, or perceived better agricultural education, extension and farming practices. This was based on a reflexive review (i.e. cultural and socio-ecological histories) of these practices. I developed a practice analysis tool adapted from the 'hypothesized zone of proximal development' tool developed by Engeström, Brown, Christopher and Gregory (1997) (see Figure 3.12 for the adapted version that I developed for possible agricultural extension praxis).

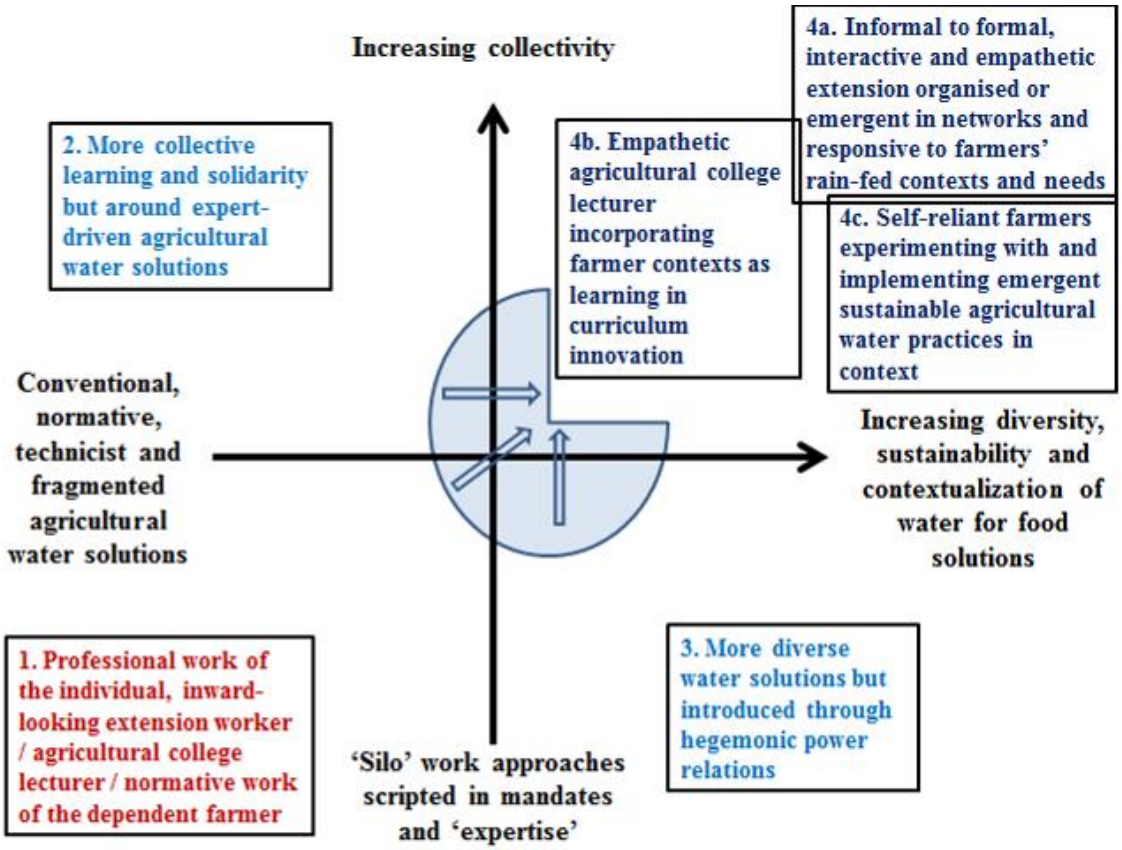


***Figure 3.12**: The hypothesised zone of proximal development for work in extension workplaces or spaces (adapted by author from Engeström, Brown, Christopher & Gregory, 1997, p.370)*

Why this notion of an emerging ZPD as a symbolic space (Meira & Lerman, 2001) is relevant in this study is because it borrows from Vygotsky's sign-mediation in activity which brings the connection with CHAT's concern with artefact-mediation. This symbolic space is also potentially interesting for

understanding how new practices emerge in and through the boundary-crossing learning processes. I therefore used the ZPD to describe the way in which agricultural actors from different activity systems worked collectively or helped each other to learn new and emergent ways of sustainable agricultural water management. This helped to articulate the changing object of activity emerging from the boundary-crossing learning processes.

To further explain and analyse the change processes emerging from a collective learning process, I searched for intentionality – the change agents' willingness and conscious intention to transform their practices, building of solidarity towards a common good and navigations of power. The expressions of agency by the various research participants representing diverse agricultural learning systems provided a good indicator of transformative change in talk and indeed Sannino (2008) argued that,

> In the terminology of interlocutionary logic, the talk through which participants commit to something practical belongs to *commissive speech acts*. This is, by definition, *agentive talk*: The speaker expresses his or her intention to act in a specified way. (p. 246, emphasis mine)

The actual implementation is analysed in Chapters 6 and 7 to reveal and track the development of transformative agency (Sannino, Engeström & Lemos, 2016; Engeström, 2015). Mukute (2016) developed some tools for analysing agentive talk based on Sannino (2008)'s analysis of experiencing where he found that implementation can be tracked back to what people commit themselves to during talk and this can be mediated by the researcher working with other farmers and network partners as formative interventionists. This was tracked in the boundary-crossing change laboratory intervention workshops. I used the typologies of agency expressions proposed by Engeström (2011) and Haapasaari (2012) as shown in Table 3.11 that follows.

Table 3.11: Type of Agency Expression based on Engeström (2011) and Haapasaari (2012)(direct citation from Haapasaari, 2012, rearranged with category G added by Lotz-Sisitka et al., 2017)

Type of agency expressions	**Characteristics**
A: *Resisting* the change, new suggestions or initiatives	Directed at management, co-workers or the interventionist
B: *Criticising* the current activity and organisation	Change-oriented and aiming at identifying problems in current ways of working
C: *Explicating* new possibilities or potentials in the activity	Relating to past positive experiences or former well-tried practices
D: *Envisioning* new patterns or models in the activity	Future-oriented suggestions or presentations of a new way of working
E: *Committing to actions*	Committing to take concrete, new actions to change the activity. Commissive speech acts are tied to time and place
F: *Taking actions*	Reporting having taken consequential actions to change the activity in between or after the change laboratory sessions
G: *Reframing power relations*	Possible navigations of power

3.6.2.4 Explaining transformative change with the notion of 'Learning leads development' in the ZPD

Vygotsky (1982) postulated that in culturally-mediated change processes, learning leads development meaning than learning precedes development in such a way that the latter becomes catalytic from a single learning step, as expressed below:

> *A single step in instruction can represent a hundred steps in development*. This constitutes the most positive feature of this new theory. … Learning to type may not change the general structure of consciousness. *Learning a new method of thinking or a new type of structure produces a great deal more than the capacity to perform the narrow activity* that was the object of instruction. (p. 196, emphasis mine)

Zaretskii (2016) argued that Vygotsky's concept of learning-led development has more unexplored dimensions that can be opened up to enhance learning possibilities when we consider the meaning of Vygotsky's maxim of one step in learning leading to two or more developmental steps. Zaretskii (ibid.) argued that according to this idea, "learning did not just precede development but *under certain circumstances* resulted in a *qualitative advance measured by many steps"* (p. 150, my emphasis). This assumption was developed by various Russian cultural psychologists to give a multidimensional conceptualisation of the ZPD as shown in Figure 3.13 (compare two-dimensional ZPD in Figure 3.11).

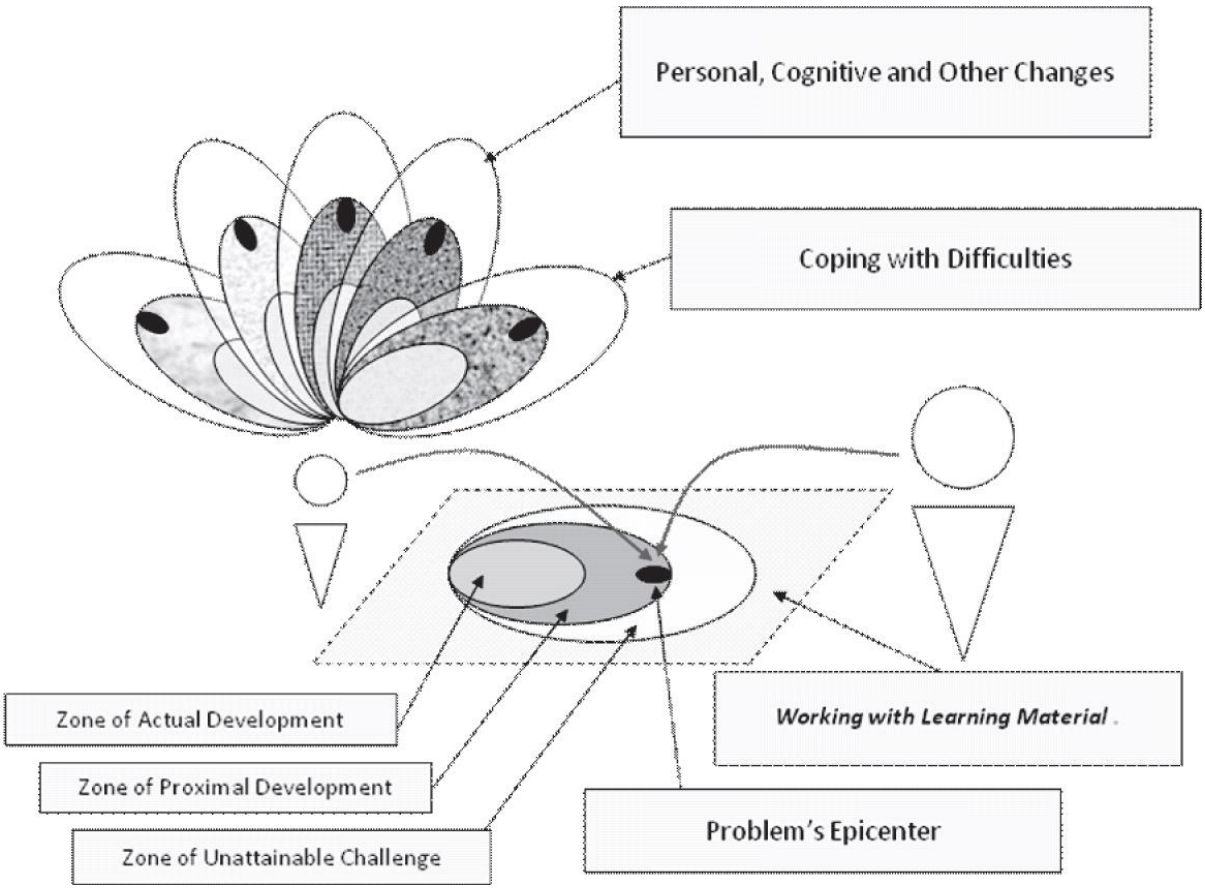


Figure 3.13: *ZPD as a generality of dimensions of potential developmental steps (adopted from Zaretskii, 2016, p. 155)*

Figure 3.13 shows multiple dimensions of change from the zone of actual development (ZAD) to the zone of proximal development, ZPD (which becomes the next ZAD for further development). According to Zaretskii (2016), these dimensions include change in the personal, cognitive and other areas including

> Self-confidence; … readiness to act by oneself; readiness to accept help; understanding the line between their zones of actual and proximal development, i.e. awareness of when the help was needed; reflection (shaped as consistent self-improvement and improvement of one's modes of action…). (p. 160)

I found Zaretskii's list above very useful for my research contexts where personal agency for self-reliance (*zenzele*) was a general problem and, in some cases, a glaring absence amongst some farmers affected by decades of oppression and capability deprivation, or misinformed by systems of donor dependency syndromes or entitlement. It highlights the need for collaboration, mutual need, relational agency and multi-voicedness. Figure 3.13 also shows the 'problem's epicentre' which represents several epicentres in reality and where the (individual or collaborative) learning problem lies. The shifts in learning are shown by different orientations of the petal-like shapes whose combination form

a ‘flower’. The changes in the colour of the ‘unfolding flower’ show developmental changes in the respective dimensions.

Speaking in terms of learning and development through the multi-dimensional model, Zaretskii (2016) argued that an

> … ‘appropriate step’ is a step made in the problem’s epicenter. The problem’s epicenter in a key dimension blocks the ability to progress in other dimensions and becomes an inseperable obstacle for development. When the child has broken through it, energy gets released immediately and progress in other dimensions starts. This process might be figuratively described as “a hundred steps in development”. (p. 159)

3.7 CRITICAL REALISM AND DIALECTICAL CRITICAL REALISM: EXPLAINING CHANGE

3.7.1 Introducing critical realism

This section discusses basic critical realism and its advanced form of dialectical critical realism, with a special focus on its inherent under-labouring concepts in relation to CHAT, its emancipatory stance, metaReality and their relevance to this thesis. It is worth noting that while CHAT emerged from (cultural) psychology and Marxist historical materialist philosophy, critical realism brings in an extended version of historical materialism which takes stronger account of the Anthropocene into the philosophical underpinnings of the study. The discussion justifies the use of critical realist ontology (Bhaskar, 2009 [1986]) which Bhaskar explains as an extension of Marxian ontological principles, outlines the principles and concepts of critical realism, examines the stratified ontology in agricultural learning systems, and explains how the latter are laminated systems in order to understand their complexity. The discussion then examines some of the contradictions in and across laminated agricultural learning systems as ‘absences’. The dialectic of ‘absenting absences’ is a useful theoretical lens for examining transformative and transgressive social learning (Lotz-Sisitka, Wals, Kronlid & McGarry, 2015; Lotz-Sisitka, 2016; Baloi, 2016) and processes of human emancipation through boundary-crossing.

3.7.2 Understanding the foundations and building blocks of critical realism

The critical realist philosophical approach is an endeavour to describe social-ecological phenomena and change. It is a philosophy that provides for ‘walking the talk’, which one can live and act by in the world. The term ‘critical realism’ has grown to be associated with the work of Roy Bhaskar although it has been used by others before such as Georg Lukács (Collier, 1994) and Ian Barbour (1971), among others, and implicitly also by Marx (according to Bhaskar). In Bhaskar’s work, the term is a hybrid of his special philosophy of the human sciences ‘critical naturalism’ and his general philosophy of science

'transcendental realism' (Bhaskar, 1989; Archer, Bhaskar, Collier, Lawson, and Norrie, 1998, p. ix). Bhaskar (1989) accepted the term and has used it in his works observing that "gradually people started to elide the two and refer to the hybrid as 'critical realism'. It struck me that there were good reasons not to demur at the mongrel" (p. 190). Together with a form of ethics called 'the theory of explanatory critique', transcendental realism and critical naturalism form what has come to be known as basic or original critical realism, the first of three phases in the development of the philosophy. The other two phases are dialectical critical realism and the philosophy of metaReality.

The argument of transcendental realism is that there exists a reality of underlying mechanisms and structures which are independent of our experience of them, but that generate phenomena that appear in experience. Andrew Collier (1994) explained the danger of falling into the trap of *epistemic fallacy* when we "reduce questions about what there is (ontological questions) to questions about what we can know (epistemic questions)" (p. 36). He does this by examining the question 'how are experiments possible?' and demonstrating that experiments are necessary to understand the operation of an isolated mechanism in a closed system if this can help to understand nature's open system. Therefore, our knowledge of the world from ordinary experience or experiment is fallible because we cannot limit the existence of what is real as its existence transcends that which we experience empirically. This is where Bhaskar departed from an element of Kant's (1965, 1998) philosophy, seeing the answer for scientific inquiry "as lying in a (realist) depth ontology of how the world is" (Norrie, 2010, p. 7).

3.7.3 Why Critical Realism?

Critical realism helped me with tools to question, explain and critique what is observed and what is absent, its reality, and to acknowledge and seek understanding of the underlying structures and mechanisms generating activity in agricultural learning, deepening the insights into the structural dynamics that shape the contradictions that Engestrom referred to. In so doing, it helped to make meaning of the nature of knowledge in the context of post-colonial agricultural learning systems seeking reflexive transformation and emancipation. It also helped me to understand how people interact and struggle to seek socially just and compassionate relationships and non-destructive production processes that do not necessarily conform with popular science or simply maintain the status quo. This is important for this study as it seeks to critically understand the social structures and mechanisms that influence knowledge construction, privileging and socialisation in farming practices, extension and agricultural education curricula. This can therefore provide possible ways of how sustainability knowledge can be generated, put into practice, expanded and scaled through formative intervention processes.

I used critical realism principally as a philosophical under-labourer to clear the so-called rubbish that obstructs the way to knowledge (rather than producing knowledge itself), thus acknowledging the

fallibility of science particularly its application in agricultural learning systems. This is based on the ideas of John Locke (1975 [1690], pp. 10-11):

> The commonwealth of learning is not at this time without masters-builders … it is ambition enough to be employed as *an under-labourer in clearing the ground a little, and removing some of the rubbish that lies in the way to knowledge*. ... the *taking away false foundations* is not to the prejudice but advantage of truth, which is never injured or endangered so much as when mixed with, or built on, falsehood.

It can be deduced from the above citation that true knowledge is not always readily available or obvious to the senses and to experience. The implication is that there are undesirable systems of thought and belief (the "rubbish") that are entrenched in accepted ways of doing things and yet block ways of gaining true knowledge of the world. Some work needs to be done to gain an own understanding of the nature of truth. John Locke's concern with human understanding as "the most elevated faculty of the soul" (ibid., p. 4) led him to see learning or

> ... searches after truth (as) a sort of hawking and hunting, wherein the very pursuit makes a great part of the pleasure. Every step the mind takes in its progress towards Knowledge makes some discovery... (ibid.)

Bhaskar's view of the role of critical realist philosophy reflects John Locke's views regarding under-labouring, as he believed that "much existing philosophy is rubbish" which needs to be gotten rid of in order to reveal truth (Bhaskar, July 21, 2013 Personal Communication). Critical realism thus proposes that humans are capable of learning objectively about the world but acknowledges that there are limits to human perception because it is subject to interference from subjective factors that obscure perception. Learning and critical reflection on the outcomes of learning and on how it was obscured by such limits enables a better understanding of the reality of the world.

Critical realist philosophy's approach to clearing rubbish involves a number of features that include what Bhaskar (2008b [1975]) saw as a demonstration of 'seriousness' [e.g. "to Hegel and the dialectical tradition" (Norrie, 2010, p. 6)], linking theory with practice and 'immanent critique'. Bhaskar (2016) described seriousness as inconsistencies in what people say they are, their being. What people do, helps to illuminate how learning takes place and what people become. An introduction of absence to critical realism therefore means doing the unexpected and the abnormal in the field, and hence is has not been accepted by some notable critical realists, but has been by some (ibid.). Immanent critique is a way of assessing a system of thought from the inside without imposing one's objection, by targeting the system's foundations, principles or constitution that it is unable to sustain. According to Cruickshank (2003),

> We could improve the precepts used in research by developing an immanent critique of those precepts, which means criticising perspectives from the inside (rather than from an a-

> perspectival position that presumed to mirror reality), and doing so by criticising them in relation to the reality they purport to explain. (p. 114)

Immanent critique was applied to the assessment of activity systems, their elements and interactions, and of the interactions between activity systems in order to search for systemic and collaborative transformative agency. This is in line with Sayer's (2000) assertion that realists are concerned with identifying necessity, potential and hence seek opportunity for transformative change. I found critical realist ontology to be more explicit in its clarification and dealing with the issues of transformative learning and human emancipation complementing CHAT framing, as demonstrated in Chapters 4 to 8.

3.7.4 Using the idea of a stratified ontology: Real, actual and empirical

Bhaskar (2009 [1986]) described reality as layered with a deep nature, that acknowledges the existence of a reality outside of the consciousness of humans. In this stratified ontology, there are three distinct domains of reality, namely the real, the actual and the empirical where mechanisms operate independently of events and human agency, and events exist independently of human experiences of them. This means that basic critical realism provides possibilities for under-labouring what manifests at the surface by digging deeper into the causal and generative mechanism of phenomena.

According to Bhaskar (1993) and Norrie (2010), "depth ontology entails delving into different levels of reality namely the real (structures, underlying generative mechanisms), the actual (phenomena and events, generated by underlying structures/causal mechanisms) and the empirical (phenomena and events experienced by the knowing subject)". Table 3.12 characterises these levels.

Table 3.12: The domains of the real, the actual and the empirical (after Bhaskar, 2008a orb, p. 2)

	Domain of Real	Domain of Actual	Domain of Empirical
Mechanisms	✓		
Events	✓	✓	
Experiences	✓	✓	✓

The empirical domain contains our data, that which we can observe, and is therefore 'tangible'. This is the domain in which natural scientists usually work and have confidence in. The actual domain, according to Danermark et al. (2002), is the space where events take place and is not dependent on our experiencing them or not, because "what happens in the world is not the same as that which is observed" (p. 21). The real makes it possible either to explain further what we experience or to provide contradictory accounts of what appearances may be telling us about occurrences.

3.7.5 Towards a deep ontology of learning

Drawing on critical realism's depth ontology and Bronfenbrenner's (1979; 1993) socio-ecological laminated system learning model, Tikly (2015) proposed a model of inclusive and laminated learning (see Figure 3.14). The model connects the individual and other levels with structures and mechanisms generating learning opportunities in different spaces of interaction and recognising three relatively autonomous levels reality.

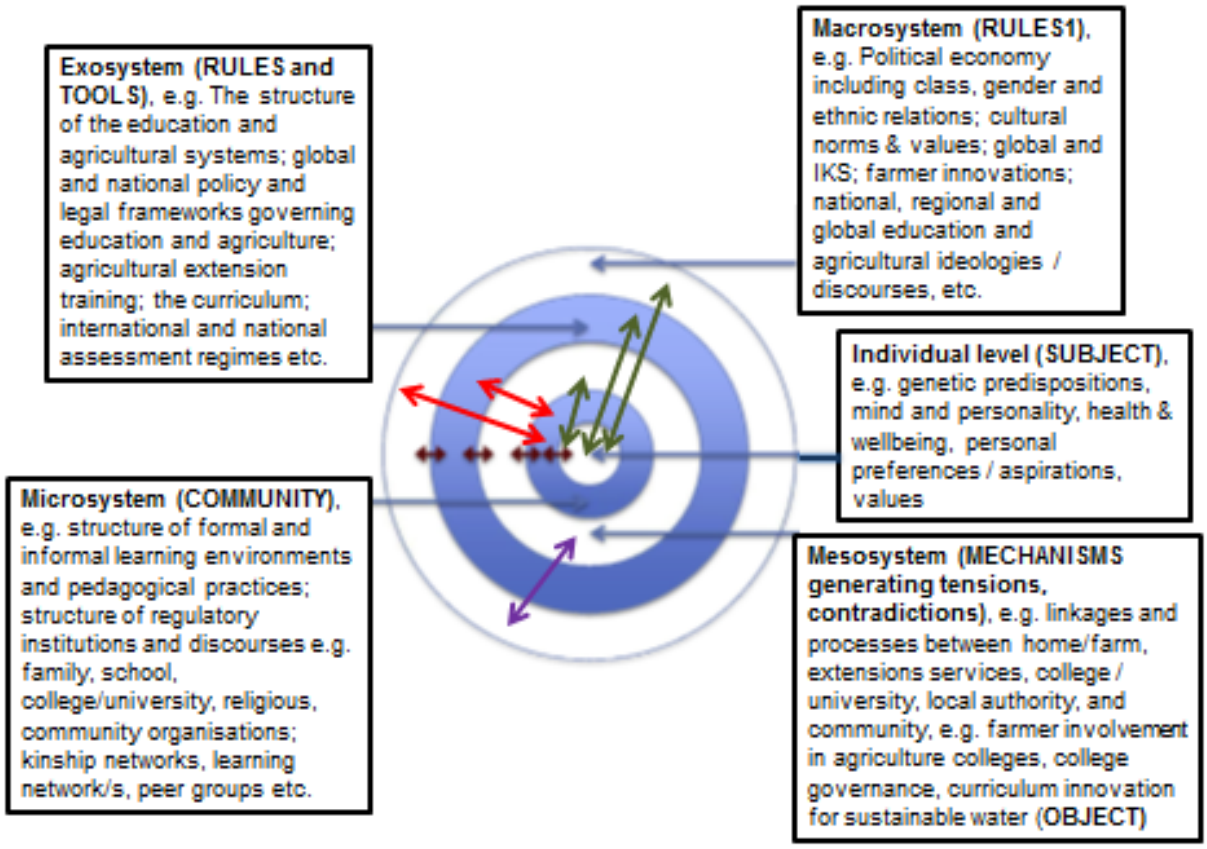


***Figure 3.14**: A laminated learning system showing connections between components of an activity system (adapted from Tikly, 2015)*

Tikly (2015) argued that researching such learning needs an ontologically robust framework that views learning in an inclusive and laminated perspective as the starting point. This will safeguard research to inform policy and practice accurately and holistically. These ideas are illustrated in Figure 3.14 above which is, however, limiting as it is not so obvious that the individual interacts with the mesosystem, or the mesosystem with the macrosystem for example. The (red, green and purple) double-headed arrows added as a modification show that the spaces of influence are not limited by any implied hierarchical boundaries, a point clarified by representation of specific components of the laminated system in second and third generation of activity systems. The uppercase parentheses

indicate some parallels to activity theory. However Tikly's suggestion that research should focus on the development and application of "theories of learning that are able to explain the natural and social structures and causal mechanisms that give rise to and inhibit learning at different scales and levels and in different contexts" is a critical escape route from the trap of epistemic fallacy (ibid., p. 237).

3.7.6 Principles and concepts of critical realism in relation to CHAT: Applications

Critical realist lenses help to *explain the emergence* of new human activity from the perspective of transformative social action, which is also a temporal perspective that accounts for the emergence of action in relation to structure via individual and collective human agency (Bhaskar, 2008a). They also helps to identify absences for enabling further learning (Bhaskar, 1993; Nunez, 2014). As can be seen from the example below, emergence is also socio-cultural, socio-political and ethical in addition to being bio-physically linked, and temporal. Not all expansions of learning are transformative in an emancipatory sense, and critical realism helps us to decide "which way is up" (Engeström, 1991) or "how praxis may be considered transformative or not" and how one might develop an emancipatory perspective on praxis.

3.7.7 Use of Dialectical Critical Realism's emancipatory and transformative nature

Dialectical critical realism (DCR) is characterised by a number of key concepts useful for this study including 'absence' where the dialectic of absenting absence is emancipatory in nature and $power_1$ and $power_2$ relations which can be turned around through reframing. The use of absence provides a point of departure for Bhaskarian dialectics compared with Hegelian and Marxist dialectics. Bhaskar's treatment of dialectics in absenting the absence provides for the possibility of transformation at the level of the individual in addition to structural (e.g. societal, political, economic, social-ecological) transformation (i.e. within the laminated system). However, to understand the argument of absenting absences in a developmental context that I use in this study, one needs to reflect on the four main elements in dialectical critical realist philosophy, namely non-identity, negativity, totality and ethical agency or practice (Bhaskar, 1993, 2008a; Hartwig, 2007; Norrie, 2010). By so doing, one treads on what other critical realists have criticised as a collection of neologisms (or new words), unconvincing truth claims in metaphysical doctrines and 'signs of intellectual decline' (Norrie, 2010, p. 3), criticisms that Norrie saw as unusually harsh. In his treatment of the dialectic, history and the pursuit of transformative change, Bhaskar (1993) made clear the underlabouring role of DCR, thereby indirectly connecting with the goal of formative intervention:

> In addition to considering dialectic historically and systematically, I have treated it, amongst a variety of other modes, as *the logic of argument*, the method of immanent critique, the dynamic of conflict, the node of change and the axiology of freedom. All my arguments converge on a position which has very radical implications. Dialectic is essentially to do with the absenting

> of constraints on absenting absences or ills (which may also be regarded as constraints (p. xxxiii).

Educational enquiry like social science operates in open systems that, according to Scott (2010), demand the "use of methods and strategies that fit with systemic openness... (and) inferential judgements from the analysis of indirect evidence" (p. 10). He further argued that social scientists do not have the luxury that natural scientists have of working with closed systems, and are compelled to use inferential judgements based on analysing indirect evidence.

3.7.7.1 Power relations as generative mechanisms: Goods or evils

History shows that the exercise of power can be emancipatory or suppressive depending on how humans relate to each other as they interpret the world, apply knowledge and make claims on and use resources and means of production (Bhaskar, 1993). While the discussion of power is often described in hegemonic relational terms, such as in the formation of subalterns in relation to 'masters' in colonial constructions, what Bhaskar (ibid.) described as $Power_2$, he introduced the notion of $Power_1$ as emancipatory. $Power_1$ is described by Hartwig (2007) as

> …the general causal powers of human agency whose characteristics entail the possibility of human emancipation, such as our capacity to investigate, communicate, plan, construct moral and ethical systems, feel and care for others, and come to agreement based on judgmentally rational argument directed at practices that transform our lived circumstances. (p. 372)

In formative interventionist research, contradictions within and between the tools that mediate activities, the rules that shape its actions and the relations between the community's interactions as they exercise their division of labour need to be critically examined for their emancipatory ($Power_1$) or suppressive ($Power_2$) potential. Schudel (2012) illustrated this point when she cautioned on how the interpretation and application of an intended $Power_1$ tool (in her case, the active learning framework) can easily validate $Power_2$ relationships. In this research, such critical examination entailed testing models jointly developed by the cross-case research participants for their multi-voiced and boundary-crossing potential (see Chapters 6 and 7).

Bhaskar (2008a) made a distinction between the power relations in emancipatory ways that are different from many conventional ways of looking at power relations mostly in hegemonic ways. He identified '$power_1$' as the capability of transformative capacity inherent to the notion of action, in other words, what people can do to transform their being. On the other hand, he viewed $power_2$ as a hegemonic power relations whereby individuals or groups have the capacity to undermine or oppose expressed interests or aspirations of other people. They use exploitative structures that give them a domineering and controlling role. $Power_1$ can develop to confront and absent $power_2$ relations. According to Bhaskar (2008a) $power_1$ includes $power_2$, "generalized master—slave (-type) relations.

The poles of such antagonistic dialectical contradictions, exemplified by the famous contradictions between capitalist and worker are typically differentially causally charged" (p. 55).

3.7.7.2 Absences and absenting absences as transformative change

Absence is a notion that comes out of Bhaskar's (1993; 2017) four term dialectic that he calls the 'MELD' schema. This is interpreted as the first moment (1M) or "the sheer real difference that exists in the world" (Norrie, 2010, p. 12), the second edge (2E) or absence, third level (3E) or totality and fourth dimension (4D) or transformative agency. This study does not use the MELD schema and hence will not delve into discussing what each of these stages entails, except its second edge. Second edge is concerned with the notion of absence, and consequently, with absenting. It is based on the understanding that the world is made up of things that are present as well as those that are not. Change and development is therefore concerned with the need to fill an absence, as much as it may be concerned about the need to absent a constraint. Given this argument, absence has a causal significance (Norrie, 2010). The key words are: absences and ills; axiology of freedom; contradiction and constraint (Mingers, 2010); omissions and liabilities. Bhaskar (2008a) identified several kinds of absences that are worth noting here as they were important in the study: absence of an entity in a particular place or time because it exists in others or because it does not exist at all; because it is finite and has perished; because it never existed before. Norrie (2010, p. 14) pointed out: "Natural necessity involves change, and change involves the passing away, the negation, of what is in favour of what has come to be in its place." The process of expanding learning processes and improving sustainable agriculture practices was essentially about removing absence through what Bhaskar (2008 a) called 'presences, commissions and powers'. Lotz-Sisitka (2016) argued that absenting absences produces ontologically framed zones of proximal development at the level of real absences, guiding emancipatory forms of expansive learning, which it also did in this study.

3.7.8 Generative Mechanisms

In addition to a stratified ontology, Bhaskarian critical realism's account of being perceives that "knowledge involves processes of accounting for the events we observe in terms of the underlying structures and other mechanisms which generate them" (Norrie, 2010, p. 7). The search for generative mechanisms comes out of a concern for determination of causality, and a challenge to simplistic explanations of 'A causes B', without due regard for other possible causes that we may not or cannot experience physically. Hedstrom and Swedberg (1998) argued for the study of mechanisms by proposing that,

> A major advantage of the mechanism-based approach is that it provides (or encourages) deeper, more direct, and more fine-grained explanations… The search for generative mechanisms consequently helps us distinguish between genuine causality and coincidental association, and it *increases the understanding of why we observe what we observe*. (pp. 8-9)

More recently, Archer (2015) proposed that the transformation of society from its present kind of late modernity to one that is morphogenetic (say a more sustainable one) is found in what she calls "its relational organisation" (p. 2). She criticised single-factor accounts of societal change as found in new succeeding ages such as information, network, risk society or the Anthropocene because they ascribe change to the social order to one form of change. In the same vein, she denied multivariable approaches that rely on prediction rather than explanation, but instead proposed, together with various other Critical Realists, the studying of generative mechanisms that explain how associations emerge and operate, and on the other hand, can account for situations where associations of causality are absent. In his interpretation of this relational organisation concept as a precursor of change, Little (2015) described it as an immanent issue:

> … change in the relational structure of modern society that is the object here; and the search for generative mechanisms is *a search for the processes internal to late modernity that bring this structural change about*. Put in these terms, the objective is reminiscent of Marx's goal in *Capital*: *to discover the internal dynamics within the capitalist mode of production that were likely to lead to fundamental structural change...* (no page, emphasis mine)

In this study, the exploration of generative mechanisms is important and linked to the idea of immanent critique in the explanation of contradictions, and the concept of absenting absences in seeking out of solutions based on working on and with the generative mechanisms.

3.8 CONCLUSION

Theory is perceived as a lens for making sense of truth or reality. CHAT and Critical Realism were described as substantive theory, and meta-theoretical philosophical under-labourer respectively. In using CHAT, I sought to draw on its epistemological access and developmental and formative orientation to frame and examine the relationships between culture, history, agency and praxis across agricultural learning activity systems. This was deepened by basic and dialectical critical realist lenses, which also look at activities and the actors in them as relational and examine becoming as a learning oriented journey though the dialectic, not unlike CHAT (Lotz-Sisitka, 2016). Critical realist depth ontology inquiry lenses, added co-constructively to the historicity and epistemic formative expansive learning orientations of CHAT, appealing to the contextual need for depth-ontological and emancipatory post-colonial analysis of historical developments and current orientations and relationships between agricultural learning systems introduced in Chapter 2. Theory and methodology need to 'speak to each other' or resonate in terms of philosophical background and worldviews among others in order to complement each other objectively. Developmental work research methodology and use of boundary-crossing change laboratories was thus explained critically with enough depth to justify and demonstrate its usefulness in this particular study. The chapter has closed with a discussion of

dialectical critical realism and its concepts of absenting absences and generative mechanisms which are useful in explaining what we experience and observe and what we do not.

CHAPTER 4
SURFACING CONTRADICTIONS FROM THE SOUTH AFRICAN NESTED CASE STUDY

"When an old man dies, a library burns to the ground." Chinua Achebe

4.1 INTRODUCTION

Chapter 3 described the nature of activity systems with a focus on the second and third generation activity theory and the methodology for data generation and analysis. Using this theoretical and methodological framing, this chapter starts by describing selected key activity systems. It then presents and analyses the data and contradictions emerging from interviews, ethnographic discussions and observations (see section 3.5.2) done with research participants in the South African nested case study. The research participants were drawn from people and organisations with a direct impact on water for food and locally adaptive seed systems. These were small-scale farmers, lecturers from agricultural colleges and university agricultural faculties, principals of agricultural colleges, extension officers; agricultural extension department managers and local economic development (LED) agency facilitators (see section 3.5). The farmers included individuals, families and cooperatives, most of whom were members of farmer associations organised in commodity groups. Some were also members of water user associations.

The wide array of participants was included to respond collectively to the complexity of agricultural learning activity systems (see section 1.6, Chapter 1), to ensure a multi-voiced representation

(Engeström, 2009) and to explore their relatedness and common motives in agricultural water and locally adaptive seed. This chapter attempts to answer research sub-questions (i) and (ii) presented in section 1.4. This entailed a first phase of data analysis from interviews and observations using inductive mode of inference (see Chapter 3) leading to initial categorisation of data. The latter were used to construct and analyse activity systems collaboratively and subsequently to identify internal contradictions in work and contradictions across activity systems using an abductive mode of inference. The historical evolution of the object was mapped out from empirical and secondary data.

4.2 UNDERSTANDING AND CONCEPTUALISING ACTIVITY SYSTEMS IN THE SOUTH AFRICAN NESTED CASE STUDY

The first step towards understanding the activity systems in the South African nested case study was to undertake interviews, meetings and observations that, together with organisational documents, generated enough data to enable clear case descriptions. The South African nested case study was made up of the five agricultural learning systems (see Chapter 1) named in the introduction above from which four key activity systems and their subjects were selected for the purposes of this study, namely

- **Small-scale farming:** small-scale farmers from various contexts; Lloyd Village cooperative garden; individual farmers from Koloni Village (Perksdale location) and Matole basin under Middledrift area; Keiskammahoek farmers; farmers from Khayalethu, Mpundu and Farmer Field Schools in three Gwali villages [including Msobomvu] in Alice,
- **Agricultural education:** agriculture lecturers from Fort Cox College of Agriculture and Forestry (hereinafter shortened to Fort Cox College), University of Fort Hare School of Agriculture and Science and Lovedale College),
- **Extension:** officers / advisors / technicians from Alice and Middledrift Extension Offices,
- **Local economic development (LED) agency:** agricultural value chain specialists from Nkonkobe Economic Development Agency (NEDA).

The rationale of grouping the activity systems as above emanated from how the people in each of the agricultural learning systems described how they were related to people in the other agricultural learning activity systems, and how the documents did the same. These activity systems and their **need states** were also evident in the documents analysed, in participant on-site observations and in interviews carried out with regard to agricultural water and climate-adaptive seed objects. The four activity systems listed above are introduced below with details of their contexts and operations. The primary contradictions and higher-level contradictions are surfaced and described in the sections below.

4.2.1 The small-scale farming activity system and its internal contradictions

The 'small-scale' farming activity system in the South African case study was made up of cropland farmers who usually also keep livestock and homestead or cooperative garden food producers. It is not a homogeneous group. The cropland farmers (such as in Koloni village and Matole Basin) typically grow their crops on small fields of one to two hectares where they do subsistence to commercial production. The homestead garden producers (such as in Koloni village, Keiskammahoek and Matole Basin) grow vegetables in their backyards with areas rarely exceeding one hectare meant primarily for subsistence. Cooperative garden producers (such as Lloyd Village garden) operate in a group plot of one to two hectares. All these farmers are usually organised into village farmers' associations at village level, and a collection of these is affiliated to the farmers' association at the municipality level. Figure 4.1 illustrates the structural organisation of the Nkonkobe Local Municipality Farmers' Association.

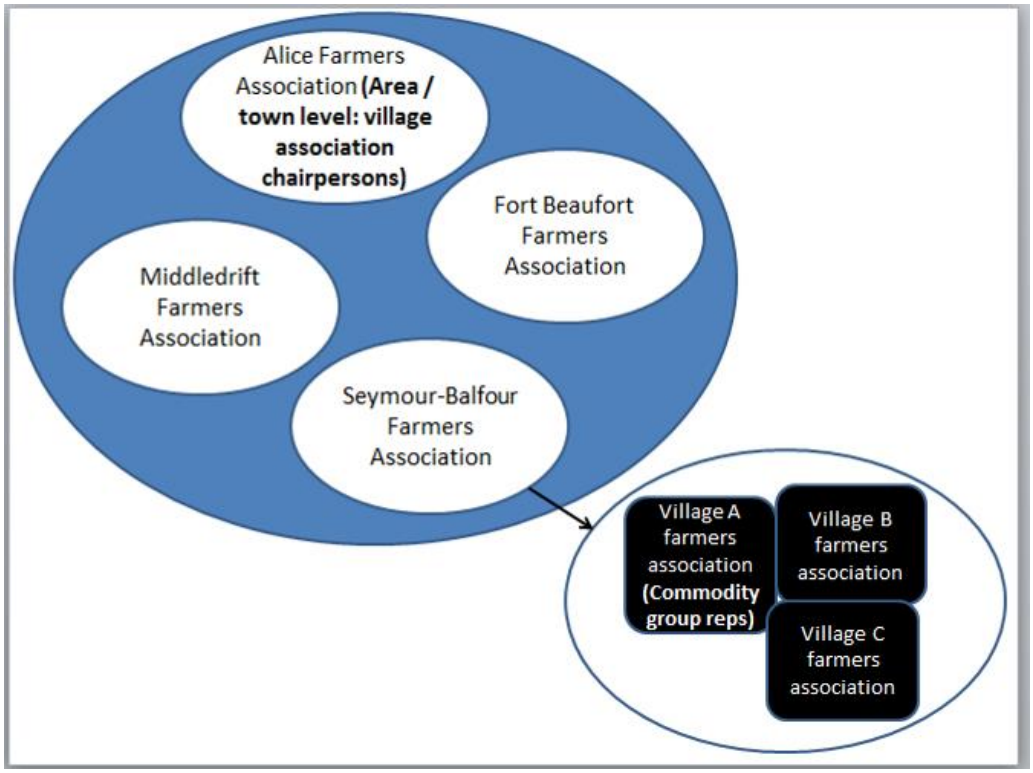


***Figure 4.1**: Structural organisation of the Nkonkobe Farmers Association from commodity groups at village and area levels to the local municipality level*

Most of these farmers depend on rain-fed farming systems with no irrigation facilities or access leaving their farming at serious risk of crop, livestock and income loss from climate change and variability (see Chapter 2). They all had challenges that were different in some ways such as time committed to farming and division of labour, and common in others such as willingness to learn with respect to water for food, locally adaptive seed and capabilities. They were all members of the Nkonkobe Farmers' Association (except for the Keiskammahoek farmers by virtue of being in a separate

municipality as described later). Figure 4.2 is an illustration of a typical small-scale farmer activity system in the study area.

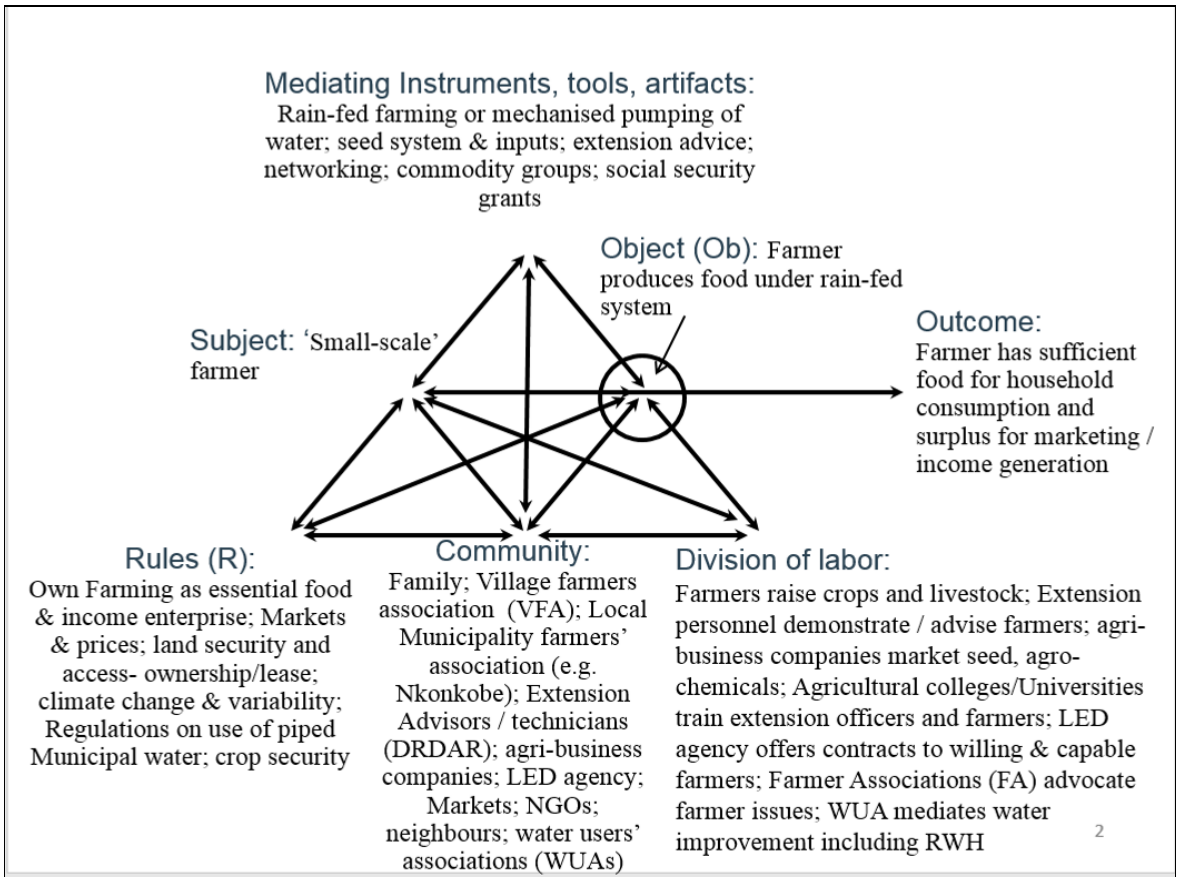


Figure 4.2: *Small-scale farming activity system for water in the South African case study*

In Figure 4.2, the object of the small-scale farmer activity system is successful food production within the prevailing rain-fed or mechanised water pumping system. The outcome from this object is sufficient food for household consumption and surplus for getting to the market for generating cash income. The resources available to the farmer to convert their land resources to food include direct physical inputs or artifacts such as seed, soil fertility materials and watering instruments, and conceptual tools that include the methods of ensuring water availability and retention, ways of ensuring seed security and ways of farming or farming systems (see Chapter 2). In most cases, however the tools available or known to the farmers are not sufficient to build their capabilities to act optimally on their object (see contradictions discussed in cases below). The farmers interact closely with a diverse community with clear roles defined by their division of labour in their farming including their families as co-workers and/or consumers, farmers associations that advocate for them, extension advisors and technicians from the Department of Rural Development and Agrarian Reform (DRDAR). Lecturers from agricultural colleges and universities train them on demand or bring students to learn at their farms. The LED agency supports selected farmers through its small-scale farmer development

programme. Farmers in Alice also fall under the eDikeni Water User Association (WUA) that has development of RWH&C as one of its strategic objectives (see Chapter 1) and is affiliated to the Nkonkobe Farmers' Association.

The small-scale farmer activity system is the referent activity system as the results of agricultural education, extension and community development are enacted on and manifested in it. The case studies below surface water contradictions in the small-scale farmer activity system.

4.2.1.1 Case study 1 South Africa: Koloni Village

The Koloni Village (also called Perksdale location, see Chapter 1) is one of those villages whose land is based on a trust community demarcation system. This means that the village's land is divided into residential plots, grazing camp areas for livestock (six in total), and a 'three morgen' (approx. 2.57 hectares) arable land for crop production. Every farmer/household's land is allocated through this system. The village has a clinic, higher primary school (Aliphi Higher Primary School) and a high school (Siseko Secondary School). One farmer was interviewed from this village for the purpose of this study. He took part in the Amanzi for Food Training of Trainers' course, and was associated with Fort Cox College's boundary-crossing change laboratory workshops (see Chapter 6).

Agricultural practice in this area is historically characterised by livestock farming (cattle, sheep – *igusha* [IsiXhosa], goats – *ibhokwe* [IsiXhosa], chickens and pigs) and crop (maize, pumpkins) and horticulture production (vegetables). Regarding soil and water conservation, the people in this area have traditionally employed a practice called *gelesha* as described by one of the participating farmers (FSA3) in excerpt 4.1:

> *Excerpt 4.1: (Interview #FSA3 Audio Transcript, April 29, 2015)*
> FSA3: Gelesha … was used in the village by the farmers' forefathers, (it is) based on the preparation or cultivation of the soil, so that when water comes from the rainfall can be absorbed or collected, or store water within the soil for future planting of crops such as maize, potatoes and beans.

The knowledge practice of *gelesha* appears to be disappearing as evidenced by most of the local people participating in the learning network and in interviews who had no knowledge or recollection of the term. However, as learning of the practice took place, it quickly inspired course participants to relate to other rainwater harvesting and conservation practices because of its local cultural appeal. The use of *gelesha* as a learning stimulus is discussed in Chapter 6.

In order to understand the water for food problem (the core primary contradiction in the object) of the Koloni farmer activity system, I was guided by the empirical data in a process akin to peeling an onion (see section 3.2.3, Chapter 3) by searching for manifestations.

- **Manifestation of a primary contradiction #PCFSA1 in the small-scale farmer's object of activity: Koloni village**

A contradiction emerged in the object of water for food of a field crop farmer (who was also doing homestead garden food production) that manifested itself as a *double bind* due to two irreconcilable demands:

> **Marginal dryland crop farming and homestead food production under risky water scarce conditions versus demand for food to satisfy domestic and income needs**

There is a real manifestation of a contradiction described above whereby developments on "both sides of the contradiction co-exist, struggle and penetrate each other" (Engeström, 1987, p. 124) as shown in excerpt 4.2 below:

> *Excerpt 4.2: (Interview #FSA3 Audio Transcript, December 18, 2014)*
> (Dialogue turns 131 end -140):
> ***Main Researcher-interventionist, R1:*** What challenges … are you facing in terms of water?
> ***Farmer, FSA3:*** *We are living in a dry place* so the ploughing that we are doing *we are depending only solely (on) the rain* so the challenge … it's *drought* because immediately *this rain is short* so it's easily affecting our plants. You see, like for instance I'm sure by the month of January they'll be *too hot* and *it will be late*. There will be *less rain*. ... Then *the crops will suffer a lot*, then that's when you'll see that with mealies [corn]... *Currently, the weather here changed a lot* ... I am telling you.
> ***R1:*** How is it changing?
> ***FSA3:*** *It change(d), the rain now, pattern,* and the *rain amount*.

The bad and deteriorating water context described in excerpt 4.2 above ('dry', 'depending solely on rain', 'it's drought', 'the weather here changed a lot', and 'change in rainfall') is typical of marginal areas designated for betterment planning during the apartheid era such as Koloni Village. All combine as multi-stressor factors compromising crop, vegetable and livestock production. Excerpt 4.3 shows the demand side and motivation for producing crops and vegetables, developments that pull in the opposite direction of the water problems above.

> *Excerpt 4.3: (Interview #FSA3 Audio Transcript, December 18, 2014)*
> (Dialogue turns 29-38):
> ***Researcher, R1***: Wonderful. Now, what are your sources of income?
> ***FSA3:*** I resigned… so I am just depending on myself now. Like if people ask me to go and *plough for them* I will. Then …you see those chains, I'm *pulling some wood for people*. I charge per load so it is always flat. I charge somebody 400 Rand.
> (Dialogue turns 89-94):

R1: Now … Amanzi for Food project, what was your motivation for joining it?
FSA3: It's to know further about the water conservation, the usage of the water… *profitable in terms of growing my crops.*

Excerpt 4.3 shows that the farmer had at least three income streams namely ploughing other farmers' fields for a fee, transporting firewood for a fee and growing crops for sale and domestic consumption. This manifestation of a primary contradiction in the object can be historicised as shown in Figure 4.3. In following the 'object' of water for food in the context of the Koloni Village farmer, I identified five object-historical distinctive cycles of expansive learning on water for food. For ease of reference, I call these Object W1 – *gelesha* as a disappearing traditional soil and water conservation practice; Object W2 – communal farm dams constructed for watering livestock; Object W3 – treated piped water for domestic use only; Object W4 – roof water harvesting and Jojo tank storage for domestic and garden use and Object W5 – rain-fed cropland farming assisted by *gelesha* in a few isolated cases. Each of these object phases is tied to forms of land use governance, market commodities and other social-historical circumstances, as will be described below.

- **Historicity of the water object in Koloni Village farmer's activity system and generative mechanisms**

To understand this emerging contradiction better in its historical context, I carried out the following historicity shown in Figure 4.3 combined with retroductive analysis.

Object historical layers and changes in water for food supply, delivery, storage, use and conservation activity in a Koloni Village Homestead Garden and crop field	Pre-1970s Land Act of 1913: Provided for demarcations that created the homeland regions, such as Ciskei where Koloni Village is located, politically and economically separated from other parts of South Africa. Disruption of people-people and people-land relations that had ensured food sovereignty. Genesis of food insecurity and hunger in homelands (Pienaar & Von Fintel, 2013). The Native Trust and Land Act of 1936 gave birth to the Betterment Planning Scheme which was designed with banishment in mind (Badat, 2012). *Cultural disruptions and changes, and gradual loss of indigenous RWH&C practices (earlier RWH&C practices such as Gelesha = OBJECT W1)* Late 1970s – early 1990s Homeland Act of 1971. Land re-allocated for communal production.

Figure 4.3.1 *Communal farm dams constructed for watering livestock (but absence of water provisioning for crop production)* (*OBJECT W2)* in Koloni Village

(Photo by author, December 28, 2014)

Piped water to betterment villages for domestic use only = OBJECT W3

Early 1990s – present (2016)

Abolishment of the Homeland Act of 1971.

Figure 4.3.2 *Roof water harvesting and Jojo tank storage for domestic and garden use = OBJECT W4*

(Photo by author, December 28, 2014)

Figure 4.3.3 *Rain-fed cropland farming assisted by gelesha among a few farmers = OBJECT W5*

(Photo by author, December 28, 2014)

Figure 4.3: *Historicity of the water object in Koloni Village*

These phases show the different ways in which the water object is encountered by villagers and farmers and in particular, by this particular farmer (FSA3) participating in the study, to show past cycles of the activity (Engeström, 1999a).

Each of the Object phases is also shaped by generative mechanisms surrounding the historical social engineering projects of the colonial and apartheid states. The latter continue to hold the core

contradiction shaping the activity in place, which appears to be strongly related to persistent inequality and capability deprivation that exists (Westaway, 2012) in spite of aspirations for change (see below).

Object W1. *Pre-1970: Cultural disruptions and changes, and gradual loss of indigenous RWH&C practices (earlier RWH&C practices such as Gelesha = OBJECT W1)*

Historical evidence shows that there has been a longstanding rainwater harvesting and conservation culture of practice in the Eastern Cape Province of South Africa (Denison & Wotshela, 2009; Pesanayi, 2016a). The practice of *gelesha* is described as one of the oldest southern African rainwater harvesting and soil conservation practices. As I have discussed elsewhere (Pesanayi, 2016b), the early practice of gelesha "showed that indigenous people used a form of retroductive or abductive analysis (…) to maximise the harvesting of precipitation (…) for food production" (p. 238). This indicates a historically deep intimacy in people's relationship with the land and the historically constituted forms of water practices for food production. The farmer interviewed in Koloni Village (FSA4) was among very few in the South African case study who (still) knew and practiced *gelesha* (see also Chapter 6), showing that it existed mostly in the form of 'fragmented memory'.

The Land Act of 1913 and the Native Trust and Land Act of 1936 gave rise to apartheid homelands and betterment planning respectively. The Betterment Planning Scheme was a tool that the apartheid state used in an attempt to purportedly improve small-scale agricultural production, improve economic viability and conserve the land in Bantustans (see Chapter 2). Its strategy of dividing land into grazing commonage, concentrated residential areas and arable lands evidently had the opposite effect as soil erosion increased and soil fertility decreased (ibid.). Critiques have interpreted the motive of betterment to be deep-seated socially engineered disruption of a whole people (race) by disrupting land-based livelihoods, making farming unattractive and indirectly creating migrant labour for white-owned mines and farms (McAllister, 1991; Lee, 2015). The gradual disappearance of *gelesha* shown in the Koloni Village case study (and also in the Lloyd Village case study below and across the Imvotho Bubomi Leaning Network discussed in Chapters 1 and 6) can be attributed to the social disruption brought about by colonialism and apartheid, and apartheid state schemes such as 'betterment' (McAllister, 1991).

Object W2. *Late 1970s – early 1990s: Communal farm dams constructed for watering livestock (but absence of water provisioning for crop production)*

A number of communal farm dams were built to support livestock watering during the apartheid period, but there are no dams for crop production, which relies on rainfall in rain-fed farming systems that dominate most rural villages like Koloni. Many of these dams were built by White farmers before they were moved from their farms to the White areas paving the way for the Black homelands and

betterment planning (see Chapter 1 and 2). There is an historically-evolved absence of water infrastructure for crop farming, which results in high risk for crop production from drought and also the unlawful use of treated tapped water (van der Horst & Hebinck, 2017).

***Object W3**. Late 1970s – early 1990s: Piped water to betterment villages for domestic use only (inadequate solution to rain-fed homestead garden production)*

The provision of clean and treated piped water for domestic water supply in Koloni Village was accompanied by an absence of water provisioning for homestead garden production, thus creating questions for both historical and future expansive learning cycles following Engeström's (2001) model of expansive learning (see Chapter 3). Foot (2014) observed that questioning is a learning action corresponding to the primary contradiction (see Chapter 3).

Questioning: Questioning in this phase was connected to the reflections and dissatisfactions voiced in earlier forms of the water for food activity. While the Betterment Planning policy demarcated areas allowing for homestead food production, it created new questions that related to how to continue food production when earlier traditional watering systems (e.g. *gelesha*) had been disrupted by forced migration and re-settlement (McAllister, 1991). Further questions arose regarding the presence of treated municipal piped water available through standpipes within metres of households for domestic use only at the exclusion of piped water for homestead food production or crop farming. Farmers reported having no options at times but to use running water from the local municipal taps, that they considered illegal practice as reported by a committee member of the Alice (eDikeni) Water Users' Association (see Chapter 1) and a farmer from another village in the excerpts below.

> *Excerpt 4.4: (Interview #FSA5 Audio Transcript, May 14, 2016)*
> ***FSA5:*** Before, there were boreholes and engines, and pumping windmill. *The engine was stopped because the municipality gave us taps*.
> ***R1:*** For drinking water?
> ***FSA5:*** Yes. *So others use that drinking water for okucecentshela* (isiXhosa for watering crops or vegetables).

Farmer FSA5 above reported the use of municipal water meant for domestic use only in the watering of vegetables, which they attributed to historical policy rearrangements in the provisioning and use of water. The illegality of this practice and therefore inaccessibility of water provision other than rainfall to resource-poor small-scale farmers was further articulated by a small-scale farmer (FSA4) from Lloyd Village as follows (excerpt 4.5);

> *Excerpt 4.5: (Interview #FSA4 Audio Transcript, May 10, 2015)*
> ***R1***: Now who pays for the water that comes, municipality water? … Do the villagers pay for the water?
> ***FSA4***: It's free water, because there are no meters. If I can get the water in my yard, I pay…
> ***R1:*** Now that municipal water what is it meant to be used for?

FSA4: To eat … for cooking and washing only. … For the garden *yhoo* (IsiXhosa expression of disbelief), the garden noo. No (watering) the garden they don't want.

The next form of the object is an attempt by individuals and government programmes to provide more sustainable water infrastructure through rainwater harvesting systems more accessible to resource-poor farmers.

Object W4*. Roof water harvesting and Jojo tank storage for domestic and garden use.*

The government's agricultural extension services promotes alternative sustainable water for food at a small scale through the provision of roof water harvesting tanks called *Jojo* tanks. A senior agricultural extension manager (EDSA1) described the provision of rainwater harvesting systems as part of starter packs given to farmers through the *Siyazondla* (literally 'we are feeding ourselves') programme as follows;

Excerpt 4.6: (Interview #EDSA1 Audio Transcript, February 8, 2016)
R1: So I was just wondering about those who don't have access to irrigation and those who don't have dams available to them in their areas, what is the department's attitude towards the promotion of water harvesting …?
EDSA1: Now what we do (in) … food security directorate ... (is) provide the farmers with seedlings, sometimes small implements like fork, spade. …they provide them with water tanks. And the *irrigation pipes* all of those things we refer to as *starter packs, so there are many of these areas that have our Jojo tanks … so we encourage the rainwater* (harvesting) ... *for subsistence farmers to do their gardening* through the Siyazondla project.

However, the government's rainwater harvesting programme was also described as underfunded and having little success due to poor farmer reception (see excerpt 4.7).

Excerpt 4.7: (Interview #EDSA1 Audio Transcript, February 8, 2016)
EDSA1: … but again may I be honest with you it is *a problem of limited success stories* in there. … Sometimes those starter packs that we provide end up being sold by recipients … not everyone is interested in agriculture.

Excerpt 4.7 provides a characteristic of small-scale farmers. A senior extension manager described some of the farmers supported as having no interest in farming, and hence not reaping maximum agricultural benefits from government input programmes including water tanks. While this was an opinion from one senior extension manager, it gave important perspectives into the small-scale farmers' activity system that needed further exploration; the small existence but poor valuing of rainwater harvesting in government farmer support programmes and the perceptions of extension agents on the attitudes of resource-poor rural farmers to agriculture. Such a perception appears to emanate from how resource-poor farmers are profiled right from university training to extension support more as subalterns not worthy of being called farmers (see Chapter 1). One agricultural

extension manager lamented this view as unacceptable and as suppressing small-scale farmers (see excerpt 4.8).

> *Excerpt 4.8: (Interview #EMSA2 Audio Transcript, March 3, 2016)*
> ***EMSA2:*** I think it's the perception that small-scale farmers can't really produce and even the focus in terms of the budget. It's not really channeled to the small-scale farmers, ... because when we categorise farmers, *the home-garden ones are not really considered as farmers, even university … call them food growers, not really farmers,* but if we can say, 'you know what, *these are farmers'*.

The excerpt above challenges the perception of looking down upon resource-poor farmers in terms of resource-allocation. The dependence on rain-fed farming is a fact of life for farmers in this area who have been working with the locally-available water resources, which apparently were sufficient historically but have been observed to change drastically over time. The criticism of "limited success" (excerpt 4.7) has another dimension that is an immanent critique of the extension activity system's own approach in working with the farmers (e.g. "the budget… not really channeled to the small-scale farmers" – excerpt 4.8) and will be discussed further under the extension officers' activity system. Below I discuss external factors that affect small-scale farmers' aspirations to improve their water showing that quaternary contradictions are invoked and manifested when external rules are limiting.

- **Manifestation of a quaternary contradiction #MQCSA1: The Koloni village small-scale farmer's object of activity and the local government's rule-producing activity system**

The farmer cited above (FSA3) had made visible infrastructural investments in farming (such as fencing for his cropland) and other material investments (such as tilling, disking and harrowing equipment and a tractor) after resigning early from a previous job (see excerpt 4.3). These investments, including a history of family farming culture (Interview #FSA3, Audio December 18, 2014), kept him in the farming practice, despite the agro-ecological risk of crop failure. However, the regular destruction of his cropland fence by neighbouring villagers' straying livestock attracted by the tall grass and green crop in the fenced area further exposed his crop to livestock destruction (see plate 4.1 and excerpt 4.9 below).

> *Excerpt 4.9: (Interview #FSA3, Video Transcript, December 18, 2014)*
> ***FSA3*** (Spool run: 01min 16sec): If I find the cattle in my plot, I will put them in here. And then I will load them and drive them to the pounding place in my trailer.
> ***R1:*** Does the Chief have a role in terms of controlling this…
> ***FSA3:*** It was just a community concern. Because when I ask them, from that village, and from that village and from my village … they said the thieves are going to steal (the impounded cattle) using this. … All that it is meant for is I am catching cows here, and when I ask the farmers I go around to that village and to another village there, *they always tell me that me that they don't know. .. A cow puts its head on my fence and it gets inside*. Because as you can see these mealies are coming up right.
> ***R1:*** It's promising.

FSA3 (Spool run: 20min 28sec): Most households have a piece of land here to cultivate. … Here it was having a fence, all up here and down there. ... Up there is another village called Mxumbu. Also they were cultivating there … All those places they were cultivating *but now the people are not cultivating, they are sitting at home*.
R1: Eeh, they are sitting at home… do they want to cultivate in the first place?
FSA3: They said they want to cultivate but they don't have cows.

Excerpt 4.9 indicates discord in farmer to community wide relations due to the rules of land use, livestock control and crop protection. Farmer #FSA3 was clearly committed to farming but his farming was facing a problem of straying cattle from surrounding villages destroying his crops, and this was also slowing down his efforts to invest in improving his water for food in this rain-fed system. There is a manifestation of a quaternary contradiction between the Koloni village farmer's object and the rules governing roaming livestock and crop and farm property protection after the formal breakdown of betterment planning. The post-betterment era was failing to keep cattle in their own area away from (the now far reduced) cropland areas even if the latter were fenced (see Figure 4.4).

Figure 4.4: *Left: Fence of cropland plot frequently destroyed by straying livestock; Right: Temporary cattle-holding pen for impounding problem cattle (December 18, 2014)*

Livestock usually roam free; there is no herding culture. This scenario strained people-to-people relations, as there were no apparent rules replacing the failing betterment demarcations, and an absence of a local forum for collaborating on farming, separation of cattle from crops and water issues. There are fewer people that are concerned with crop farming or growing crops ("but now the people are not cultivating, they are sitting at home"). Rather the neighbouring farmers are more concerned with the security of their straying cattle when they get impounded ("they said the thieves are going to steal").

4.2.1.2 Case study 2 South Africa: Lloyd Village Cooperative garden producers' activity system

Lloyd village is a former White-owned farm that is located along the road between Fort Beaufort and Alice towns, 8 km from the latter (see Chapter 1). It was reallocated to Black villagers when the area

was declared a homeland through apartheid policies. A member and vice chairperson of the Lloyd village garden described the place as follows (excerpt 4.10);

> *Excerpt 4.10: (Interview #FSA4, February 6, 2015)*
> ***FSA4:*** This is Lloyd Village, it was a farm, and the person's name was Lloyd and this was his house (pointing) and now it is a crèche.
> ***R1:*** So when did this farm become a village?
> ***FSA4:*** Early '80s.

The village has a population of approximately 2 000 people made up of about 340 households. It hosts a pre-school (in the former farmhouse) and a primary school and is serviced by a high school in a neighbouring village. The Alice Extension Office, Alice Farmers' Association and eDikeni Water Users' Association service the village farming system. A number of disused farming plots are scattered around Lloyd Village (see Figure 4.4). A fenced cooperative garden exists in the village with 18-23 members, mostly elderly women. This garden production and its water for food activity was one of the nested case studies of this study.

Figure 4.5: *Photograph of typical abandoned crop fields in Lloyd Village, Alice showing invasive succession by secondary vegetation (taken by author, February 6, 2015)*

With very little to no crop farming taking place in the fields around Lloyd Village and in homestead grounds, the Lloyd village garden becomes a very important local food production space. Abandonment of crop fields in Lloyd Village was partly attributed to water scarcity as follows:

> *Excerpt 4.10: (Interview #FSA4, February 6, 2015)*
> ***FSA4:*** I have a land that side and I was farming there - it is about three hectares.
> ***R1:*** Are you still farming it? … When did you last farm there?
> ***FSA4:*** It is about three years back *because it is too dry there*; *but* I still have the impression if it is raining lots to take the tractor and go there. I was making very well there with maize, beans and butternuts. …

A *dilemma*, manifested by the linguistic cue 'but' can be inferred from farmer FSA4's talk above, whereby he had been hesitating to farm his cropland (see Figure 4.4) for three consecutive years because of the uncertainty of rainfall. With virtually no crop farming activity, food production in Lloyd Village is concentrated in one cooperative garden that also faces water problems as described below.

- **Manifestation of a primary contradiction #PCFSA2 in the object: Lloyd Village garden**

Members of the Lloyd Village garden manifested a *critical conflict* (see Chapter 3) in their daily work with water. They felt ***violated by the removal of 'their' diesel engine that was providing power to pump water from underground, by the local municipality on the pre-text that it needed repairs when the members were sure that it was working well***. Failure to restore the diesel engine powering a borehole pump at Lloyd Village garden over a period exceeding two years placed the members in a situation whereby they were confused and discouraged as shown in excerpt 4.11.

Excerpt 4.11: (Interview #FAS4, May 10, 2015)

1) ***R1***: May you please tell me about water in this village. Where does the village get its water?
2) ***FSA4:*** …from municipality, Sandile dam.
3) ***R1:*** There are also some tanks there. (Pointing to raised plastic tanks). Where does that water come from?
4) ***FAS4:*** Down there you get the boreholes.
5) ***R1:*** Ah, are they working?
6) ***FAS4:*** Jaa they are working but the engine, municipality they take it.
7) ***R1:*** Why?
8) ***FAS4:*** *I don't understand why*. By the time the water is not here the community go down there to open the engine to bring the water here. After the tank is full, they closed the engine. *But now municipality take the engine, so no water, municipality is not coming to open the water. We are suffering [...] the water here.*
9) ***R1:*** Was it working?
10) ***FAS4:*** *Jaa it's working.*
11) ***R1:*** Has anybody gone to municipality to find out?
12) ***FAS4:*** The community they go there to municipality to check the engine. … (inaudible). I don't understand.

Based on excerpt 4.11 above, the critical conflict occurred as follows:

- The engine was removed by the local authority [dialogue turn #6] to repair when it was apparently working well [dialogue turn #10];
- Farmers did not understand why their engine had been removed by the authority that had given it to them in the first place [dialogue turn #8];
- Follow-ups made by farmers were not honoured by the local municipality, and this frustrated the farmers [dialogue turn #12].

Own replacement of the engine appeared not to be an option because the farmers felt they could not afford it, as expressed by one of the farmers in the excerpt 4.12 below:

> *Excerpt 4.12: (Interview #FSA4, December 2, 2014)*
> FSA4: We would like to repair our pump . . . but there are other problems. We don't have the funds at the moment, and our delivery pipe from the tank was damaged during road construction by the Municipality.

An economic dimension of the water problem is clear in the above citation that shows financial incapacity as an aspect of capability deprivation and unsustainability. Further empirical evidence discussed by Pesanayi (2016b) showed the historicity of the object and indicated that the reason given to the farmers for removal of the engine as "broken" and needing repairs (ibid., p. 243) was inconsistent with the facts of a still working engine as experienced by the farmers (see paper in Appendix 4.1). This raised the question of whose knowledge counts and how, and the relationship between knowledge, resources and power. Furthermore, the farmers kept hoping that the engine would be returned after it had been repaired despite the long time – two years since it had been taken. When asked if they had and would like to try other ways of developing their water for food such as rainwater harvesting, one of the cooperative garden farmers indicated that the group members were too old to consider digging of what they called *amadanyana*, which are infield rainwater harvesting ponds similar to what the Agricultural Research Council had piloted in different villages in the same area of Alice. These form part of the history of the small-scale farmers' object of water for food.

- **Surfacing the key primary contradiction from the Lloyd Village farmers' activity system**

From the discussion above and reflecting on discussions documented in detail elsewhere (Pesanayi, 2016b, Appendix 4.1), it can be seen that there is a *critical conflict* in the object of water for food that is related to cost of installation and maintenance, affordability, ownership and limited alternatives. Figure 4.6 illustrates that the intentional capturing and storing of water from a natural source (for example a rainfall event) is an internally contradictory object represented in the diagram by the zig-zag double arrowed sign, and the explanations given in the inner oval shapes.

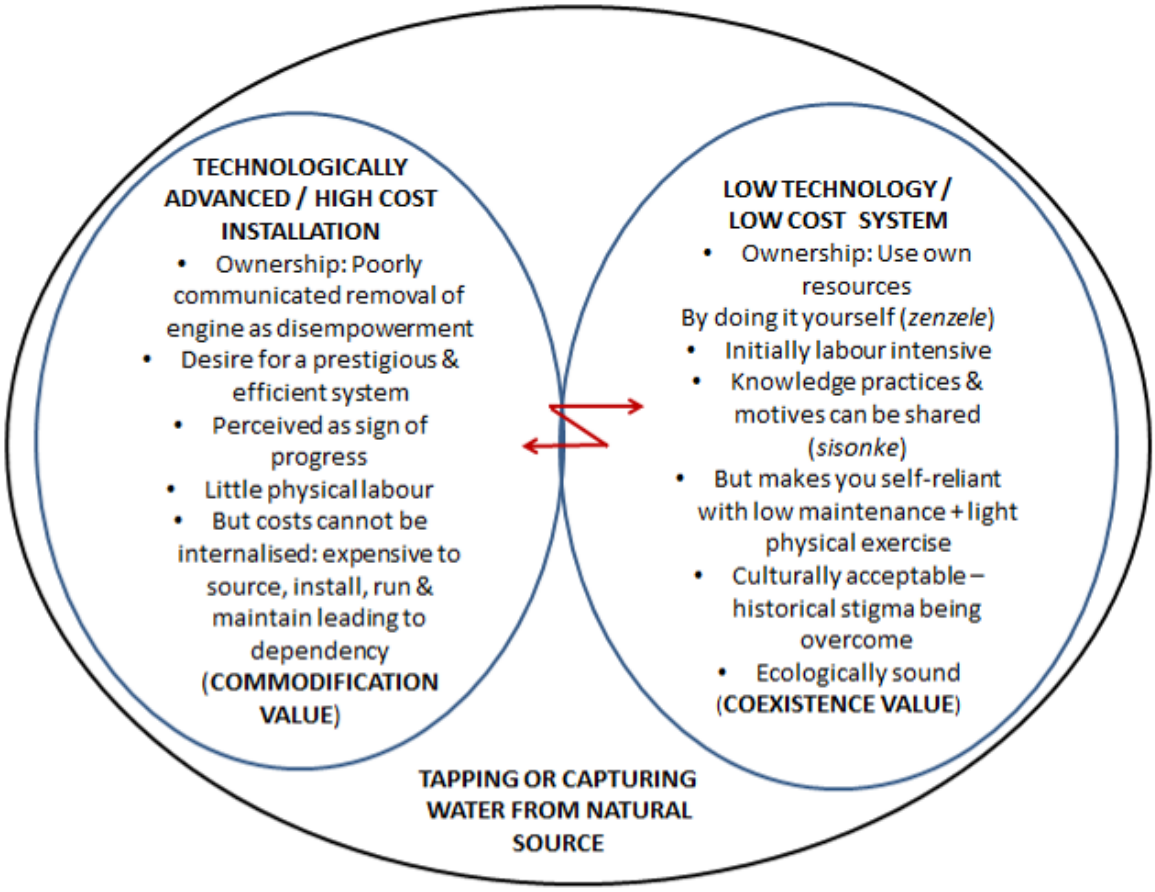


Figure 4.6: *Diagrammatic representation of the fundamental inner contradiction in the object of water for food at Lloyd Village garden cooperative (adapted from Engeström et al., 2012)*

On the one hand, water can be obtained but at a cost beyond farmers' capabilities such as bringing piped water into the garden or the group buying and maintaining its own engine (commodified water). In addition, the existence of an engine historically that was available for the group's assumed sole use was violated by the engine's removal by the municipality without a truthful explanation. The further lack of restoration of the engine for reasons that were noble in principle but were not communicated or documented enough to be recalled by the group members also made the engine's removal a mockery of social justice. On the other hand bringing 'free' water from the village dam to the garden or capturing it and storing it *in situ* in the soil all required using manual labour. The effort from the village dam seriously challenged the capability of the elderly women farmers on their own because the younger generation was not participating in farming (value of intergenerational division of labour).

In addition, the soil in the garden beds and paths remained bare thus losing the little moisture available from rainfall (see Figure 4.7). The following dialogue reveals a two-pronged climate problem of water scarcity on the one hand and heat syphoning moisture from crop plants on the other.

Excerpt 4.13: (Interview # FSA4, *6 February 2015)*
R1: What has been the biggest challenge?

> ***FSA4:*** *The biggest challenge is water* from me *on my side. For me if I can get water I can plough the whole season! ...* [my sweet potato crop] *is burning out from the sun.*

According to the farmers, the moisture problem was caused by water scarcity due to drought affecting rain-fed farming and solar heat affecting plants through enhanced evapo-transpiration and scorching. Bare soil surfaces were not mentioned as a contributory factor to moisture loss by any of the eight farmers interviewed at Lloyd Village garden despite being prevalent in the garden (see Figure 4.7 below).

Figure 4.7: *Top left: Vegetables wilting in Lloyd Village garden; Top right and bottom: Bare soils in vegetable beds and paths (Photos by author December 2, 2014 – top and May 31, 2016 – bottom)*

The situation in Figure 4.7 shows a contest between energy-intensive manual watering from a distant source (symbolised by the bucket) and soil and plant moisture loss due to lack of rainfall, absence of soil protection, shade and alternative water supply.

Hence there is a heightened critical conflict: ***Lloyd village garden farmers' experience of violation due to the unilateral removal by the local municipality of 'their' diesel engine that was providing power to pump water from underground versus the farmers' desire to restore the diesel engine that they were incapable of replacing or maintaining, while at the same time neglecting to conserve the little moisture available to the soil from rainfall***.

The next case study presents a different dynamic in the agricultural water object.

4.2.1.3 Case study 3 South Africa: Matole Basin small-scale farming activity system

This case study was located in Matole Basin whose situation and proximity to Fort Cox College was described in Chapter 1 (section 1.5.1.4). The case appeared much later in the study but registered its importance and agency very quickly. The core of this case study was an innovative farming family in Mqayise village that was interested in improving their family and neighbourhood's water for food. The family was involved in food sovereignty activities through Ilizwi Lamafama Farmers Association through Zingisa Educational Project, an NGO and was supported by NEDA's Smallholder Farmer Development Programme in income generation from growing locally adaptive OPV maize seed linked to a local value chain. They were also networking well with their village community and farmers in many other places, willing to share and learn. The latter enjoyed support from Zingisa Educational Project.

The importance of the farmers' association regarding its replication potential is further seen in the conversation below (excerpt 4.14).

Excerpt 4.14 (Paired Interview #FSA10 and NASSA1, May 13, 2015)

1) ***NEDA Agricultural Specialist, NEDSA1***: (introducing researcher). … They are training... It's called Amanzi for Food.
2) ***NEDSA1:*** Amanzi for Food, okay the one X [name of extension officer supplied] (was talking about), because Mr X [same name supplied] is our Controller.
3) ***R1:*** Ah he is in the project, talk to him about it.
4) ***FSA10:*** I am an *executive for Nkonkobe Farmers Association*. … We usually meet with him every month. I know Mr X [name supplied] a lot, because we work together.
5) ***R1:*** All of us that is what Y [name of NEDA Agricultural Specialist supplied] was saying that we link with each other as partners.
6) ***NEDSA1:*** *Together we can do more nee*. There is that statement. *If you put it into practice nee, it works*.
7) ***FSA10:*** It can change the mind-set of the rural community people.

The deliberations in excerpt 4.14 from an interview with the farmer FSA10 (see photo in Figure 4.8) indicate the farmer innovator's links with people in her network who were active in the IBLN, the knowledge flows within the combined networks and expansive learning possibilities based on the belief that co-engaged learning can 'change the mind-set' (dialogue turn #7) of rural small-scale

farmers. The self-introduction (dialogue turn #4) indicates the farmer's connectedness, farmer representation and potential generative influence.

Figure 4.8: *Researcher's first interview with one farmer innovator (Mrs Peter), May 13, 2015 at Mqayise village, Matole Basin*

The interview with the farmer innovator and the NEDA Officer showed that there are a number of actors interacting with her farmer activity system (community). These included the Middledrift Extension Office, Zingisa Educational Project, Ilizwi Lamafama local farmers' association, Nkonkobe Economic Development Agency (NEDA), Middledrift and Nkonkobe Farmers' Associations and other local villagers. The farmer innovator was an active executive committee member of the Middledrift and Nkonkobe Farmers Associations thus placing her in a position of influence. Locally she was active in garden horticulture production, crop and livestock farming together with her family. Her 'innovativeness' was anchored on a number of factors including her personal interest in producing her own food organically informed by her background health knowledge from a professional nursing career (tools). Secondly, she had a flair for on-farm experimentation with sustainable agriculture innovations such as agro-forestry with such species as *Moringa oleifera* and OPV maize (variety ZM1523) production for sale (both supported by NEDA Smallholder Farmer Development Programme), drip irrigation and mulching using organic and inorganic materials as shown in Figure 4.9 below).

***Figure 4.9**: 'Current state': Agricultural water innovations before the formative intervention at Matole Basin farmer innovators gardens (left: mounted drip irrigation system, centre: cardboard paper mulching, right: organic mulching)*

Agro-ecological knowledge practices acquired and applied from an agro-ecology training course the farmer participated in the previous year was evident in her garden as shown in Figure 4.9 above. Despite the above innovations, the farmer innovator experienced the need for more sustainable water for food as she felt her geographical area was no longer receiving as much rainfall as before and the usual rains were no longer coming at the expected time. Figure 4.10 is an illustrated description of the Matole Basin small-scale farmer activity system. This activity system adds extra matters of concern to the first two case studies of the general small-scale farmer activity in that it brings in the issues of locally adaptive seed, land and water rights and gender into the water for food object, and innovation into the subject's agency.

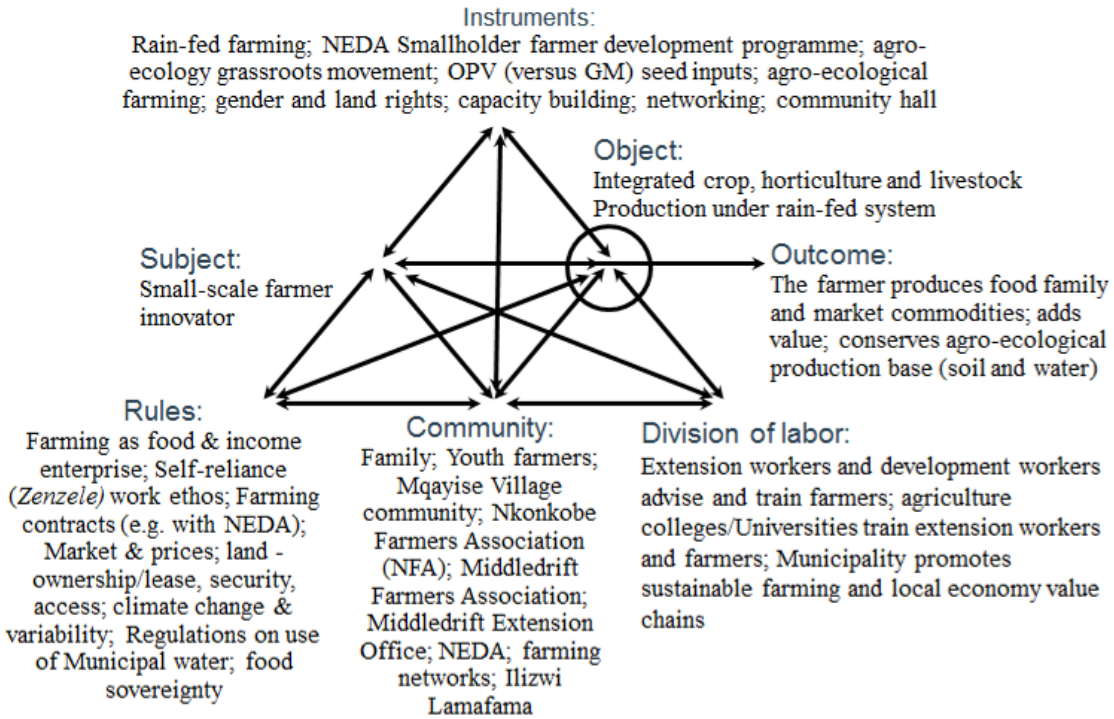


***Figure 4.10:** Matole basin small-scale farmer activity system*

Figure 4.10 above shows that the subjects are also innovators because of the unique artefacts that they use such as locally adaptive OPV seed and conceptual tools such as Agroecology principles that are responsive to water scarcity. Active networking and reaching out are also characteristics of this activity system. It was evident in the Matole basin case study that a **different farmer typology** was at play, namely one that rejected government handouts of GM-seed, preferring and advocating for seed saving and exchange, and better access to water and land.

- **Manifestation of a primary contradiction #PCFSA3a in the object: Matole Basin small-scale farmers' activity system**

The object of the small-scale farmers' activity system was to produce food using locally adaptive open pollinated varieties (OPV) of seed. The seed varieties were adapted to the water-scarce environment within the obtaining rain-fed farming system. The object was described as follows by farmer FSA10;

> *Excerpt 4.15: (DIBSA8a, July 21, 2016)*
> ***FSA10*:** This food sovereignty is *more of justice, more of social cohesion* because we used to *share*. We used to *share indigenous knowledge*; we used to travel to another province just to *access the indigenous knowledge* on how to do your farming, *or just to share indigenous seeds*. *But where is that now*? Because of the capitalist system**,** *it has created something that's in our minds.*

The principles of working together and building relations ('social cohesion', 'justice', 'share') are embodied in the object and point towards valuing each other and various knowledges (including 'indigenous knowledge') and common resources ('indigenous seeds'). However, the farmer laments the tension existing between these common good values and the values of "the capitalist system" that destroys the "minds" and therefore this valuing culture. A field officer from an Agroecology NGO (FONSA1) further described the object as revolutionary in the sense that it sought to challenge the commodification of communal resources by reclaiming control by rural small-scale farmers over the means of production including water, seed and land as shown in the excerpt below:

> *Excerpt 4.16: (DIBSA8a, July 21, 2016)*
> ***NGO Field officer, FONSA1:*** Food sovereignty or Agroecology is not just a technology of farming but it's *a revolution*. When we talk of food sovereignty we talk of *ukunganga wokutsha* – the *control over means of production, not just control of food, but (also) control over the means be it water, be it land.* .. You can be food secure but not food sovereign...

Figure 4.11 illustrates the historicity of water for food, locally adaptive seed and collective learning culture in the Matole Basin farmers' activity system in Mqayise village.

O b j	Pre-1970s

	Homeland Act of 1971 – separate racial development; marginal development of Black people in so-called Homelands *Cultural disruptions and changes, and gradual loss of indigenous RWH&C practices (earlier RWH&C practices such as **gelesha** = OBJECT Ob1)* *Traditional local seed value chain systems based on seed saving and seed exchange (earlier local traditional seed system relational goods such as **OPV seed** = TOOL S1)* *Traditional practices of people working together in each other's fields to ease division of labour and improve societal relations such as **illima** = TOOL R1*
	Late 1970s – early 1990s *Villagers given land titles in Matole Basin*
	Early 1990s – present (2016) *Abolishment of the Homeland Act of 1971; introduction of democratic governance in South Africa, 1994* *GMO Act 15 of 1997 implemented in 1999 as main Act regulating production and release of GMOs in South Africa. Consumers bear most liability (see section 2.3.2.4)* *Consumer Protection Act 6 of 2008 (CPA) provides for regulations on compulsory testing and labelling (South Africa. Parliament, 2009), but has taken many years to implement* *Introduction of Massive Food Production Programme (MFPP) in Eastern Cape 2003 by DRDAR providing 'free' **genetically modified (GM) seed** (MEDPT, 2010, p. 11) to farmers via extension services = TOOL S2* *Ambivalence: Introduction of a type of 'learning against learning' (Saussy, 1999) by government department of agriculture: partial learning of the 'benefits' of GM seed value chain systems from extension with absence of potential socio-ecological risk vs. Traditional collective learning in local seed saving and exchange.* *Training of farmer innovator in agro-ecology by Zingisa Education Project in 2014. Adoption / intensification of garden **mulching** using organic and cardboard box materials = OBJECT Ob2* *Resuscitation of **local seed systems and seed bank through an agro-ecology** project by Zingisa Education Project in 2014 = TOOL S3*

Figure 4.11: *Historicity of water for food, locally adaptive seed and collective learning culture in the Matole Basin farmers' activity system*

Based on the interviews and historicy above, Figure 4.12 illustrates manifestations of contradictions in the Matole Basin farmer innovator activity system.

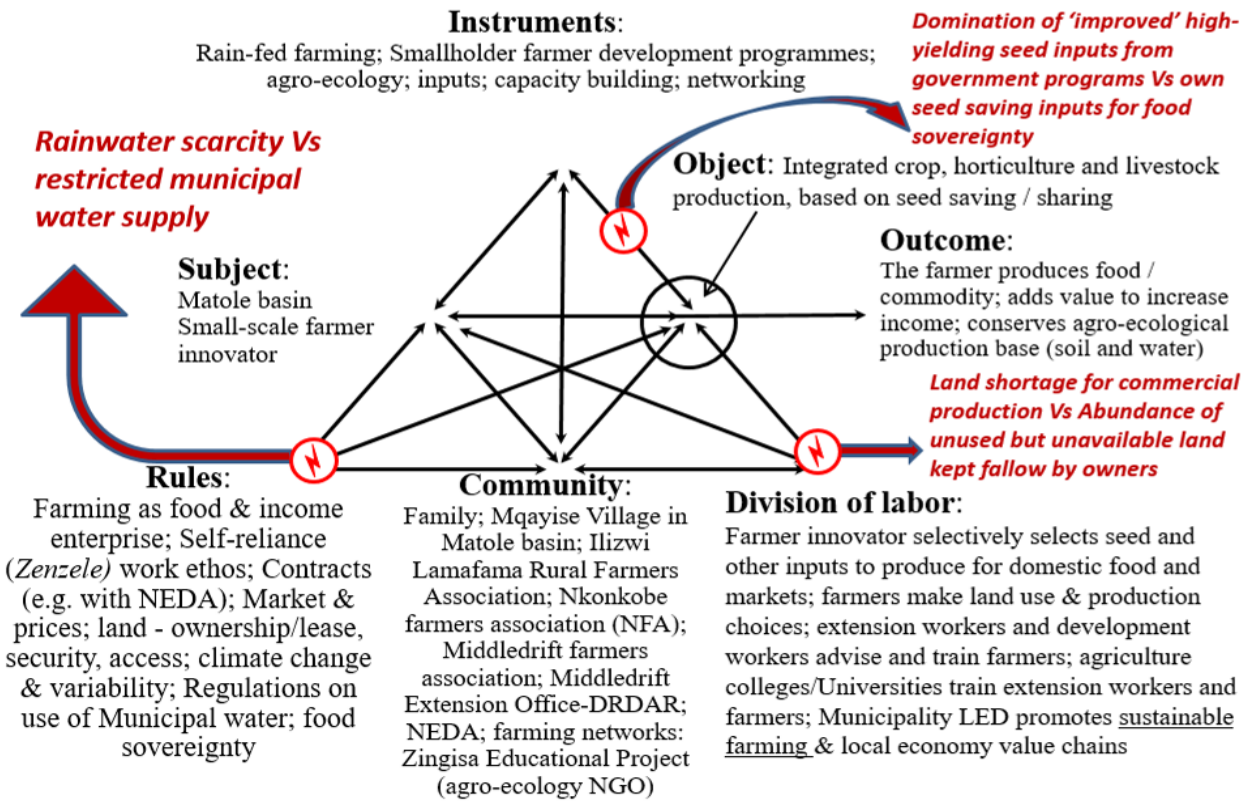


Figure 4.12: *Manifestations of internal contradictions in the Matole basin small-scale farmer innovator activity system*

- **Manifestation of a quaternary contradiction #2 between the object of the Matole Basin small-scale farmers' activity system and tools of the Extension Officers' activity system**

There is a tension between the Matole Basin farmer's object of producing food from locally adaptive OPV maize seed and OPV vegetables and the Department of Agriculture's promotion of GM maize seed through the Cropping Programme. The tension is aggravated due to the extension services' material and cognitive support excluding farmers operating outside the Cropping Programme.

> ***Farmer innovator's pursuit of locally adaptive OPV maize seed as an agroecological adaptation measure to scarce water resources (object) versus Extension Officers' mandated promotion and conditional grant support of GM maize seed exclusively for the government Cropping Programme (tools)***

This contradiction was surfaced in a discussion in an IBLN meeting on the lack of support from extension services to Agroecology farmers growing OPV maize seed as follows:

Excerpt 4.17 (Boundary-crossing Change Laboratory session of IBLN, 7 September 2016)

1) ***Researcher, R1***: During this season …would the extension officer be obliged to help that farmer, if the farmer requests for support?
2) ***Extension Officer, EOSA1***: Yes, we take any application from the farmers, *but we have the programmes that are tailor-made…* So for now *if we are talking for the ploughing of maize… there is no other way I can take you, except for the cropping programme that is in the plan*. That is what is frustrating X [farmer named] and others, because when we are there, we only talk, if you want to participate in the cropping [programme] "*here are the rules*".
3) ***R1***: So, if the farmers are breaking the rule like X.
4) ***EOSA1:*** Then, if he is not catered.
5) ***ACLSA2***: If he is not part of the programme…
6) ***EOSA1:*** We are playing soccer here, if he wants to play rugby, then he could change to the rugby field. That is the programme.
7) ***R1:*** …she is saying "my rugby match is starting, are you coming to help me?"
8) ***EOSA1:*** Yes, the door is opened.
9) ***ACLSA3:*** But not financial.
10) ***EOSA1:*** *But in reality, when the budget is loaded, it will be loaded for this one* [referring to Cropping Programme]. …We don't know where to get the money from the government that's the problem, and the unfortunate part, I am here for the extension, *but we are only here as implementers*. …But we are not the influencers. ... *The only people that can influence the policy makers are the farmers themselves*.

From excerpt 4.17 above it can be noted that the contradiction is manifesting itself as a critical conflict (Engeström & Sannino, 2011; De Dreu & Van de Vliert, 1997) characterised by the use of strong metaphors, in this case derived from sport ("we are playing soccer here"). The farmer felt violated by the extension services' support of GM seed to the exclusion and perceived detriment of OPV seed farmers. The conflict emerged metaphorically through the incompatible rules of soccer and rugby ball games representing the Government Cropping Programme with its GM grain production and ambivalent messages versus OPV grain production in the local traditional seed system. The exclusion of the agro-ecological farming group by extension is represented by such discursive expressions as "*there is no other way I can take you, except for the cropping programme"* and "if you want to participate in the cropping … *here are the rules*" that show a unidirectional and non-negotiable path and rules.

Haapasaari, Engeström and Kerosuo (2012) identified the expression by the extension officer (EOSA1) above as a form of 'resistance' to change by refusing to aligning with Agroecology farmers' needs, and as a type of agency expression. The tension in this resistance is embedded in what Caruso et al. (2009) called 'intergroup bias' (see Chapters 1 and 8). The Agroecology farmers showed empathetic agency towards the favoured group by requesting official research trials on locally adaptive OPV maize seed. "We are not stopping those that are doing GMOs, but let them pilot this group that is saying we don't want GMOs … we need to research this and go to the government being sure of what

we want" (FSA10, September 7, 2016). This statement distinguishes Agroecology farmer typology from the **conventional (GM) seed farmer typology**.

The extension services had a clear exclusionary approach or positioning (see section 3.4) that is biased towards their GM seed system and the farmers subscribing to it at the expense of those farmers that do not, thus creating a critical conflict with the latter. The relationship between the Cropping Programme and Agroecological smallholder farmers in the Matole basin case study can be interpreted as symbolic violence (Bourdieu & Wacquant, 1992) using contested seed as a normative tool for tacit cultural domination. This is because of how the rules from the cropping programme indirectly but effectively violate individual choices of seed, traditional community relations and the property rights of ordinary people (see section 2.4.1). By design, the farmers in the villages serviced by government's department of agriculture are complicit by embracing the Cropping Programme's rules.

The farmer (FSA10) and the Ilizwi Lamafama group that she belonged to were in fact fighting for the right to food sovereignty though valued relational goods (locally adaptive seeds) they saved from season to season, exchanged and passed on freely according to their time-tested Xhosa culture. They were transgressing the state-sponsored symbolic violence through exercising their cultural value and protecting value they knew had been passed from one generation to the next as a culturally appropriate coping mechanism to drought events. Theirs was a cry and aspiration for something beyond even the legal-illegal duality; it was about livelihoods and survival. Bhaskar (2016) attempted to describe such an aspiration for the common good as *eudemonia* because of the sense of purpose embodied in growing seeds that are adapted to water scarcity. The data and the argument advanced above shows the critical connection between adaptation to water scarcity through seed, self-reliance and rights to land and water ("not just control of food, *but control over the means be it water, be it land*... You can be food secure but not food sovereign" FONSA1, excerpt 4.15 above). These matters of concern affecting farmers appeared not to stir the agency of extension officers who felt tied to the mandate provided by their higher (provincial) office ("we are only here as implementers. …But we are not the influencers." excerpt 4.16, EOSA1, dialogue turn #9). It can therefore be seen that the quaternary contradiction manifested above requires a change in the tools or the way the tools are applied. Part of the solution lies in the extension officer (EOSA1)'s suggestions that "the only people that can influence the policy makers are the farmers themselves" (ibid.). This implied the possibility of extension officers working with farmers, the latter taking the lead in influencing policy and transgressive extension practice (see Chapters 6 and 8).

This is an important contradiction because it raises social justice issues about the right to a certain livelihood of one group of farmers with respect to the actions of government working with another

group of farmers whose farming activity has an absenting impact in the former. This relation is $power_2$ in the sense that it is both hegemonic and physically damaging with respect to the seed multiplication base and value of smallholder farmers who prefer to use open pollinated seed varieties. This $power_2$ relation is complex because government feels its tools (represented by GM seed) in the Cropping Programme are tried and tested with respect to productivity and food security and therefore are transmitted to smallholder farers without question. At the same time, the Agroecology farmers felt their OPV seed was better adapted to the climatic conditions especially resilience under scarce water, a quality that the GM seed does not offer, and did not threaten their land use rights.

- **Concretisation of the primary contradiction in the wider small-scale farming activity system**

From the case studies of small-scale farmers above, it has been shown from the manifestations of contradictions discussed that the **key primary contradiction in the object** of small-scale farming pertains to the presence of:

> ***Confrontation with persistent poverty, lack of realised alternatives and capability deprivation exacerbated by commodification tendencies and values versus human rights-based policy and socio-economic objectives for well-being, capability development, equity and sustainability, the roots of which can be found in co-existence tendencies and values.***

The manifestation of the primary contradiction in the small-scale farmer activity system as demonstrated by case studies 1, 2 and 3 above does not seem to fit neatly into the classical Marxian dual nature of 'use value' versus 'exchange value' described by Engeström (1987), but can be more helpfully described by a central contradiction of commodification vs co-existence value (see below). When applied to small-scale farmers' reliance on rainwater in rain-fed farming systems, the issues of resource poverty are invoked that affect people's capabilities to access and use water for food and to find viable alternatives to stressed rainwater situations. These farmers' reliance on rainwater is related to their historical marginalisation regarding the places they were forced to settle in that do not have sufficient rainfall, are vulnerable to climate change and are far removed from where dams and irrigation infrastructure exists. Historically, this effectively removed these farmers from participating competitively on the open national market. The systems of commodifying common resources (such as land, water and seed) established during colonialist land expropriation turned into private property intrusions, and apartheid racist separatist development policies and practices persist for these farmers under new forms of commodification (e.g. GM seed).

Rainwater by nature falls in the commons and has traditionally been enjoyed communally as it naturally watered the croplands on which it fell. Ideas of water provisioning, on the other hand, are based on commodification of water by an authority that invests capital for damming, pumping and

piping infrastructure and then sells it to users at some profit in order to maintain the system at least. The latter is not accessible to resource-poor farmers presented in case studies 1, 2 and 3 above. The core primary contradiction in the object of the small-scale farmers' activity system appears therefore to be between commodification value (a type of exchange value: external economic cost to the provision and access of water for food) and co-existence value (a type of use value: equitable and affordable access and use of sufficient water in the commons). Under colonialism, apartheid segregation and contemporary post-colonial segregationist politics (see Figure 4.11 and discussion), equitable co-existence value was and is denied to small-scale farmers in marginalised, rain-fed areas due to continued knowledge and skills deprivation and institutional failure. The role of institutional failure will be discussed further under quaternary contradictions. Secondary contradictions are surfaced in the next section via their manifestations.

- **Manifestations of secondary contradictions in the small-scale farming activity system**

Here manifestations of secondary contradictions were considered for all the three small-scale farmer case studies above together in order to consolidate the small-scale farmer activity system as a single unit. This was done in preparation for exploring its quaternary contradictions with other activity systems. Engeström (1987) proposed that secondary contradictions are fertile ground for learning to understand the root of problems in order to resolve them.

- **Tertiary contradictions in the small-scale farming activity system**

Farmers in the Alice area can and do subscribe to membership of the eDikeni Water User Association (WUA). Farmers in all the other areas participating in this study have this this WUA as a rich source of learning as it has a well-developed business plan that fulfils the requirements of the Water Act. The business plan (eDikeni WUA, 2013) has four strategic objectives addressing water for food, namely:

1) "**Plan new agricultural water projects**: Facilitate rural development through the collaborative planning and implementation of water use initiatives by identifying potential irrigation and water harvesting projects, and concept plans to facilitate the funding of new initiatives.
2) **Improve stock water availability (boreholes and small-dams)**. Identify priority villages in need of stock water development and then develop practical solutions to provide water for stock.
3) **Build organisational capacity of the WUA**: Progressively develop skills, institutions and systems to administer water-use within the WUA area of operation.
4) **Obtain and distribute information on smallholder-irrigation and water-harvesting methods to improve crop-production**: Actively pursue sources of

information and training and make linkages with key support institutions in the area." (p. 9, emphasis in bold in original)

Two of the four strategic objectives (1 and 4 above) directly focus on rainwater harvesting to improve crop production among other things, through identifying its potential, disseminating information, fundraising, collaborating with other organisations and facilitating training. This makes water harvesting a very powerful potential tool for meeting the eDikeni WUA's vision of using water resources in its area of operation "productively and sustainably for the prosperity of the WUA members and future generations" (ibid., p. 7). However, *a manifestation of a tertiary contradiction emerged between the water for food object of the small-scale farmer activity system as the central activity and the water object of the eDikeni WUA as a culturally more advanced central activity* as follows:

> ***Despite a strong orientation towards rainwater harvesting in the eDikeni WUA business plan and a recent history of rainwater harvesting training in the area (culturally more advanced central activity), in practice this was overshadowed by an exclusive pursuit of conventional irrigation infrastructure and a perceived licencing bottleneck for capturing any water (the dominant central activity). This led to the absence of rainwater harvesting and conservation promotion and lack of generativity of local successful rainwater harvesting pilot projects.***

The dialogue below with one of the eDikeni WUA committee members (FSA5) reveals the source of this contradiction:

Excerpt 4.17 (Interview #FSA5, May 14, 2016)

1) ***Researcher, R1***: What is your interest in the Water User Association?
2) ***FSA5:*** *My interest is to see all the producers of crop production to get irrigation system* because you see… they depend on rainfall. ...
3) ***R1:*** OK. Now in the absence of irrigation what is the Water Users Association doing to assist farmers to have water?
4) ***FSA5***: There was the forms from [Department of] Water Affairs that we are filling… helping the farmers. But it is a long process.
5) ***R1:*** What does that form promise?
6) ***FSA5:*** It's a license for water…

In dialogue turn #2 in excerpt 4.17, the farmer (FSA5) reveals the WUA association's pursuit of large-scale irrigation systems for the farmers in an effort to access available rivers and dams. This is apparently a 'long process' (dialogue turn #4) that has been proven to be unfriendly to small-scale farmers (see Chapter 2). RWH&C thinking was found to be largely absent in the discourse of WUA leaders and their members (farmers) as indicated in the excerpt 4.18 below despite strong goals to pursue it in their business plan:

Excerpt 4.18 (Interview #FSA5, May 14, 2016)

R1: How does water harvesting feature in the Water Users Association? Is it important or is it not there?
FSA5: You know when others invite Water Affairs they said to them we make our own dams and you know what Water Affairs says? They have the right to charge you because even if you can make your own dam *you need a license* for that water. *So I don't know if it is possible … to make those dams without the consent of Water Affairs because of the license*.

In excerpt 4.18, an executive member of the eDikeni WUA (FSA5) justified the perceived water licencing requirement as a bottleneck for any rainwater harvesting initiatives. This was further evidenced by observations of absences of any rainwater harvesting structures in the fields and gardens of typical members of the eDikeni WUA (see Figure 4.13 below).

Figure 4.13: *Tractor-ploughed, rain fed field of eDikeni WUA member in Alice showing no rainwater harvesting and conservation structures (taken by researcher, December 2, 2014)*

The exception was Jojo tanks and makeshift concrete tanks for storing harvested roof water in some homesteads that was used mostly for domestic purposes (cooking, drinking and laundry).

Apart from the promotion of RWH&C in the eDikeni WUA business plan, the Agricultural Research Council (ARC) had afforded practical experiences of RWH&C to the same area of Alice (also known as eDikeni) through training carried out a few years back. Local farmers and extension officers from Alice were involved in the training whilst extension officers from neighbouring Middledrift received adequate exposure. Below is a photograph (Figure 4.14) of the in-field RWH&C practice (called *amadanyana* by local farmers) taken from the garden of one of the ARC project participants tracked by the researcher-interventionist in the process of gathering the history of RWH&C in the Nkonkobe Local Municipality.

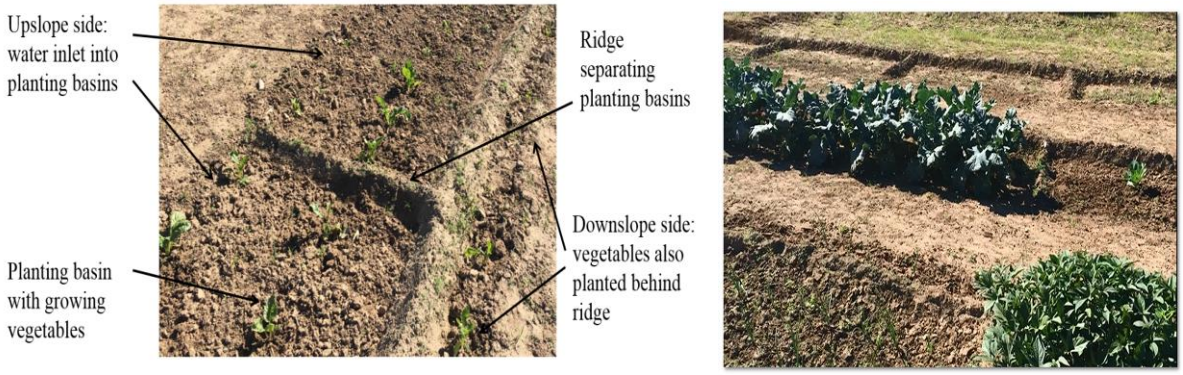


Figure 4.14: *In-field RHW&C carried out by a farmer in Khayalethu village trained by the ARC; Right: Some production in the amadanyana (photos taken by author, March 19, 2015)*

The principle of capturing runoff in the infield RWH&C tied ridges is quite clear in plate 4.4, which illustrates the action of basins opening to runoff water in the upslope of the land, and concentrates it in basins where it is forced to sink into the soil. Figure 4.14 also shows some of the production that was seen taking place in the infield RHW&C structures.

What is apparent in the tied ridges above (both photos taken at one site), and from a second site was the lack of mulching to reduce water loss. Only a fraction of the **germ cell** (capturing, storing [in the soil] and using) appeared to have been internalised by these farmers, thus giving room for expansion of the object at this stage of development. The practice of *gelesha* discussed in section 4.2.1.1 provided a powerful germ cell for the capturing, storing and sinking of rainwater and its use (Pesanayi, 2016a).

4.2.2 The Agricultural Extension activity system and its internal contradictions

Extension officers advise farmers. The Extension activity system is based on extension services in the Alice and Middledrift extension offices, connecting along their hierarchical chain with their higher offices at regional, provincial and national levels. Agricultural Advisors and Extension Technicians, generally called Extension Officers in this case study, operate under the Eastern Cape Department of Rural Development and Agrarian Reform. The Extension Officer's activity system is very closely related to that of the small-scale farmers because public extension services are mandated by government to offer advisory services to these farmers and engage them through various extension approaches that broadly consider extension as education. The multiple extension approaches recommended for South Africa from research commissioned by the government include technology transfer, advisory, project and participatory extension the latter of which expects farmers to "take the lead and think about their own problems and their solutions" (South Africa. Department of Agriculture, 2005, p. 16). The activity triangle in Figure 4.15 below attempts to represent the Extension activity system following the object of water for food and, to some extent, the object of seed system support.

4.2.2.1 Case study 4 South Africa: Alice and Middledrift Extension Activity system

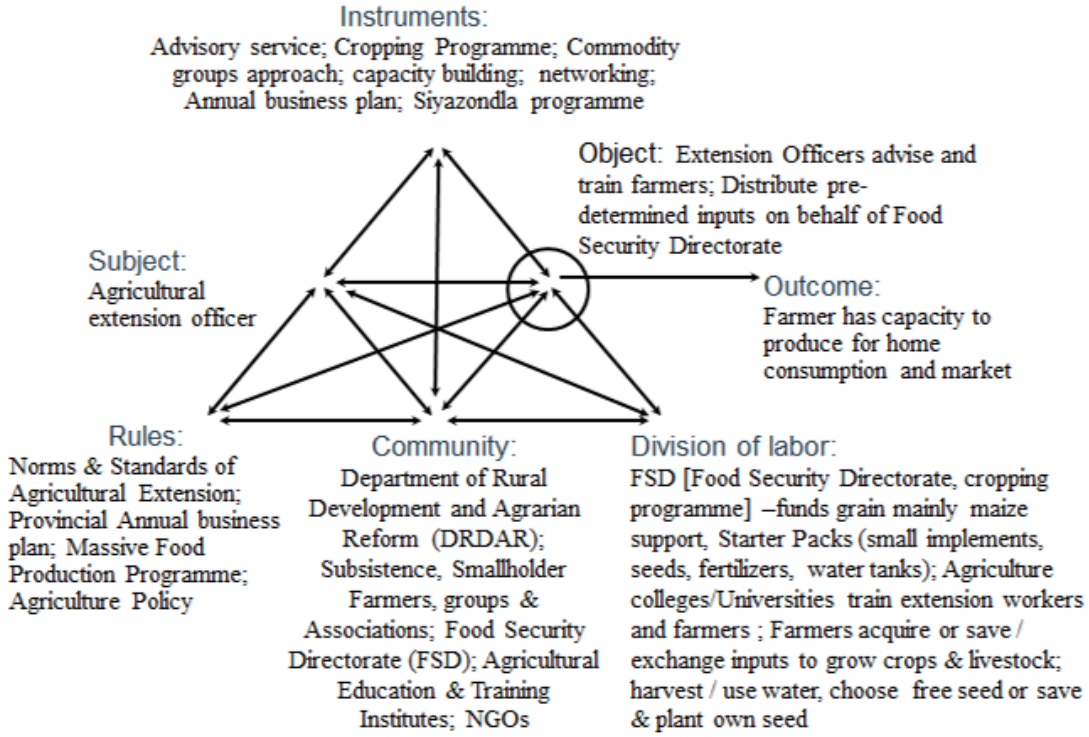


Figure 4.15: *Agricultural Extension activity system in the South African case study*

In Figure 4.11, the elements of the agricultural extension activity system are shown, with the object forming the defining feature, that is extension officers / advisors (subjects) work on advising and training farmers. In this case, it entails providing predetermined inputs (such as GM seed through the Cropping Programme as part of the artefacts and tools) in accordance with the provincial government's approach to food security (see section 2.3.2.4). More instruments include the commodities approach, the Siyazondla programme (see excerpt 4.6 and section 2.4.5.1), the annual business plan and agricultural shows as conceptual tools listed under 'instruments' that are used to mediate the work on the object. The expected outcome is that farmers are food secure and can generate income by selling surplus. In so doing, the extension officers are guided by some binding rules such as the norms and standards of extension and advisory services (see Chapter 2), targets provided by the Provincial Agriculture Annual Business Plan, the Agriculture Policy and the provisions of the MFPP (see section 2.3.2.4). The producers of these rules are part of the community that influences this activity system, for example DRDAR, rural small-scale crop, horticulture and livestock farmers and homestead food producers, and ATIs, each with its own role in the division of labour.

The major challenge in the extension officers' object of activity is the promotion of food security without a concerted effort to promote water for food necessary for successful dryland farming. While the climate of the study area is drought-prone, rainwater is becoming increasingly scarce due to climate

variability and change, hence a climate-proof solution is needed as long as farmers depend on rainfall for watering crops and vegetables. A senior agricultural extension manager described the link between climate, climate variability and crop yield in this need state as follows:

> *Excerpt 4.19 (Interview # EDSA1, February 8, 2016)*
> ***EDSA1:*** So it's really a concern... Over the past years, we haven't achieved the planned yield of the crops. Now in our food security programme… called Cropping Programme we grow mainly grain, specifically maize. Our target is to achieve five tons of maize. Under dryland, we normally get between 2.5t and 2.3t OK… *one of the reasons for that is unpredictable climatic conditions*... Of course, this season has been the worst with *exceptional circumstances of drought. Even under normal conditions, we don't get good rains especially in the area where you are doing this research.*

Water scarcity is increasingly affecting food production ("unpredictable climatic conditions"; "we don't get good rains" – excerpt 4.19). However, there was also an acknowledgement of lack of deliberate extension-wide water for food support in the extension plans from provincial to local level (see excerpt 4.20):

> *Excerpt 4.20 (Interview # EDSA, February 8, 2016)*
> 1) ***Researcher 1, R1***: We talked to the people on the ground – farmers, agricultural college lecturers and extension officers and there was a strong indication of a need to learn rainwater harvesting... So… we ended up working together.
> 2) ***EDSA1:*** Umm
> 3) ***Researcher 2:*** OK I am aware like eh... you are involved in a lot of things but then since my research is in RWH, … what are the concerns regarding water issues here?
> 4) ***EDSA1***: *They wouldn't be concerns of the extension directorate it concerns the other directorate particularly* …we have got a *food security directorate ok, it's the one that oversees the actual production*. Ok now, *they do that with our assistance because we have got the personnel, they have got the finances to assist the farmers* and all of that.
> 5) ***Researcher 2 and Researcher 1***: OK
> 6) ***EDSA1:*** *Like I said... it's the concern of everyone especially in this point in time where drought is affecting a lot of communities.*

From the dialogue above it is clear that the Food Security Directorate is responsible for crop production and by default, issues of water for food and seed systems. The problem, however, is that they do not have people on the ground. They rely on the extension officers in the Extension Directorate to be their foot soldiers on the ground; "they do that with our *assistance* because we have got the personnel" (dialogue turn #4).

- **Manifestation of a primary contradiction #4 in the object: Extension activity system**

There is *a manifestation of a structural level contradiction embodied in the extension officer's object and his work on behalf of the food security directorate in the form of:*

> *An internal* ***conflict within the object of the extension activity system: advice on food security in crop, horticulture and livestock production versus absence to poor water-for-food advice to small-scale farmers thus compromising food security.***

This is a manifestation of a primary contradiction in the form of a dilemma as indicated by the hedges (see section 3.2.3.1) in the discourse in excerpt 4.20 (e.g. "*Like I said... it's the concern of everyone*" in dialogue turn #6 versus water issues "would not be" our concern in dialogue turn #4). On closer analysis, however, the contradiction in its historical development carries issues emanating from what is described as a historically bifurcated and dysfunctional extension system to a desire for an efficient, accountable and streamlined extension support function (South Africa. Department of Agriculture, 2005; Greenberg, 2013; see also section 2.4.5.1). An analysis of the operational plan of the Eastern Cape Department of Rural Development and Agrarian Reform (DRDAR) further surfaces the contradiction. The DRDAR operational plan is the unit's annual business plan that operationalises and aligns with the strategic plan, budget and annual performance plan (DRDAR, 2015). The operational plan informs individual work plans for all departmental staff and of particular interest, the extension staff.

There is a virtual absence of sustainable water for food and seed system alternatives relevant to rain fed farmers and a comparative over-emphasis on irrigation in the Operational plan of the Eastern Cape DRDAR. Among the activities of the quarterly targets, one activity close to the object of alternative water for food is "monitor and maintain research trials on cereals, legumes, tillage and cropping systems, climate smart agriculture and indigenous knowledge systems" (DRDAR, 2015, p. 86). I used 'virtual' in the opening statement in this paragraph because the extension officers implement a small programme (Siyazondla) that distributes rainwater harvesting (Jojo) tanks among other things to only a small selection of farmers as described earlier in this section. Water captured in these Jojo tanks is used mostly for domestic purposes (Interview #FSA1, September 3, 2014). The way extension supports farmers as a group aggravates this contradiction to a secondary one as discussed below.

- **Manifestation of a secondary contradiction #5 in the Extension activity system**

The object of the Extension Officer/Advisor's activity is to advise farmers on matters concerning their production within a commodities organisational framework as indicated by an extension officer (EOSA1) in excerpt 4.21.

> *Excerpt 4.21: (Interview #EOSA1 Audio Transcript, July 15, 2014)*
> ***EOSA1:*** *We identify commodity groups; commodities that are existing there in those wards...* Though we have these commodity groups per village ... then they have their structures there and then those structures make up a village farmers association. The village farmers' associations then come and affiliate to the (area) farmers' association *so it makes it easier for us to work with them*. ... This is how we work, through groups. *However, we have a dilemma when an emerging farmer such as X deserves material support*. Sometimes we end up giving them.

From the commodity group-focussed extension approach described above, a discursive manifestation of a contradiction is expressed as a dilemma in the effectiveness of extension support to deserving farmers (see section 2.4.5.1). As a rule of the provincial extension policy, extension officers may not provide individual support to farmers even when they need it, despite demonstrating their individual agency and multiplier potential. The commodity groups are tailored according to government agricultural priorities to which budgets and plans for extension support are aligned and may not be reallocated (see case study 3 above). Extension officer EOSA1 described the problem as "but in reality, when the budget is loaded, it will be loaded for this one …We don't know where to get the money from the government that's the problem" (excerpt 4.16, dialogue turn #9). Farmers operating outside these commodity groups even due to variety divergences (such as the OPV versus GM maize discussed under Matole Basin case study above) or excelling beyond others, tend to have to progress alone. A senior extension manager (EDSA1) further highlighted the dilemma faced by extension officers in the targeting and provision of material support to farmer groups as having limited success. "Sometimes those starter packs that we provide end up being sold by recipients … not everyone is interested in agriculture" (excerpt 4.7). This is a problem of providing generic pre-designed solutions in planned change interventions (see section 3.4.2). This reveals a dilemma between the object and the tools of the extension officers' activity system that can be expressed as follows:

> ***The object of the extension activity system is to provide advice and material support to farmers guided by commodity group formations (tools) but these groups are not always coherent and functional such that material starter pack support ends up being provided to groups that either do not need them and thus end up selling them instead of to deserving individual farmers.***

Sometimes the deserving individual farmers do not get assistance because they are not operating in prescribed government Cropping Programme as discussed under case study 3 above. A different level of contradiction is described below.

- **Manifestation of a tertiary contradiction between the object of the agricultural extension activity system and the object of a culturally 'more advanced' activity system**

The National Department of Agriculture, Fisheries and Forestry (DAFF) has a research programme on rainwater harvesting that produces results from pilots that are recommended to the provinces for roll out. Unfortunately, farmers do not benefit fully. There was a perception within management at DAFF's Directorate of Water Use and Irrigation Development that RWH&C are trivial solutions, as shown in excerpt 4.22 from an extension manager (EMSA2) from DAFF, below.

Excerpt 4.22: (Interview #EMSA2 Audio Transcript, March 3, 2016)

1) ***R1:*** The move from pilots to rollouts. …what is hampering that, because you said the pilots were successful?

2) ***EMSA2:*** What hampered that is the criticism; … By then our senior manager felt we are "*really playing with our Black people". … he saw irrigation of food production at the bigger scale without considering that you can do more at the smaller scale*. So, now he crushed the idea to say … "you are bringing all these *small, small things while our White counterparts started big and they are big now"*. With the challenge, the resources are not there… And our kids they don't know these things. … so you can try everything but *if the idea is not conceptualised at a higher level then you will never get any support at all*.

The Agricultural extension activity system in Alice and Middledrift has had several opportunities of interacting with alternative water for food options relevant to small-scale rural farmers in at least three ways. These are the Siyazondla programme within their own institution, Agricultural Research Council (ARC) training and demonstration plots (see section 4.2.1.1 and excerpt 4.22) and recommendations from RWH&C pilot studies done by DAFF's Directorate of Water Use and Irrigation Development. These are represented as strengths and opportunities in Figure 4.12 (left column). Excerpt 4.21 above and 4.23 below show that the national Department of Agriculture (DAFF) conducts research and pilot studies of alternative water for food options that are relevant to farmer contexts (see section 2.4.5).

Excerpt 4.23: (Interview #EMSA2 Audio Transcript, March 3, 2016)

1) ***R1:*** When you are looking from a national point of view what is the Directorate's view of the importance of rainwater harvesting?
2) ***EMSA2:*** At national level, we do value issues of rainwater harvesting. *There are projects that were piloted in our Directorate* in the Free State, in Limpopo together with Department of Water and Sanitation. Everything was documented and *the challenge is the GAP between national and the provinces*. Those projects were successful because we were looking at all kinds of rainwater harvesting…not focussing on the rooftop… also ground harvesting...
3) ***R1:*** OK.
4) ***EMSA2:*** So *those things were found to be successful* but in terms of implementation there is a linkage in terms of where the budget will come from. *The Provinces liked it but they were unable to continue with the project because they were lacking budgets and even other things that come with the project*.
5) ***R1:*** Ok how do you think that could be corrected…? …
6) ***EMSA2:*** Ah you know *budget comes from national but in terms of budgeting it comes from the provinces* – province has to outline… that this is what we want to do... As national, we accept … but if it doesn't come from the province *we don't impose*.

The weaknesses of ambivalence shown in Figure 4.16 in poor valuing of RWH&C are derived from excerpts 4.21 and 4.23. A senior manager saw RWH&C as "small, small things" used for "really playing with our Black people" (dialogue turn #2, excerpt 4.22). He preferred rather to pursue "irrigation of food production at the *bigger scale*" without considering that "the resources are not there" and that more food security can still be achieved by implementing water for food innovations "at the smaller scale" (ibid.). In addition, small-scale RWH&C pilots were "found to be successful" (dialogue turn #4, excerpt 4.23).

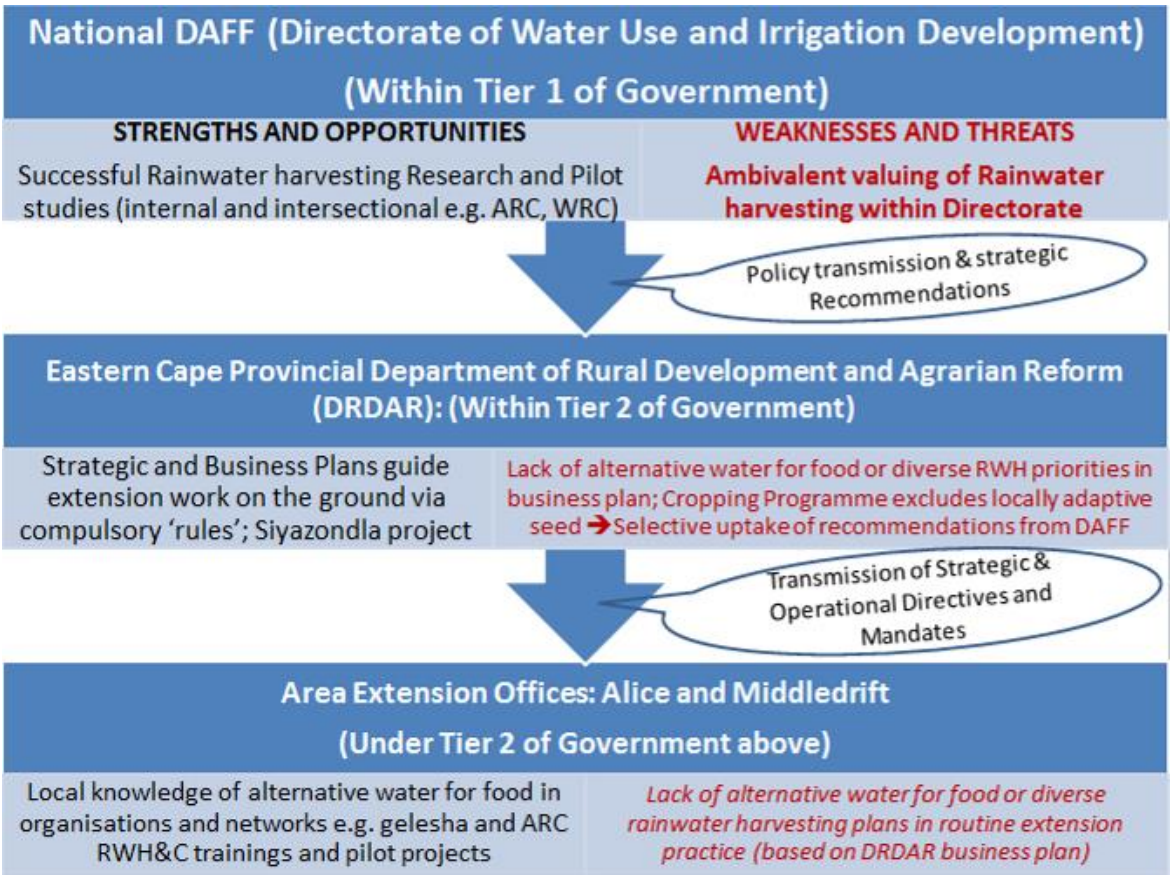


Figure 4.16: *A simplified strengths/opportunities and weaknesses/threats analysis of alternative water for food options available to extension officers and farmers in the study area*

The weakness of poor transfer of RWH&C pilots from national to provincial level can be attributed to its weak representation in policy and therefore in budgeting processes ("the Provinces liked it but …were lacking budgets", dialogue turn #2, excerpt 4.23) and ("the challenge is the GAP between national and the provinces", ibid.). There is probably a boundary in the three-tier system of governance gate keeping the transfer of good practices from national to provincial levels. Provincial extension business plans however easily transfer to the local extension level as a mandatory process. This means that if provincial extension plans were to integrate RWH&C, then it would show in routine extension practice.

At a local level, extension officers were involved in ARC training on a specific In-field RWH&C practice but were facing challenges to roll it out to farmers as shown in the excerpt 4.2.4 below.

Excerpt 4.24: (Focus Group Interview # EOMSAFGI1, July 15, 2014)

1) ***EOSA1:*** For it to be rolled over here, ehh I don't know, what can I say but they were trying that farmers from the neighbouring places like ourselves and Fort Beaufort to go and copy that *but I don't know, I don't want to talk bad about the farmers or the people's perceptions* because *when there is a project and there is funding, there are many people who want to participate... But when there is no funding and one has to start it on his or her own then you find that less people are interested*. ... They saw the

yield; they saw everything even the ones in the villages, the ones who were members of the programme. By the time the project went to the fifth year, they were few. …

2) ***R1:*** What will be the dynamics, challenges with a technique like madanyana?
3) ***EOSA2:*** People have to go and do. If you have one hectare then you have to make sure that you do it physically yourself… do you have human power for that, are the people willing to sweat to do that? Those are the things.
4) ***EOSA3:*** And mostly we are dealing with the *older people* so that is also a challenge.

The discourse in excerpt 4.24 reveals hedges and hesitations ("*but* I don't know, I don't want to talk bad about farmers" … "*but* when there is no funding… less people are interested" dialogue turn 1; EOSA1) that indicate a dilemma in the pursuit of a RWH&C object as a more culturally advanced activity. Two other extension officers added their hesitations to the discourse ("*if* you have one hectare… do you have the human power for that?", dialogue turn 3, EOSA2; "dealing with older people … also a challenge" dialogue turn 4, EOSA3). The hesitations all have to do with blaming farmers' deprived capabilities in terms of their attitudes to funding, labour and age and lack of agency even in the face of demonstrated success ("they saw the yield, they saw everything" dialogue turn 1; EOSA1). The new mediation tools provided by the ARC experiences were criticised as unsuitable for the local farmers because of the perception that they were linked to a donor dependency syndrome and are labour intensive. The possibility of using *ilima* (collective pool of labour) was not mentioned as a possible response to the labour problem and will be explored in Chapter 6.

These dilemma and absences above indicate a manifestation of a tertiary contradiction in the agricultural extension activity system as illustrated in Figure 4.17.

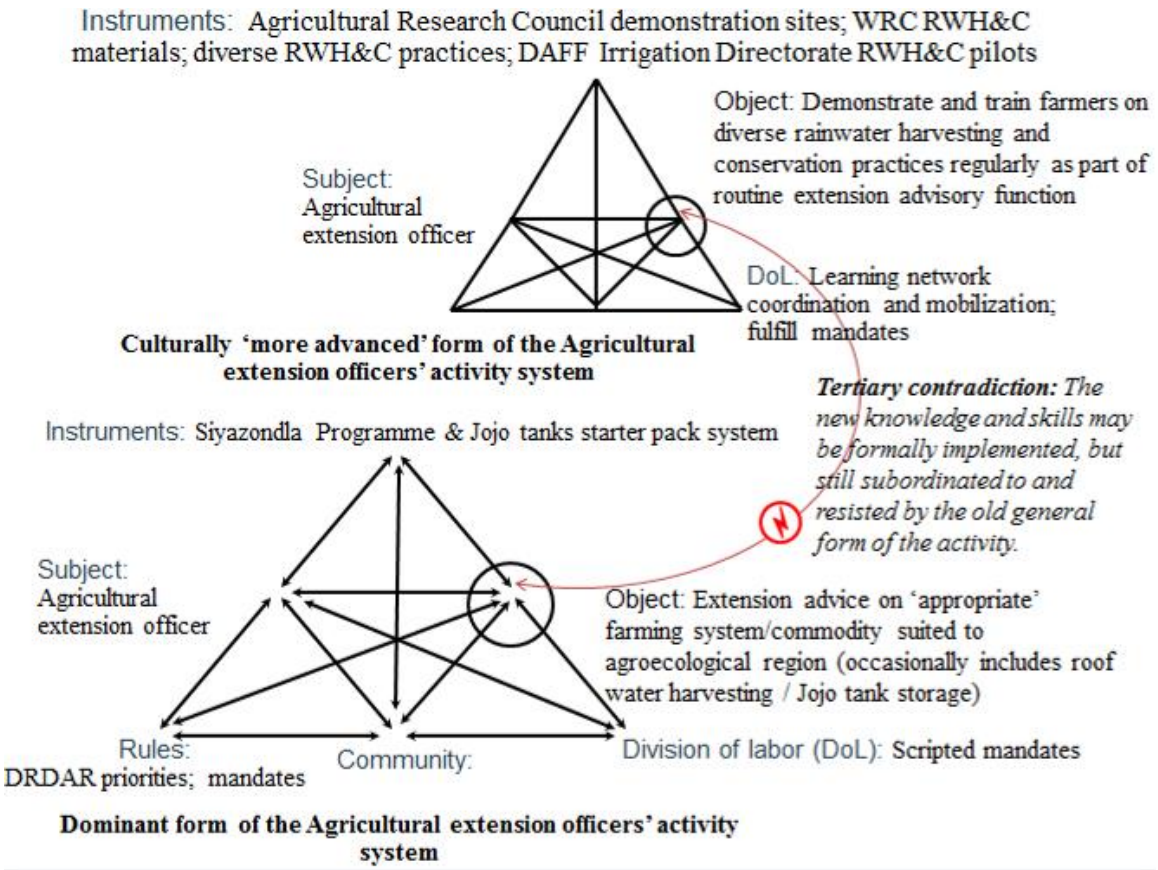


Figure 4.17: *Tertiary contradiction between the dominant form of the agricultural extension activity system and a culturally more advanced form of the same activity system*

Figure 4.13 illustrates a manifestation as a tertiary contradiction as:

> ***A conflict between the old general form of the extension activity system that is dominating with regard to assuming irrigated farming in rural crop and homestead food production versus new knowledge and skills provided by rainwater harvesting pilots from DAFF, local ARC training and WRC training materials that are still subordinated.***

There was a challenge regarding whether rainwater harvesting was culturally more advanced compared to ordinary rain-fed farming. In this case, the provision of irrigation was considered by an influential senior manager in the national agriculture department to be the only serious option to be pursued *instead of* rainwater harvesting thus leaving the latter subordinated and of low priority. Mukute (2010), as discussed in Chapter 3, also noted this type of tension. The tertiary contradiction manifested here appears to be based on a comparison of two ends of the bifurcated agricultural system and an expectation of leap frogging to what the perceived advantaged class had arrived at in view of the democratic dispensation ("our White counterparts started big and they are big now" excerpt 4.21). This thinking seems to have its roots deep in the pro-democracy government philosophy, as shown in excerpt 4.25 below in conversations with a LED agency senior manager (NEDSA1).

Excerpt 4.25: (Interview # NEDSA1 Audio Transcript, November 6, 2015)

1) ***NEDSA1 Officer*** 1: We in South Africa *we have a problem. We like big*… projects, big buildings…we don't know that the journey of a thousand miles begins with a step. When we want to do things we want them to be big. Big projects. So when for example X did dam scooping with these interns and a couple of small farmers using their shovels and picks, you know, just over a day I don't think they were working the whole day this contributed because there was water that collected in that dam.
2) ***Researcher, R1:*** Amazing.
3) ***NEDSA1:*** So when you talk to people about those types of projects *they say aah we want the b-i-g things*, the ex-ca-vators. Jaa.
4) ***R1***: They don't believe in small projects?
5) ***NEDSA1:*** They think that '*we have big problems that need big solutions'*.
6) ***R1:*** OK.
7) ***NEDSA1***: But sometimes when you have got big problems you require small solutions. I also think its confusion with regards to technology. *They confuse technology with solution. If its advanced technology, big and its massive we confuse that with solutions to our big problems* and … We had this big backlog. So at the time when [President] Nelson Mandela came, the expectation was that they wanted to come up with this big bang approach to the solution. … So huge projects, not small ones. So *I think these created an impression that we can have this one solution*. The Presidency was quite powerful in terms of planning.

A senior LED agency manager (NEDSA1) in excerpt 4.25, dialogue turn #7 ("sometimes when you have got big problems you require small solutions"), also proposed the efficacy of small solutions proposed by an extension manager (EMSA2) where appropriate. He observed that people had an obsession with big solutions linked to technology to catch up on a "backlog" of development, feeling that small solutions were ineffective. This thinking may be one of the generative mechanisms causing poor integration and thinking of alternative low-tech water for food solutions. The tertiary contradiction manifested in the extension officers' activity system may thus be:

> ***The object of the extension activity system is directed by large-scale commercial farming policies and dominated by normative agriculture water thinking and training that promotes large scale irrigation solutions in theory at the exclusion of water for food solutions suitable for small-scale rain-fed farming systems (dominant form of the activity) Versus demand for practical extension advice and water for food solutions such as rainwater harvesting and conservation that are context-relevant for dominant rain-fed farming and homestead food production systems with a past and contemporary history of exclusion and cultural reduction (culturally more advanced form of the activity)***

The manifestation of a tertiary contradiction above reveals a need state within extension services for an effective way of supporting farmers in their diversity. This need may find fulfilment beyond the extension officer alone as suggested by ASSAf (2017)'s knowledge triangle (see section 2.4.4.2). The next section discusses the agricultural lecturer (or educator) activity system

4.2.3 The agricultural education activity system and its internal contradictions

The agricultural education activity system in the South African case study consists of highly trained university agriculture graduates possessing a range of qualifications from Honours degrees up to PhD, appointed as lecturers / educators. These are the subjects in the activity system. These educators are either lecturers teaching on formal courses aimed at producing agricultural college diploma graduates who will become extension officers / advisors, commercial crop or livestock farmers or agri-business managers among others; or are farmer trainers supporting non-formal training on demand. The former also support farmer-training courses in their specialised areas. Specialised training areas are embedded in the diploma courses and revealed by the lecturers' specialisations. They include soil science, crop production and horticulture, agricultural engineering, animal science and agribusiness among others. The case of focus for this study was Fort Cox College of Agriculture and Forestry (which later became Fort Cox Agricultural Training Institute (ATI)[18]).

4.2.3.1 Case study 5 South Africa: Fort Cox College of Agriculture and Forestry

Fox Cox College of Agriculture and Forestry (referred to as Fort Cox College for short) is located in the Middledrift area of Nkonkobe Local Municipality in Cwaru Village. The College offers two programmes, namely a Diploma in Agriculture and a Diploma in Forestry (FCC, 2015, p. v). These academic programmes received full accreditation from the South African Council for Higher Education (CHE) in 2002, a status that was re-affirmed in 2004 and remains to date (2017). The academic programmes were re-accredited in 2012. The College vision, mission and motto: *"Not for oneself, but for the people",* points towards farmer-friendly, innovative, quality and sustainable agricultural education practice (FCC, 2015, p. ii). The College was established in 1930 making it one of the 'Historically-Black public institutions' in South Africa. Fort Cox College was granted autonomy in April 1990, a status that it has to date. In 1991, the College became affiliated to the University of Fort Hare. Fort Cox College also has a unit dedicated specifically to rural development. "We also have a Rural Development Centre that is busy with a youth training programme" (ACLSA1, personal communication #FCCSA1, June 10, 2014). A more detailed case description of Fort Cox College is found in Appendix 4.3. Figure 4.18 illustrates the Agricultural Education activity system.

[18] Note that this transition was taking place while the study was taking place. I therefore use Fort Cox College in this thesis.

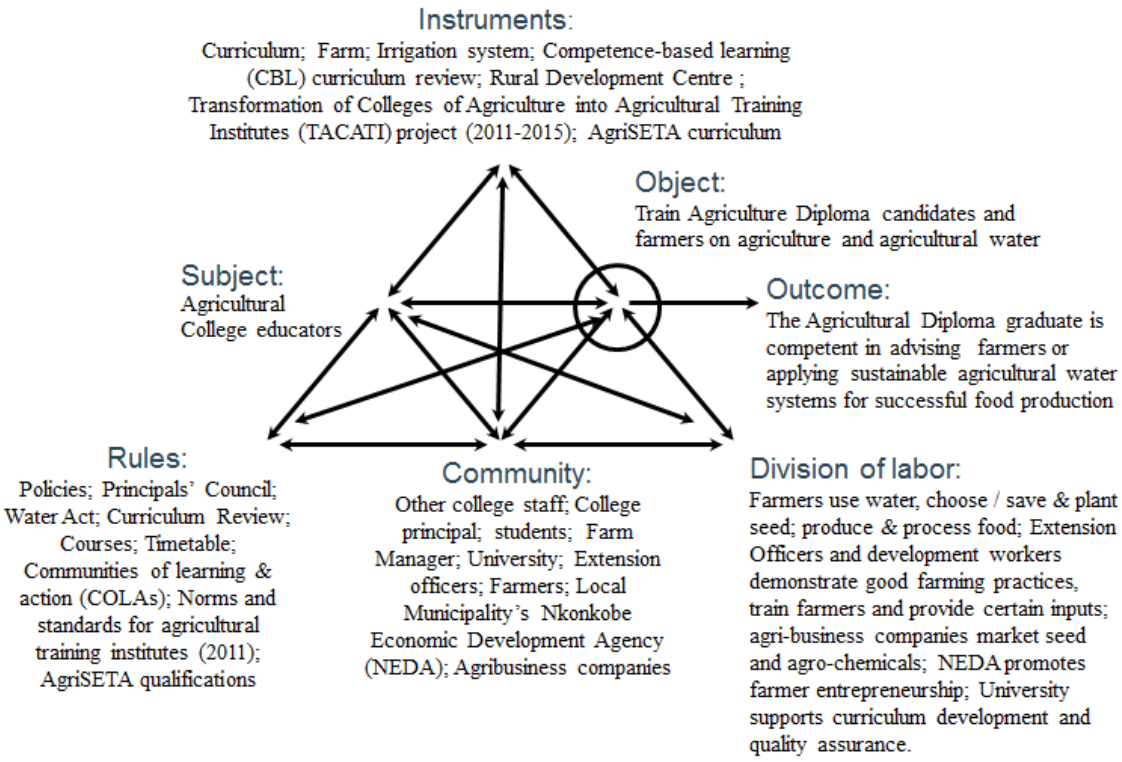


Figure 4.18: *Agricultural Education activity system in the South African case study*

The activity system shown in Figure 4.18 indicates that the object of agricultural college educators is to train diploma students (and practising farmers upon demand) in agricultural production principles and practices, including the use of water specifically. Water is an essential input for successful food production, which is the desired outcome of working on the object. Being a formal institution, the agricultural college has rules that guide the operations of the agricultural educator such as meeting set standards, operating according to the set teaching timetable and implementing resolutions of the principals' council and the COLA (see sections 1.5.1 and 2.7). Government sets laws, policies and regulations on agricultural education and training. These come in the form of Norms and Standards for ATIs, National Qualifications Frameworks, Agricultural Sector Education and Training Authority (AgriSETA) standards and the Water Act, among others. The community and its division of labour includes other college staff in management and general work, students as learners, farmers as learners and providers of student practical farming experiences, extension officers as supporters of extension training and university staff supporting the college as board members and research associates. The primary contradiction in the object of the agricultural college educators' activity system was analysed from empirical data.

- **Manifestation of a primary contradiction #PCAESA1 in the object of the agricultural education activity system: Fort Cox College of Agriculture and Forestry**

Agricultural college educators faced a *dilemma* between their two-fold responsibilities of completing teaching a course of study stipulated in the syllabus to ensure students' readiness for an examination through business as usual, and at the same time ensuring enhanced quality teaching and learning that are relevant to (newly realised) rain-fed farming contexts. In practice, these two responsibilities were incompatible because there was no space in the timetable to innovate the curriculum with content that was not emphasized in the written curriculum. Such internal conflicts in educators characterise dilemmas as they demand difficult choices to be made on a daily basis especially when time is limiting. The following series of excerpts from several agricultural college lecturers from different disciplines revel a manifestation of a primary contradiction in the object of water for food.

> *Excerpt 4.26: (Interview #ACLSA2, July 15, 2014)*
> ***Researcher, R1:*** ... you are … an agricultural engineering lecturer although you are teaching other subjects here … what is the focus of your curriculum with regards to issues of water?
> ***ACLSA2:*** ... currently of the courses we are teaching here I can say *the one that deals more with water issues is irrigation principles*, the one that we are teaching for the Crop Production and Animal Production options. … So in the irrigation principles that's where we have got some items on water resources, the water efficiency, systems applications, etc. but *we don't necessarily have something specifically on water harvesting*.

The excerpt 4.26 above from an Agricultural Engineering teaching perspective shows that there is a dominance of conventional irrigation, water resources management and water efficiency teaching, and an absence of teaching specific water alternatives such as rainwater harvesting and conservation that bare relevance to rain-fed farming systems. A Soil Science lecturer (ACLSA3) indicated that RWH&C is actually reflected in the curriculum but only nominally on realisation that it is not seriously integrated in an appreciable depth. ACLSA3 realised the need and indicated that it can be fitted in some courses as follows:

> *Excerpt 4.27: (Amanzi for food course assignment #DIBSA6f, July 3, 2015)*
> ***ACLSA3:*** *… fitting it in the courses such as soil and water conservation (SS 221 and SWC 211) and Irrigation principles that implicitly* cover RWH&C. I believe that the above-mentioned courses must cover RWH&C in depth rather than the way it appears in the curriculum now. An example is that in SS 221 and SWC 211, *RWH&C is covered only as the examples or introduction.*

The curriculum had some but seemingly uncoordinated knowledge of other water for food teaching happening in various sections. Lecturer ACLSA2 described it as follows:

> *Excerpt 4.28: (Interview #ACLSA2, July 15, 2014)*
> 1) ***ACLSA2:*** ...There is a course called Soil and Water Conservation. ... So in that course I haven't looked at the content per se but you might find that *it doesn't have something specific on water harvesting*. But the other water conservation techniques like mulching etc. I am sure ... is teaching all that kind of stuff.

2) ***R1:*** But with some of the current activities that are happening now if you had adequate knowledge of RWH do you think …that has an opportunity to integrate in any area?...
3) ***ACLSA2:*** Definitely, because *it is a subject that is just being ignored*. *Not that it's not important, it is very important*. And water is scarce almost everywhere. Here in the Eastern Cape you can get water probably during the rainy season adequately if you know the areas. But you will find in winter people are stuck, they can't do any cropping activities. *So I don't know why for one reason or another water harvesting has been neglected*.

In the discussions above, it can be seen that agricultural water pedagogy is biased towards irrigation and neglects or ignores (excerpt 4.28, dialogue turn #3) alternatives that can work for rain-fed farmers such as RWH&C. The soil and water conservation course referred to is shown in outline in an extract in Figure 4.19 below:

SS 221CP	**SOIL AND WATER CONSERVATION**
Objective	An introductory course that is aimed at building the students' understanding the sensitivity of the soil and how it can be utilized sustainably by conserving it
Course Outline	Soil Erosion (types, causes, prevention and control), Reclamation of degraded lands, Soil conservation techniques (contours, ridges, terracing etc.), Water conservation techniques, Rainwater harvesting (infield and outfield), and Loss of water in the field.
Instruction	2 lectures/week/1 practical (mulching, soil moisture measurements, constructing, constructing water conservation structures, determination of evaporation)
Assessment	Two major tests, one- 3 hour examination, practical reports, assignments, presentations
Credits	8
Pre-requisite	SS 212CP

Figure 4.19: *Extract of an agricultural college SWC course (source: FCC, 2015, p. 62)*

Figure 4.19 shows that 'rainwater harvesting' is mentioned in the course outline indicating that its importance is recognised in the written curriculum (College prospectus) and therefore that it can be taught and examined. The actual teaching and practical work on RWH&C was however missing "water harvesting has been neglected" (excerpt 4.28, dialogue turn #3). This educators' activity system therefore shows a key **manifestation of a primary contradiction in the object of <u>agricultural water</u> in the Fort Cox College curriculum** as a follows:

> ***Teaching and learning of conventional technicist irrigation systems in the diploma course for potential extension graduates and in farmer training programmes versus alternative low-tech knowledge practice demands for rain-fed solutions in the agricultural college curriculum***

The primary contradiction in the object 'Train Agriculture Diploma candidates and farmers on agriculture and water for food' thus appears to the agricultural college educators in two competing forms. Firstly, it is a reproduction of conventional agriculture and water for food teaching text and

discourse to enable success of students in the exams presumably "in line with the (agricultural) industry" (FCC, 2017, p. v) and labour market. Secondly, the training has an expectation of using the curriculum to support students to master their own future work relation and service to society outside the college when they become farmers or agricultural extension advisors.

The above manifestation of a primary contradiction, which presents as a dilemma, has a past and contemporary history discussed in the section below (see also Chapter 2) that shows the impacts of agricultural and water policy, the role of apartheid laws and the role of interventions (see Figure 4.16).

- **Historicity of the object of agricultural water at Fort Cox College**

The object of agricultural water has evolved over time with a dominance of a conventional irrigation system and side experiments on infield rainwater harvesting and conservation brought in either by NGOs or through student projects facilitated by lecturers as shown in the extract below.

Excerpt 4.29: (Interview #FCCSAFGI1, June 10, 2014)

1) ***Researcher, R1:*** (raised a question regarding Fort Cox College's networking potential)
2) ***Leading lecturer, ACLSA1:*** There *at least we have open fields where we could make a comparison study between the traditional and RWH techniques...*
3) ***ACLSA2:*** Farming God's way, Foundations for Farming.
4) ***ACLSA1:*** O yes, they started as Farming God's way. *They established a plot, is it still running*? Anyway, that is purely on those types of principles. *No-till, making your own compost you know.*
5) ***Researcher 2:*** Where is that?
6) ***ACMSA2:*** By the nursery,
7) ***ACLSA2:*** We planted for the previous season but this season we haven't planted anything yet. It is basically to do with *conservation farming* whereby they use farming methods that do not disturb the soil too much and using organic fertilisers, composting etc. and also emphasising *the blanket method which is basically mulching to conserve water*.
8) ***ACLSA1:*** The lovely thing about it is that they spoke about it as being one hectare per person; it is an area a person can handle easily.
9) ***ACLSA2:*** Yes they say the smaller the area the better.
10) ***ACLSA1:*** Yes it's sort of the low technique, they only use … a shovel
11) ***ACLSA2:*** They only use available resources; they call it *low cost techniques*.
12) ***ACLSA1:*** Yes, you know they don't need a tractor
13) ***Researcher 3:*** As low as possible inputs?
14) ***ACLSA1:*** We have worked with them as well.
15) ***Researcher 3:*** So do you consider them as a NGO partner, sort of?
16) ***ACLSA1:*** Its nothing like that, they came here and did a course with us and we established that plot so we thought we should work with them to keep the established plot so some of our students were exposed to that.

The dialogue above shows that the college has a recent history of experimenting with alternative water for food that is doable by small-scale farmers, in this case 'alternative' to conventional irrigation

systems that are out of reach of farmers. The changing nature of the object of activity is shown in Figure 4.20 below.

Object historical layers and changes in water for food activity in Fort Cox College of Agriculture and Forestry	Pre-1970s *Cultural disruptions and changes, and gradual loss of indigenous RWH&C practices (earlier RWH&C practices such as gelesha = OBJECT W1)* "'agriculture' / 'gardening' activities undertaken by African pupils *associated with impoverished curricula* under colonialism and apartheid". (Paterson, 2014, p. 93). Africans' industrial curriculum intended to improve work capacity not skills, (*ibid.*) Fort Cox College established in 1930 as a 'Native Agricultural' School. Bordering Keiskamma River is source of raw irrigation water for College's crop production.
	Late 1970s – early 1990s *Homeland Act of 1971. Land re-allocated for communal production; system of cooperatives in communal gardens.* Fort Cox College receives treated water from Sandile Regional Water Supply Scheme which also supplies urban centres of Middledrift and Dimbaza and over 50 rural villages in the middle reaches of the Keiskamma River Basin (South Africa. DWAF, 2002). Fort Cox College granted *autonomy* in April 1990 until to date.
	Early 1990s – present (2017) *Abolishment of the Homeland Act of 1971.* New field irrigation system at Fort Cox College of Agriculture and Forestry (1993-1994). Centre pivot installed. [Launch of the College of Agriculture and Environmental Sciences at the University of South Africa (UNISA), August 2006 (South Africa. DAFF, 2008a)] Farming God's way project: no-till, mulch cover and rotations demonstration (isolated, no multiplier effect). Agricultural Research Council project on in-field RWH on farm and Soil fertility from bio-digester sludge and RWH&C at Rural Development Centre spearheaded by Soil Science team (2012) – see Plate 4.5. below. TACATI project (2012-2015): Under the Engineering (Civil & Mechanical) Competency Profile: - Specific Competencies: Design, construct and maintain soil and water conservation structures (contours, waterways…), module topics: Drainage, Irrigation scheduling, Design & installation. Technocentric competence. "2013: Fort Cox College adopted the CBL principles as orchestrated by TACATI project lead by DAFF" (FCC, p. v.). Fort Cox 'Crop Production' curriculum focussed on 'economic crops' (FCC, 2015, p. 56), and introduced students to "major field crops (cereals, *pulses*, and potato)… [cereals featuring] maize, *sorghum*, wheat…" (ibid., p. 59). However practical on-farm cropping systems for staples featured only (GM or hybrid) maize. Sorghum not planted in farm. No direct link made between locally-adaptive seed varieties such as sorghum, pulses and OPV maize to climate change / variability or rain-fed contexts. 'Advanced Crop Production' affords students with learning of "conservation tillage, … tillage systems, production of …*genetically modified crops, organic farming*" (ibid.., pp. 63-64) thus theoretically allowing the curriculum space to innovate with RWH&C and locally-adaptive seed. Plans to harvest water from roofs underway spearheaded by farm manager but terminated upon his departure (2014). Plans not integrated into curriculum. WRC Amanzi for Food project (2014-2016): Training and demonstration plots, curriculum innovation, learning network (see Chapter 6)

Figure 4.20: *Historicity of agricultural water in the Agricultural College Educators' activity system*

The historical analyis was carried out by reflecting on and analysising the mirror data from interviews, photographs, videos and participants' drawings. Participants also narrated how they understood the changes in settlement, land use and water provisioning over different colonial and apartheid time periods. A similar process was carried out with the Loyd Village garden case study (Pesanayi, 2016a) and the other case studies from South Africa and Zimbabwe. It can be seen from Figure 4.20 that a historical transition is traced from teaching a dominance of conventional agricultural water aligned to industry and the apartheid state's social engineering apparatus excluding small-scale black farmers, through a similar state under democracy, and finally to co-engaged type of work in which deliberations are initiated between farmers and agricultural educators. The agricultural educators started placing smallholder, rain-fed farmers at the centre of their curriculum deliberations instead of an exclusive bias on industry, while the farmers took ownership of their own production contexts instead of systematically relying on decontextualized extension advice. Figure 4.21 below shows a demonstration plot (left picture) established by the ARC at Fort Cox College's Rural Development Centre (see Figure 4.20, last time period), and rainwater harvesting potential shown by run-off on college roads (right picture).

Figure 4.21: *Top Left: In-field RWH&C at Fort Cox College established with ARC support; Top Right: Runoff potential (photo by author on 2 December 2014); Bottom: Infield RWH&C demonstration plot supported by ARC, producing peppadew (12 August 2014)*

The productive rainwater harvesting innovation in Plate 4.5 above shows circular beds with dead-level channels that capture rainwater that were developed with support from a project funded through the South African Agricultural Research Council. This horticulture and soil-fertility (from bio-slurry made from animal waste in a bio-digester) innovation forms part of the history of the object of agricultural water at Fort Cox College (see also chapter 6). Staff working near the site were happily harvesting and using the flourishing vegetables and herbs. The project was led by a lecturer at the main campus but apparently not known by many others, being located out of sight from the road at the Rural Development Centre campus, and was not being used for teaching purposes. A similar situation was witnessed at the college farm (also out of sight from the everyday roads used by staff, students and visitors) where a rainwater harvesting demonstration site also supported by the ARC was implemented. Despite a good crop of peppadew (sweet piquanté peppers) developing there, the crop was lost due to lack of harvest and the site was eventually ploughed through by a new farm manager presuming the experiment to be complete. "*The farm [management]... destroyed it. I think maybe nobody gave them the information...* They knew there was an experiment but because they heard that the experiment is over *they didn't wait for the handover*" (ACLSA3 in DIBSA1c, August 12, 2014). A **secondary contradiction #SCAESA1 emerging here between the subject (lecturers) and division of labour** with other staff members not participating in the interventionist research indicates the problem of professionals working in silos. Fragmentation is a trait that is typical of work culture in the agricultural college learning activity system which leads to communication breakdown and information loss as captured in the contradiction below:

> ***Working alternative water for food innovations (rainwater harvesting) which were led historically by some lecturers in the agricultural college were lost in the agricultural college learning system where sharing of information is subjugated by a systemic silo work culture.***

Secondary contradictions emerging from the agricultural education activity system

> **Between the object of water for food and the mediation tools used to produce the aspired competence in a (farmer / extension) graduate**

One of the major manifestations of the problems in the agricultural water curriculum of agricultural colleges is the incapacity of extension officers produced from agricultural colleges to advise small-scale farmers regarding their (increasing) agricultural water problems. An agricultural college lecturer ACLSA3 recognised this problem as follows:

> *Excerpt 4.30: (Interview #FCCSAFGI1, June 10, 2014)*
> ***ACLSA3:*** On the curriculum base, *we are producing extension officers that have to advise the farmers, yet when we give them the theory...* it means that everything they face in the field

they have to go back to the book and *the book does not have the scenario that they are meeting on the ground*.

The potential for capturing runoff water at Fort Cox College is further evidenced by the observations of much runoff and pools of water and pools of water on the college's service roads (see Figure 4.21). In addition to the primary and secondary contradictions identified above, I was also able to identify tertiary contradictions in the agricultural colleges activity system as outlined in Figure 4.22 below.

Tertiary contradiction #TCAESA1 between the object of the agricultural education activity system and the object of a culturally 'more advanced' activity system

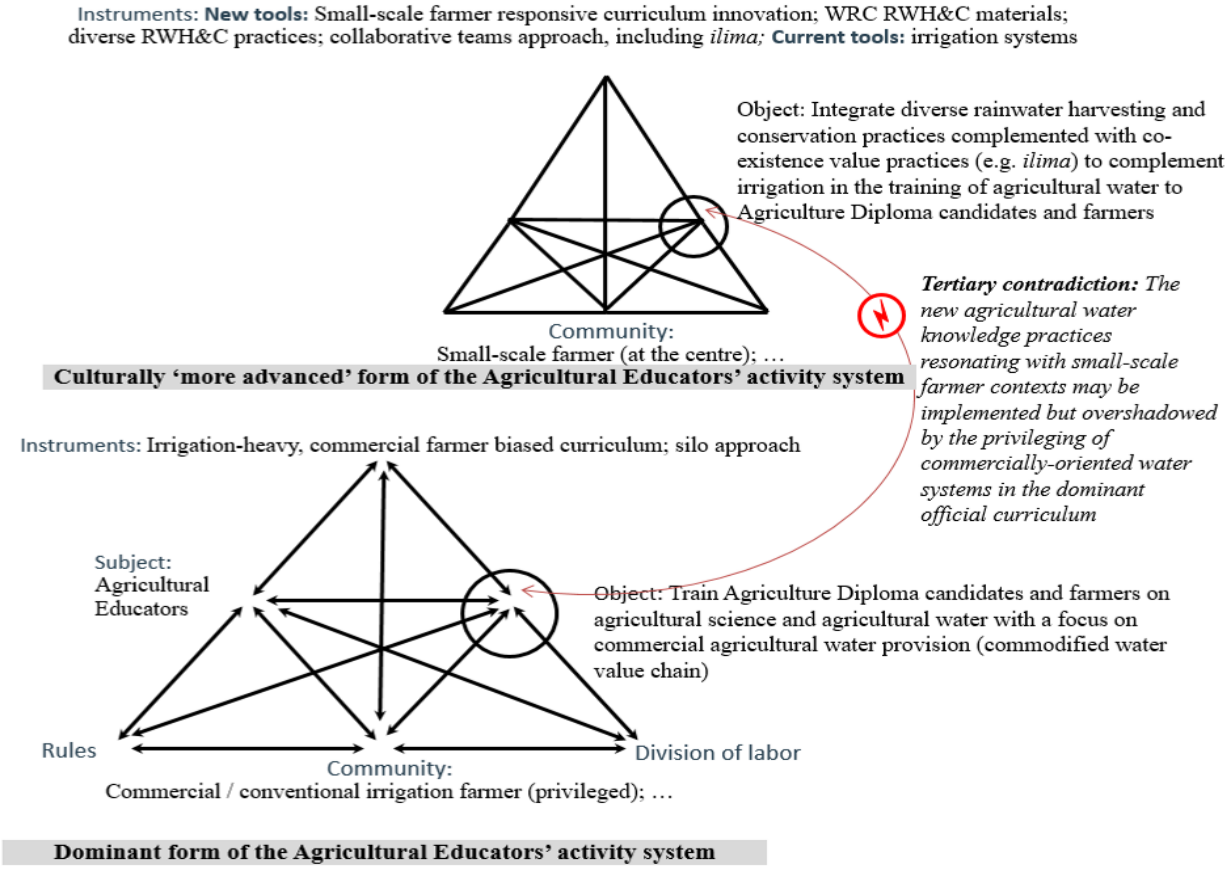


Figure 4.22: *Tertiary contradiction in the agricultural education activity system*

This contradiction, as outlined above, had much to do with the re-imagining of the College's role in not only serving commercial agricultural demands, but also the demands of smallholder farmers who were reliant on rain-fed agriculture. This demand was also reaching the college via the work of the local economic development office who was using its influence and mandate to establish a local system of smallholder farming, supporting local farmers to improve their practice. Agricultural college

lecturer ACLSA3 articulated the need for considering farmer contexts in teaching, using an example of a project by the Agricultural Research Council (ARC) with potential to influence the college as follows, "the ARC were having another site in Krwakrwa ... a small-scale farmer ... That is really what makes agriculture different ... because *it is applied*. That is why *it's important to share*" (DIBSA1b, August 12, 2014). This emerging contradiction was of a 'long duree' and was visible across the life of the project. Its detail is further revealed below as being connected to the introduction of sustainability perspectives into mainstream agriculture curriculum and learning. The citation below shows the college's function as a farmer training organisation through its Rural Development Centre (FCC, 2016) as well as via its diploma programmes, and indicates the agricultural college's connectedness to the Department of Agriculture, researchers, extension workers and in particular, to smallholder farmers, thus providing historicity to this tertiary contradiction.

> *Excerpt 4.31: (Curriculum Workshop #AESACAW1, September 24, 2014)*
> ***ACLSA3:*** Yes. We decided to reshape the curriculum. … Now we again, this was another call by the Department (of Agriculture) that they now require… isn't that we were producing knowing that *our students might be farmers, researchers or technicians, they might be extension officers*. Of which more than 60% will be extension officers.

The curriculum workshop referred to in excerpt 4.31 clarified the college's motive in terms of its intended training product, being graduates who could function as "*farmers, … extension officers"*. The discussion above indicated the high level of connectivity of the agricultural institute to the key agricultural actors in Nkonkobe Local Municipality that extend beyond local boundaries to provincial and national levels. The meaning and depth of 'connected' and the level of learning taking place between the various organisations and their individual agents was interrogated as a new tool [rather than a third object] of collaborative activity in this study with respect to learning alternative agricultural water and locally-adaptive seed inputs. It evolved from an initial position as a tool for the pioneering members (see Chapter 6) of the Imvotho Bubomi Learning Network. The connections in the learning network were thus conceptualised and problematised as described in the sections that follow as they provided further insight into the primary, secondary, tertiary and quaternary contradictions that were surfaced in this case study.

4.3 CONTRADICTIONS IN SUSTAINABILITY PERSPECTIVES INDICATE VALUE OF ASPIRATIONS AND AGENCY IN WATER AND SEED FOR FOOD; INFLUENCING CONTRADICTIONS IN THE ACTIVITY SYSTEMS

As Engeström (1987, 2001, 2016) has repeatedly indicated, activity systems are *dynamic*. Capturing the dynamic nature of the activity systems is often difficult to do, and one can end up representing the

activity systems as 'historical object trajectories' or 'static triangles' (as partially reflected above in Section 4.2). To avoid this, I engage in a discussion here on the object of activity as shaped by complex issues such as sustainability and aspirations and how these shape the contradictions as they surface. Sustainability of agricultural water is a complex and contested concept with economic, environmental and social 'pillars' or dimensions valued or combined in diverse ways linked to motive (see Chapter 1). From the discussions above, it is clear that contradictions in perceptions of sustainability of water and seed for food by small-scale farmers, agricultural educators and extension advisors can yield important data regarding motives and aspirations. I will therefore attempt to interpret these sustainability perspectives further in context and analyse them using inductive reasoning. This process leads to the answering of research question #i (see section 1.4, Chapter 1).

4.3.1 Sustainable water and seed for food needs to satisfy domestic food needs and be reflected in college curricula and extension praxis: Social pillar

Research participants expressed the social pillar of sustainability in various ways including inter-sectorial and intergenerational relational agency in sustainable water development, adaptation to water-stressed conditions and active development of commonality. In the excerpts below, sustainability of water in agricultural learning systems is associated with *professional empathy, harmonious social relations and reciprocity* between the people involved across their activity systems.

> *Excerpt 4.32: (DIBSA1b, August 12, 2014)*
> ***ACLSA3***: The *farmers and extension officers; they know what they want* because they go to the ground and apply. *But we teach what we want* instead of what the extension person *needs.* ... Because *it's us who decides, it's not them.* … So *we are sitting, taking decisions to give these people the education that we think they need, but when they go to the field we are not sure whether that was supposed to have been taught to them* or … they are now asked for something that was never part of their programme of their learning.

The excerpt above shows a ***quaternary contradiction (#QCSA3) between the small-scale farmers' needs and aspirations in agricultural water (object) and agricultural educators' curriculum tools*** ("we teach what we want… it's us who decides)". What the agricultural college curriculum has prioritised regarding water for food is predominantly conventional irrigation systems that are not resonant with small-scale farmers' contexts of affordability and accessibility. There is a social disjuncture between these two agricultural learning activity systems, with the agricultural college lecturer's activity system acting as a tool producing activity system to the small-scale farmers' activity system. This happens firstly and directly through farmer training and secondly and indirectly through extension training reproduced in the extension officers' activity system.

The latter part of the above excerpt proposes an element of a political dimension in the social pillar regarding the need for distributed empathetic decision-making ('what extension needs'; 'them') rather

than hegemonic ('we' and 'us'). What the agricultural college lecturer proposed was essentially to commit an act of what Mignolo (2000) called 'class treason' by joining the farmers in efforts to meet their need for relevant water knowledge flows that potentially transgress conventional agricultural thinking. The problem of curriculum absences in and tensions with household food and water security issues cited above (DIBSA1b) and rigidity of approved curricula was repeated by a university agriculture lecturer (UALSA2) in the excerpt below highlighting the same contradiction:

> *Excerpt 4.33: (WRC 'National' Workshop, DAfFS2, May 11, 2016)*
> ***UALSA2:*** *We design courses according to our expertise,* and they are approved by Higher Education ... *I am to teach what is approved,* then *I cannot come and change the curriculum as [X] and say I should put household issues into that*. So that is the major problem.

In the above immanent critique, this university lecturer lamented the crisis of knowledge, knowledge flow and the curriculum privileging the expert domain at the expense of small-scale farmer knowledge and household contexts. Easterly (2013) referred to such an expert-driven crisis as a tyranny of experts devoid of empathising with the other (see section 2.4.5). The same absence was identified by a small-scale farmer who demanded that "*there must be something that is relevant from these institutions*... That is what we are crying for" (DIBSA8a, July 21, 2016). This contradiction, when illuminated by voices of outsiders, placed university and agricultural college curricula in the spotlight of a crisis of relevance and reproduction. Their normative curriculum development processes faced difficulty in transforming themselves from inside regarding addressing farmer-relevant food security and water for food knowledge flows. The farmers' cries recorded above point to excluded knowledges. De Sousa Santos, Nunes and Meneses (2008) warned that the changing legitimation of what is valid knowledge using scientific protocols of legitimation is a colonising system that marginalises other forms of knowledge. A view from the outside meeting an empathising one from the inside helped to point out possible model solutions as lecturers and farmers became co-protagonists of creating new knowledge and transformative agricultural water actions centralising rain-fed farmers. A senior manager in an agricultural college (ACMSA1) described the curriculum's tyranny by questioning the contradiction in water education offered in a college farmer training course design and its inapplicability on the ground using a current live example. His immanent critique was as follows:

> *Excerpt 4.34: (DAfFS2, May 11, 2016)*
> ***ACMSA2:*** I know the programme has already been designed for those ones. But I know yesterday when I was monitoring that, *they were very happy to see sprinklers but they are not going to afford them tomorrow.* But we are *expecting them to go back and start seeing their livelihoods and food security changing*.

The excerpt above questioned the relevance of farmer training focussed on water technology that excludes alternatives suited to small-scale farmers' and household food producers contexts. This implied a cognitive promise raising false expectations in practice. The research participants often

connected the social pillar with the economic pillar. A WRC participant agreed with the above ***quaternary contradiction between the tools of learning brought to the farmer by training institutions and the farmers' water object*** by suggesting venture capital as an economic tool for development of the small-scale farmer activity system:

> *Excerpt 4.35: (DAfFS2, May 11, 2016)*
> ***WRC Participant, WRCSA1:*** I just want to thank Y for putting this question across. This is precisely the issue that we should address... The one is *it's not training for the sake of training alone but training to use the knowledge and improve skills, to start a business.* We must *find ways to link up with existing farmers that have potential and that can be a mentor*. Second, a group at the University of Cape Town Business School specialise in entrepreneurial training. … One should also *form a link with them because they can identify the possible venture capital* that can give start-up capital to anyone who wants to start a business. ... I think *if we don't form these sort of networks similar to your learning network then we will end up with graduates who are stuck.*
> ***UALSA2:*** You need a pathway for the training to be successful in the world.
> ***WRCSA1:*** That's right. …someone who does a practical skills training *needs to see a pathway for themselves to become a successful businessman*.

There was also a suggested model in the excerpt above that trainees equipped with RWH&C skills be connected with experienced farmer mentors during courses and beyond (through mediated social learning). These ideas are in line with research results from other parts of Africa that have identified a 'cultural gap' between agricultural education, extension practice and small-scale farmers and the need for co-engaged interaction (Chittoor & Mishra, 2012):

> In many cases, *the lack of relevance of extension education to the rural world is a problem for students graduating from agricultural institutions*. … The development of mechanisms and channels of communication which *facilitate the understanding and utilization of local agricultural knowledge* is of vital importance for the training of extension workers. (p. 127, my emphasis)

A high level of humility would be required for agricultural college lecturers working in conventional contexts and holding such powerful responsibilities as curriculum development to transform curriculum practice in ways that reflect and value the perspectives and real contexts of small-scale farmers in extension and farmer training. The possibility of such humility was described as a need by a senior Agricultural College lecturer (ACLSA1) as follows:

> *Excerpt 4.36: (DIBSA1b, August 12, 2014)*
> ***ACLSA1:*** You know we have done a little bit of RWH projects here at Fort Cox and *it actually amazes one to see the effect of it*, and although we saw that effect, *none of us are changing our old traditional ways of ploughing and farming to incorporate these new ideas*. … whenever there is something new *we should maybe open our minds a little bit* and let's take the restrictions of the past thinking … aside, *observe what is the new knowledge and on that decide* where will I fit in.

It can be deduced that ACLSA1 proposed that sustainability of agricultural water requires **perspective-taking social transformation of curriculum practice** (a boundary-crossing mechanism) that departs from business as usual for expansive learning to take place. The immanent critique above is followed by an implication that learning ('we saw that effect') must lead development ('take restrictions of past thinking aside... observe... and... decide'), especially in an agricultural college demanding scientific evidence-based curriculum actions. This is illustrated by one of the 'critical outcomes' in the Fort Cox College agriculture curriculum that states, "Students will apply their knowledge of science and technology to further their education in agriculture" (FCC, 2015, p. 47). In this statement and all other Fort Cox College agricultural curriculum objectives, there is an absence of the contribution of small-scale farmers' knowledge (ibid.). The trajectory of learning-led development is supported by Zaretskii (2016) and was explored in boundary-crossing learning in this study (See Chapter 6-8). When farmers started demanding curriculum transformation that reflects their true farming contexts and lived experiences in the learning network forum, the moral and ethical considerations of the social pillar of sustainability were amplified. The boundary-crossing laboratory workshops in the learning network brought its diverse members closer enough to each other to test the practical meaning of **building commonality** and solidarity in the learning network, as shown in the excerpts below.

> *Excerpt 4.37: (DIBSA8a, July 21, 2016)*
> ***Small-scale farmer leader, FSA13:*** We are crying for that as farmers... *there must be something that is* ***relevant*** *from these institutions (referring to ATIs) to what we are doing*. That is what we are crying for from that workshop (held May 2016) and *we are still crying for that.*

> *Excerpt 4.38: (DIBSA9a, September 7, 2016)*
> ***EOSA1:*** Otherwise *they can channel that through us to say that '****we have been talking to our officers****',* **we then can agree** on what they are saying that *we have been faced with this for many years,* because I think this is the third year now that Y has been raising this …

The excerpt 4.37 from the small-scale farmer above (DIBSA8a) has aspirations for curriculum relevance that are in tandem with the views of a university agricultural lecturer who lamented the absence of food security in the agricultural curriculum despite advocating (unsuccessfully) for its inclusion in the past (DAfFS2, May 11, 2016). She indicated strongly that it is critical to include people's indigenous knowledge and food sovereignty in extension education and farmer training:

> *Excerpt 4.39: (DAfFS2, May 11, 2016)*
> So issues of food security will never be addressed if we do not look at them in terms of *availability, accessibility, utilisation, stability, sovereignty and even the indigenous knowledge systems of the people* we are trying to develop.

Integrating sovereignty and indigenous knowledge perspectives imply building commonality, within which the element of *self-reliance* was found to be a critical sustainability factor. In its extension work, the Nkonkobe Economic Development Agency (NEDA) found it to be a critical success factor to work with farmers within a contractual seed production value chain programme on the basis of their social

ability to work and deliver results independently (*zenzele*) while contributing to the value chain commons with others (see excerpt 4.40).

> *Excerpt 4.40: (Interview #NEDSA1, November 6, 2015)*
> ***NEDSA1:*** In the '70s there was one NGO… had a small centre called *Zenzele* which means 'do it yourself'. Now I realise that *they were trying to teach people … to do everything for yourself*. What *government wants us to do is to go back to that idea*. I think it's because the 'one size fits all' solution coming from Pretoria it's not working. It looks good on paper.

The *zenzele* philosophy was apparently promoted successfully by political parties and NGOs during the apartheid period to build capacity for self-reliance amongst the marginalised grassroots masses (Interview #NEDSA1, November 6, 2015; see also section 2.2.1). While social security benefits have reduced abject poverty and are considered essential for lowering economic risks for South African society's most vulnerable (Leibbrandt, Woolard, McEwen & Koep, 2010), the way they play out in some communities was also identified as disruptive to *zenzele*. Another dimension of the social pillar was the **embodied physical challenge of manual labour by elderly** small-scale farmers in carrying full water vessels from a distant reservoir that was a physical strain:

> *Excerpt 4.41: (Interview #FSA6, May 10, 2015)*
> ***Researcher-interventionist, R1:*** Do you enjoy carrying water every day?
> ***Lloyd garden farmer 3, FSA6:*** Yes. … Not easy, no, no.
> ***R1:*** Can you describe it? … What is your vision of something better as far as water is concerned, and your aspiration?
> ***Lloyd garden farmer 3:*** *When I come back, my arms are sore. … If we can get easier access to water, like a tank or a dam nearer.*

> *Excerpt 4.42: (Interview #FSA8, October 28, 2015)*
> ***R1:*** How much time do you spend in your garden, and is it every day?
> ***Lloyd garden farmer 5, FSA8:*** I normally go to the garden at 9 o'clock and then leave at 12 o'clock. … because I have to prepare lunch for the child coming from school. … No, we are not doing garden work each and every day. *We don't have that power and energy as we are troubled by sore knees.*

The elderly farmers linked the challenge of discomfort they were facing with the lack of youth participation and *division of labour* in water collection and farming that lays the burden squarely on the ageing family members alone. Youths perceived their attitudes towards farming in different ways. A youth studying in an agricultural college concurred with the assertion of youth apathy in agriculture:

> *Excerpt 4.43: (DIBSA1b, spool #4, August 12, 2014)*
> ***Agricultural College Student:*** I would agree … sometimes, as youth we want to see results now, now. …something that takes a long time to achieve discourages us; we have a negative attitude towards that. …gardening is a process that needs time.

The statement above summarises the attitude of youths that was observed in Lloyd Village over a two-and-half-year period where youths were virtually absent from meetings and collective work in the

garden. A significant number of youths surprisingly emerged from their houses when a tractor arrived from University of Fort Hare to assist with mechanical digging of diversion furrows for RWH&C on 11 May 2015. This indicated their fascination with mechanised technology in contrast to their disinterest in manual labour; perhaps this is where their passions lay, which needed further expansive exploration. Such asymmetric relations as between the elderly and the youths have been described as yielding relational 'evils' (Donati, 2014; see also section 2.2.1 of this thesis), that need to be socially transformed in formative intervention processes. A focus group interview with three youths participating in Lloyd village garden revealed that the youths either had inherited the plot from their parents or were integrated out of their expression of interest to join the cooperative garden members.

> *Excerpt 4.44: (Focus Group Interview #SAFYL, October 28, 2015)*
> ***LVGYSA1****:* I think it's been ten years now since he was part of it or since this project was formed; my father was one of the founding members. …I am having five years in the project. I am benefiting and profiting out of the garden. There is no employment, and *by involving myself in gardening production, it has helped us a lot*. The garden space and the land is big enough and available for other people, but what I can say is that people are lazy. There are many youths in the village that are just doing nothing, staying at home.

> *Excerpt 4.45: (FGI #SAFYL, October 28, 2015)*
> ***Researcher-interventionist, R1:*** When, how and why did you join the garden?
> ***LVGYSA2:*** Seven months. *I had a job with CWP (Community Work Programme) that was dealing with gardening production, and from that job… that is when I developed an interest* ... I took someone else's place in the garden; the owner of the plot has retired. …the results are positive.

The excerpts above show that there are both elements and exceptions to youth apathy to agriculture in the study area. One enterprising youth farmer summarised the exceptional position by indicating simply "we are not all like that" (Youth farmer 1, DIBSA1b, spool #4, August 12, 2014). This indicated that *youths may not be ruled out of farming and that their agency for farming could be developed further* if approached with empathy and care.

Regarding the impact of productive RWH&C demonstration plots when the garden farmers installed farm ponds in their garden following BCCLWs, one farmer described the *proximity of the newly developed water source* as very helpful.

> *Excerpt 4.46: (Interview #FSA8, October 28, 2015)*
> ***FSA8:*** So, actually what happens is that there were some furrows that were dug to channel over-flowing water from outside to the small ponds. Those ponds were *very helpful*, as *we get water for irrigation nearby*.

Apart from relations with division of labour, embodied individual *comfort* in accessing water is thus a key sustainability factor for elderly farmers. It was expanded through formative intervention within the local learning network as discussed under section 6.4.4 for Lloyd village. A senior manager in the

local municipality's local economic development section viewed farmer development as a matter of individual agency and relationality, "it's about the *individual* and also about *how each and every one relates*" (Interview #NEDSA1, November 6, 2015). He then suggested a cautious and mediatory approach in extension that requires delicate management of participatory processes to ensure that all voices are heard and that solutions generated are discursively emergent.

> *Excerpt 4.47: (Interview #NEDSA1, November 6, 2015)*
> ***NEDSA1:*** One meeting for all the farmers would focus on the loudest people. If it's those guys dealing with cattle farming who are the loudest …the *other one doing whatever is small they won't be heard*. So it becomes *very important that you understand that space*. The smallest component ... is very critical.

The above excerpt indicates that even among smallholder farmers themselves, there are boundary issues involving power relations that can easily generate relational 'evils' such as dominance (Donati, 2014) (see sections 2.2.1 and 6.4). The suggestion for mediating multi-voicedness above resonates with Engeström (2001)'s proposition for the same. In the same vein, a farmer practising food sovereignty explicated the social pillar in terms of social justice, cohesion and sharing that she felt was getting lost, and connected the social to the economic and the political dimensions (see FSA10, excerpt 4.15). Group discussions in BCCLWs also linked rights to social development thus:

> *Excerpt 4.48: (DIBSA8a, July 21, 2016)*
> ***Group work feedback:*** (farmers, colleges and NGOs): *Government should speed up the process of issuing water rights* to small-scale farmers because *it always affects their food sovereignty*. … Government should speed up the process of that framework of agroecology because *in it there are principles of harvesting water*.

In summary, the social pillar of sustainability was perceived with diverse dimensions at different levels. These included harmonious social relations and reciprocity in water development, perspective-taking social transformation of curriculum practice that considers smallholder farmer contexts, commonality, self-reliance (*zenzele*) and intergenerational division of labour. These dimensions point to boundaries existing between people in different organisations and family structures and the potential for social learning to re-imagine and improve management of relationality, social relations and the relational goods and evils that emerge out of these relations. While several dimensions of the social pillar were identified by various agricultural actors (subjects) in different activity systems, the economic pillar was also identified as a sustainability factor. It is presented and discussed below.

4.3.2 Representations of the Economic pillar of sustainability in water for food

Smallholder farmers, local economic development specialists, agricultural college lecturers and extension services alike linked sustainable agricultural water directly to production, income generation and markets. A smallholder farmer struggling to market her agro-ecological gardening produce reported a boost in her farming after she was introduced to a new and ready market by a colleague.

The two met at a boundary-crossing change library reflection workshop with Lloyd village garden farmers in 2016 which motivated these elderly farmers.

> *Excerpt 4.49: (Interview #FSA10, June 8, 2016, Research Journal entry, see below)*
> ***FSA10:*** The lady whom you connected me to, X, *has introduced me to a market* for organic vegetables and herbs in Hogsback. Now we are working closely together on marketing and water conservation and harvesting.

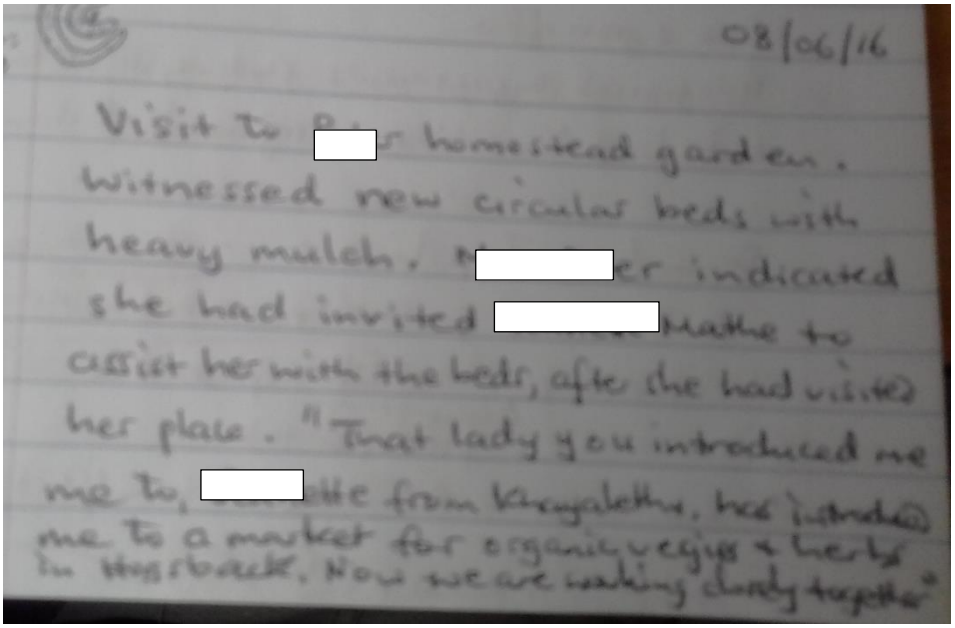


Figure 4.23: *New boundary-crossing marketing relations reported in the IBLN (RJE, June 8, 2016)*

The mediated learning and market linkages in Figure 4.23 is also evidenced by the testimony; "I learnt *from Imvotho Bubomi* they *connected me with X*. It's from her that I learnt this ..." (FSA10, DIBSAM3, August 1, 2016). Income generation and market access were key aspirations by smallholder farmers. The research approach followed by R1 included mediating the access of a linkage to such markets and the introduction of FSA10 to FSA14 yielded results as shown in excerpt 4.49. In addition, FSA10 indicated in a BCCLW that such marketing was taking place, "as for me *I have an appointment in Hogsback to sell some vegetables and herbs*" (FSA10, DIBSAM2, June, 7 2016). Most of the BCCLWs conducted in Amathole District with the IBLN had episodes of marketing interactions connecting the sustainable agricultural water object with the outcome of smallholder farming activity namely food and processed products. Figure 4.24 shows such a marketing activity during an IBLN teaching garden demonstration.

Figure 4.24: *Busy marketing corner of organic vegetables, herbs and ointments from a farmer innovator's productive demontration plot (Fort Cox College, August 1, 2016)*

The excerpts below show further aspirations by smallholder farmers for income generation.

> *Excerpt 4.50: (Interview #FSA4, October 28, 2015)*
> ***Researcher:*** Two or five years from now, what is your vision for the garden…?
> ***FSA4:*** We want riches and treasure from that garden; if we can be able to get a *market* for us to sell our produce to ... like Spar.

> *Excerpt 4.51: (Interview #FSA6, May 10, 2015)*
> ***FSA6:*** We … grow vegetables. The produce that we harvest *we are selling it in order to have some income*. We sell produce locally.

At another level of marketing, NEDA promoted smallholder farmer development based on an economic model of consistent production, disciplined cooperation to meet scale and participation in local value chains that satisfy a market.

> *Excerpt 4.52: (DIBSAM1, May 27, 2016)*
> ***NEDSA2:*** What is important is to do things *consistently*. If Y is producing spinach, don't produce it this month and then the next month, you don't have spinach. Then you won't be able to *market* your things. And also we must remember our pieces of land they are small. So we can only be able to supply Spar, Shoprite, Saverite *if we work together*. … Every day we can supply Spar maybe 50 bundles of spinach.

The above citation indicates that markets have a short memory of inconsistent suppliers. Reflecting on observations from a look and learn tour that was part of dual stimulation for learning alternatives during a period when both farmers and colleges were experiencing the impacts of drought, a farmer innovator attributed successful and sustainable farming and agribusiness to learning of agro-ecology principles and acting upon the new knowledge practices connecting design, water harvesting and conservation, and production, as follows:

> *Excerpt 4.53: (DIBSAM1, May 27, 2016)*
> ***FSA11:*** OK what I have seen at Y's garden is that I liked the fact that she went to attend a workshop on agro-ecology and when she came back she came to implement. That is what is needed in our society because we always get educated but we don't do. *What is needed now is to learn and act. ... The design of plots, the way she has done it to conserve water, water harvesting, everything is there*.

The *problem of perceptions of development as large-scale activity* was identified across different activity systems as hampering sustainability of interventions as both farmers and decision-makers perceived small-scale interventions as unacceptable in some cases. NEDA viewed the problem of large-scale biased development perceptions as national and historical (see excerpt 4.2.5).

The suggested reductionist approach of prescribing big and technological (technicist) solutions as the default to any type of problem considered big appears to handicap ordinary farmers' thinking about the options and alternatives for rural and water for food development. Shiva (2000) metaphorically called this one path development model a monoculture of the mind. While this way of thinking may appear to be at variance with the South African National Development Plan's (South Africa. DP, 2012) foregrounding of capability development, it was also identified as a problem by a senior agricultural department manager operating in water development capacity experienced in the domain of the real, the actual and the empirical. This is shown in excerpt 4.22, dialogue turn #2, further demonstrating that the default mode for development intervention is often thought of as a big and technicist solution as a given without giving space for critical reflection and emergence. It is laden with a philosophy of closing the gaps created by historical inequity using the same development model as a way of leapfrogging but without engaging critically with local context. This governmentality appears to be a metaphor of developmental intervention that has trickled down to the community, as will also be seen in the discussion on locally-adaptive seed value chains with the metaphor of massification of food production (see Chapter 6).

4.3.3 Representations of the Environmental pillar of sustainability in water for food

The excerpts below show how the different agricultural actors across the agricultural learning systems perceived the environmental pillar of sustainability. In Chapter 1, a systemic model of the environment that views the environment as the interactions between the dimensions of the social, economic, political and the biophysical life support systems rather than separate domains of activity was presented. In reality, people and organisations may perceive the environment in disaggregated ways depending on their values, objectives and motives. This section presents how the biophysical life support systems and political dimensions of the environment and their interactions with other dimensions were represented in discourse. In the excerpts below RWH&C was described from expansive learning experiences as a viable and practical adaptation measure to water scarcity resulting from climate variability (agricultural drought) and semi-arid agro-ecological conditions.

> *Excerpt 4.54: (DAfFS2, May 11, 2016)*
> ***UALSA2:*** Yes because extension is to address the issues of small-scale farming and household gardens as from the department or DAFF. It would expect them to do all those activities. But are we trained to look into that or are we trained to be more specific in terms of our expertise?

So if I train them (extension learners) to excel in crop production in terms of the production of sugar cane or whatever..., *I haven't trained them in terms of mung beans, in terms of cow peas, which can actually* ***adapt*** *to these water issues*.

Excerpt 4.55: (DAfFS2, May 11, 2016)
Extension Officer: …during the *drought period* that we had this year *people who have adopted these (rainwater harvesting and conservation) practices have seen the difference*. So *it is really something that we have to introduce to all especially the communal rural farmers where we work* … If people can conserve this water, use some of these practices that we are introducing to them then they can see a difference in their food security.

Excerpt 4.56: (DAfFS2, May 11, 2016)
ACLSA3: Now due to the *drought* Fort Cox area *didn't receive any rain* from mid-November up to the end of January. And when we came back after the closure of the school *we found that the crops were doing very well as if they were not affected and the soil beneath the mulch was still moist* meaning that there was a very good retention of moisture.

The excerpts above and the one below demonstrated agency by reporting to have "taken consequential actions" (Haapasaari, Engeström & Kerosuo, 2016, p. 243) in this case implementing mulching, pond and diversion furrow construction resulting in healthy crop growth under adverse environmental conditions "to change the (agricultural water) activity … after the change laboratory sessions" (ibid.) (see also Chapter 6). I include these excerpts here to show the dynamics of the 'environmental pillar' which were less expressed prior to the Change Laboratory workshops.

Excerpt 4.56: (WRC 'National' Workshop, DAfFS2, May 11, 2016)
ACLSA2: … when you site the pond you need to be strategic that you don't have to do an extra excavation work of having to divert water to the pond. So the best way to do that is to get a little umbrella and gum boots and a raincoat and then walk in the rain and see where the water is flowing. You are *manipulating the natural forces of gravity to bring the water where you want it*. It is not advisable for you to start digging a pond where you don't know where the water will flow. So it's very important that you *wait for the rain to see where the water is flowing then you start digging*.

In the description above minimising excavation work saved time and both financial and ecosystem costs. The solutions suggested above for conserving water also point to the possibility of creating cool natural microclimates by integrating demonstration plots with natural plant canopy or other cover, as was suggested in the second IBLN change laboratory workshop (see Chapter 6).

There were also strong representations of the **political dimension** of the environment as already indicated in the other pillars of sustainability above and also in the excerpt below.

Excerpt 4.57: (DIBSA8a, BCCLW7, July 21, 2016)
1) ***NGO Extension Officer, ZEPOSA:*** We capacitate (farmers) on *political education*, not party politics, … on *how they should pursue their rights* ...
2) ***Agro-ecology farmer:*** Poverty is a political issue. ...

3) ***ACLSA2:*** Now with food sovereignty we are saying as a family, as peasant farmers *we should be in control of what we eat, how we access it and how it is distributed*. You don't have control when it's in a supermarket, but you have control when it's in your garden. You can pick it anytime.

Issues of reframing power (e.g. dialogue turn #3 "peasant farmer should be in control") and policy (dialogue turn #2) are captured here. It can be seen from the discussions above that the way farmers perceived sustainability regarding type of seed used changed over time through formative intervention. This included discussion of tense issues. For example, agroecology farmers who posted their opinions on the WhatsApp group received some serious questions from conventional farmers regarding legitimacy and privileging of OPV seed versus GM-seed; "Is everybody in this group on the Food for Us group chat? X is raising an issue (use of Agroecology vs conventional market products in food preparation in the IBLN meetings) that was decided on the last ToT IBLN" (FSA10, 17 January, 2018).

4.4 SUMMARY

This chapter has analysed the emergence of contradictions evolving from the work of the different activity systems in the South African case study, pointing to the dynamic nature of the activity systems and the object of activity; as well as the relations between activity systems. These contradictions were observed at primary, secondary, tertiary and quaternary levels, being conflicts within and between the elements of the activity systems, and between the activity systems. These are summarised in section 4.4.1 below. In Table 4.3 it can be seen that some contradictions in different activity systems are related to each other as a chain, forming a vicious cycle. This is illustrated by the contradiction of inappropriate training of agricultural advisors (and farmers) in the college leading to advisors lacking knowledge and / or agency regarding locally-adaptive water harvesting and conservation practices. This in turn leads to farmers not knowing how to produce successfully in increasingly drier conditions. This relation between contradictions in different activity systems show that the agricultural learning system is implicated.

4.4.1 Summary of contradictions

This section provides a summary of the primary and secondary contradictions that emerged from the activity systems discussed in this chapter using agricultural water and local seed-based inputs as objects in Tables 4.3 and 4.4 respectively. These contradictions were presented as 'mirror data' to participants in boundary-crossing change laboratory workshops as discussed in Chapter 6.

Table 4.3: Summary of categorised manifestations of primary and secondary contradictions following the object of agricultural water cross-referenced across different activity systems

PRIMARY CONTRADICTIONS (object of agricultural water)	Simplified version of primary contradictions as mirrored to participants and forward pointers
In the object of the **small-scale farming** activity system ***Marginal dryland crop farming and homestead food production under risky water scarce conditions versus*** ***demand for food to satisfy domestic and income needs***	Farmers want to grow crops and vegetables for domestic consumption and income generation because they have to feed and fend for their families this way. However, growing crops under dryland conditions in poor rainfall areas presents risks of crop and income loss that farmers face daily, and yet have no effective solution. (see Koloni village farmer case study)
In the object of the **small-scale farming** activity system Critical conflict: ***Lloyd village garden farmers' experience of violation due to the unilateral removal by the local municipality of 'their' diesel engine that was providing power to pump water from underground versus*** ***the farmers' desire to restore the diesel engine that they were incapable of replacing or maintaining, while at the same time neglecting to conserve the little moisture available to the soil from rainfall***	(see Lloyd village farmers case study)
In the object of the **extension** activity system Dilemma: **Conflict within the object of the extension activity:** ***Advice on commercially-oriented production in crop, horticulture and livestock production to small-scale farmers*** ***versus*** ***Absence of, to poor agricultural water extension advice to small-scale farmers that compromises household food security***	*Agricultural extension officers / advisors do not feel equipped or obliged through mandate to advise farmers on improving their water-for-food except for very limited and exclusive supply of Jojo tanks and irrigation pipes to support vegetable production to GM seed users.* • This provides opportunity for boundary learning of alternative agricultural water • The poor investment also implies poor valuing of smallholder and subsistence farming systems by government despite robust policy for the same (ambivalence) • This points to a need for non-simplistic solution development to complexities in smallholder farming and rural development • College/university curricula show that agricultural advisors are not taught to advise farmers on water provisioning in dryland farming systems (see contradiction below).
In the object of the **agricultural education** activity system: ***Focus on conventional technicist irrigation and mechanisation in the teaching of potential extension graduates*** ***versus*** ***absence of commitment to low-tech alternatives such as rainwater harvesting and animal traction in the agricultural college curriculum***	*Agricultural colleges (college lecturers) are teaching extension students agricultural water methods that will not help them to assist smallholder farmers operating in rain-fed contexts where irrigation is not accessible to them.* *Agricultural colleges (rural development centres) are not training smallholder farmers on agricultural water methods that will help them to operate successfully in rural, rain-fed contexts where irrigation is not accessible to them*

SECONDARY CONTRADICTIONS (object of water for food)	**Simplified version of primary contradictions as mirrored to participants and forward pointers**
In the Object vs Tools of the **small-scale farming** activity system ***A high dependence on natural rainfall that is increasingly erratic (object)*** ***versus*** ***little or absence of knowledge of viable alternative water for food practices (tool)***	*The Xhosa people historically knew in their lived experiences how to conserve their soil and moisture using a practice called* 'gelesha' *but today most Xhosa farmers engaged have lost this knowledge practice. This has mas made them more dependent on rainfall. Reasons include forced racialised dislocation during apartheid leading to loss of sense of place, community and traditional resource commons, and loss of cattle traction culture suitable for* gelesha. *With perceptions of unfulfilled promises and aspirations for government support in elusive irrigation, and no new knowledge they helplessly watch their crops perish with increasing drought events.* • There are clear double-binds which invite collective boundary learning (see Koloni village farmer case; learning network)
Object vs Rules in **small-scale farming** activity system: • As perceived by small-scale farmers: ***Scarce rainwater in rain-fed food production systems*** ***versus*** ***available municipal water supply restricted to domestic use only but still used illegally for on-farm purposes by farmers*** • As perceived WUA Committee: ***Rainwater harvesting (OBJECT) is clearly articulated in the eDikeni WUA business plan as an option for developing alternative agricultural water for farmers but the licencing requirements of the Department of Water Affairs (RULES) for such structures as understood by the farmers constrain this object severely***	*There is water that appears to be available from municipal taps – like a mirage - but only for use in the home which food producers / farmers are* ***not allowed to use to water their vegetables*** *in their gardens even when they are wilting from heat and drought. It is treated water.* *The WUA business plan has clear strategic objectives of rainwater harvesting but Committee members are uncertain about legal requirements, and believe they need a licence first hence not promoting it among farmers or practising it themselves*
Object of farmers vs Tools: ***Farmers' aspirations to have adequate water access to produce crops and attain food security successfully (object)*** ***versus*** ***dependency-driven, technocentric mind-set of pursuing high impact but unaffordable solutions (tools)***	*Farmers aspire to solve their water problems with technologies they cannot afford instead of trying out and testing low cost and low technology solutions that may actually improve their production*
Object (of trained farmers and extension officers) vs division of labour (of scaling out to others) (historical, smallholder farmers and extension) ***Infield rainwater harvesting training and implementation by selected group*** ***versus*** ***lack of expansion to other water-stressed food-producing communities through trained farmers and extension officers and exposed others***	*Rainwater harvesting and conservation knowledge and skills gained in a previous pilot project seem to have remained with a small group of farmers and extension officers with no expansion to other farmers needing it in surrounding water-stressed farming environments*
Subject vs division of labour in **college lecturer** activity system: ***Working alternative agricultural water innovations (rainwater harvesting) which were led historically by some lecturers in the agricultural college were lost in the agricultural college learning system where sharing of information is subjugated by a systemic silo work culture***	*Same as in left column*

Subject vs division of labour in small-scale farmer activity system: ***Farmers in need of guidance*** ***versus*** ***demotivated and unavailable extension services support***	*Farmers are not finding the support they need from extension services because they feel extension officers are demotivated to support or are not available when needed, or not adequately staffed. However, an intern was made available for occasional Amanzi for food project work.*
The eDikeni Water User Association as an institution is failing its small-scale farmer members who were optimistic of collaborative participation and coordination with such powerful member institutions as the Department of Rural Development and Agrarian Reform, the Department of Water Affairs and the local municipality whom farmers believe to have neglected their part in ensuring delivery of agricultural water.	*The eDikeni Water User Association executive is not adequately engaging with its members on their contexts and needs. Members interviewed were not aware that rainwater harvesting is a key strategic objective in the business plan because the executive was not pursuing it.*
Elderly farmers working alone to feed themselves and young people in the home ***versus*** ***youths who consider garden work demeaning***	*Same as in left column.*
Subject vs tools in small-scale farming activity system: • As perceived by extension officer: ***The mostly elderly farmers (subject) found manual work associated with construction of certain rainwater harvesting and conservation practices familiar to them (tools) [which they called* amadanyana *and generalised to all RWH&C practices] too strenuous for them and yet these may carry potential to ease in the longer term their burdens of having to carry water daily from a distance.*** • As perceived by resource-poor elderly food producers (small-scale farmers): ***The mostly elderly resource-poor female farmers (subject) found manual work associated with construction of rainwater harvesting and conservation practices (tools) too strenuous for them because of a poor division of labour with their grown grand-children who did not participate in any garden activities despite consuming the produce thereof.***	*Same as in left column.*
Outcome vs object in small-scale farming activity system: ***Farmers' aspirations of and efforts at successful crop or vegetable production and productivity (outcome)*** ***Versus*** ***vegetable loss from moisture and heat stress (object)***	*Farmers' aspirations and efforts in preparing and working for their own food are frustrated from losing their vegetables and crops often from moisture stress and heat due to frequent drought events. This is worsened by lack of soil cover and shade to conserve the moisture still available in the soil.*

Object vs Tools of the small-scale farming activity system: ***The need for alternative agricultural water that is resilient to rain-fed conditions (object)*** ***versus low capability among farmers to develop low input and self-reliant alternative agricultural water systems (e.g. rainwater harvesting) (tool)***	*Smallholder farmers know that they need alternative agricultural water solutions (object) but have neither knowledge of nor capability (tool) to develop such alternatives except aspire for irrigation and engine powered solutions they neither have access to nor can afford.* • *Knowledge of traditional water conservation methods such as gelesha still exists in a few farmers but is disappearing* • *It is undermined by loss of animal-drawn ploughs replaced by (inadequate) mechanised traction* • *Points to need for formative intervention, reflexivity and boundary learning*
Dilemma: **Object vs Tools** in extension activity system: ***The object of the extension activity system is to provide advice and material support to farmers guided by commodity group formations (tools) but these groups are not always coherent and functional such that material starter pack support ends up being provided to groups that either do not need them and thus end up selling them instead of giving to deserving individual farmers***	*Extension officers / advisors face a dilemma as to how to target their material support and advisory time because they are expected to report on the support and progress of commodity groups according to their action plans feeding into provincial operational plans. They lack a way of supporting excelling individual farmers of farmers not complying with prescribed programmes and yet could contribute to meeting the local and provincial food security targets.*

Table 4.4: Summary of categorised manifestations of primary and secondary contradictions following the object of locally adaptive seed across different activity systems

SECONDARY CONTRADICTIONS (object of locally adaptive seed)	**Simplified version of discursive secondary contradictions as mirrored to participants**
In typologies of the small-scale farming activity system: **Object** of OPV / Agroecology farmers **vs division of labour** (neighbouring farmers growing GM seed) There is a conflict between ***the values embodied in the object of farmers growing traditional open-pollinated seed varieties adapted to the local climate versus*** ***the values of farmers growing GMO and hybrid seed promoted and supplied by extension services (division of labour)***	*Farmers growing open pollinated maize seed varieties from seed saving and exchange (Agroecology farmer typology) felt that they had no protection for their seed from the pollen of GM crops from their neighbours who were growing GM maize (conventional GM-seed farmer typology)*

Table 4.5: Summary of categorised manifestations of tertiary contradictions following the object of water for food between the central activity and a culturally more advanced activity

TERTIARY CONTRADICTIONS (object of water for food)	Simplified version of discursive tertiary contradictions as mirrored to participants
Despite a strong orientation towards rainwater harvesting in the eDikeni WUA business plan and a recent history of rainwater harvesting training in the area (culturally more advanced central activity), in practice this was overshadowed by an exclusive pursuit of conventional irrigation infrastructure and a perceived licencing bottleneck for capturing any water (the dominant central activity). This led to the absence of rainwater harvesting and conservation promotion and lack of generativity of local successful rainwater harvesting pilot projects by the farmer leaders and extension officers involved.	*Alternative water for food options such as RWH&C were being neglected by water user association leaders and members despite their being highlighted at strategic objective level in the eDikeni Water User Association business plans. As a result, members of eDikeni WUA were failing to put their plans for rainwater harvesting into practice as they focussed on pursuing elusive irrigation development and meeting intricate licencing requirements from Department of Water and Sanitation.*
	Extension officers/advisors exposed to ARC RWH&C training and farmer leaders did not show any evidence of own uptake of the new practices into their routine daily work resulting in lack of generativity or scaling up
Promotion of tightly controlled seeds linked to multinational companies (commodification) versus preferred use of locally-procured and shared seed that are adaptable to climate change	*There was a strong sense of tight control from above felt by extension officers to implement government policies that were in many ways at variance with agro-ecological farmers needs' in the South African case study (e.g. Cropping Programme's promotion of GM maize, as one of the activity's mediating tools)*
Manifestation of a **tertiary conflict** in the **Object of the dominant** versus **a culturally more advanced** form of the extension activity system: ***A conflict between the old general form of the extension activity system that is dominating with regard to assuming irrigated farming in rural crop and homestead food production*** ***versus*** ***new knowledge and skills provided by rainwater harvesting pilots from DAFF, local ARC training and WRC training materials that are still subordinated***	*Extension officers / advisors have been exposed to several alternative water for food practices that contribute to diverse rainwater harvesting and conservation options but have resisted institutionalising them into their routine extension practice. This could be due to the lack of such approaches in the provincial extension business plan or the lack of strategy on how to take it up by the local extension officers.* *Extension officers / advisors lacked skills in, knowledge of and a practical mandate for advising farmers on sustainable water for food but some had encountered water for food-led rainwater harvesting innovations from which they were learning in widely varying degrees.*
Concrete tertiary contradiction in the **object of the dominant form** of extension activity system versus the **object of its culturally more advanced form**: ***The object of the extension activity system is directed by large-scale commercial farming policies and dominated by normative agriculture water thinking and training that promotes large scale irrigation solutions in theory at the exclusion of water for food solutions suitable for small-scale rain-fed farming systems (dominant form of the activity)*** ***versus*** ***demand for practical extension advice and water for food solutions such as rainwater harvesting and conservation that are context-relevant for dominant rain-fed farming and homestead food production systems with a past and contemporary history of exclusion and cultural reduction (culturally more advanced form of the activity)***	*What extension officers / advisors do with small-scale farmers in rural areas regarding water for food is insignificant to the farmers because it does not meet their expectation of good results from the inputs they give farmers to grow crops and vegetables under their rain-fed farming contexts. This is because it is aligned to large scale commercial farming thinking that expects prescribed farming systems aligned to the agroecological region or assumes a fallacy of the presence of resources to install irrigation infrastructure*

Table 4.6: Summary of categorised manifestations of quaternary contradictions following the object of water for food across different activity systems

QUATERNARY CONTRADICTIONS	Simplified version of discursive quaternary contradictions as mirrored to participants
A tension between farmers' object of crop production and water development versus the government rules governing protection of crop production investments against straying livestock and property destruction.	*Farmers' aspirations to improve their water for enhanced crop production and compromised by destruction protective fences and crops by straying livestock and allegedly jealous neighbours* *(see Koloni village farmer case study)*
Farmers felt violated by the removal of 'their' diesel engine that was providing power to pump water from underground, by the local municipality on the pre-text that it needed repairs when the members were sure that it was working well.	*(see Lloyd village garden farmers case study)*

4.5 CONCLUSION

The data presented in this chapter was analysed to reveal manifestations of contradictions and to surface existing primary, secondary, tertiary and quaternary contradictions in the work of the subjects of the four main agricultural learning activity systems in this study as they pursued water for food. These contradictions centred on a key primary contradiction in the object of the small-scale farmer activity system, which is 'confrontation with persistent poverty, lack of realised alternatives and capability deprivation versus human rights-based policy and socio-economic objectives for well-being, capability development, equity and sustainability'. This contradiction was interpreted as a tension between coexistence (use) value and commodification (exchange) value. This key primary contradiction aggravated to secondary, tertiary and quaternary contradictions that have a potential to stimulate co-engaged learning and agency. In addition, curriculum conflicts showing focus on irrigation and industrial production versus a demand for low tech solutions resulted in production of extension graduates who did not know how to advise farmers working in increasingly water scarce areas succumbing to climate variability and change. The contradictions surfaced in this chapter were used to stimulate boundary learning and boundary-crossing as discussed in Chapter 6. Chapter 5 which follows discusses the surfacing of contradictions from the activity systems in the Zimbabwe nested case study following a similar approach to what has been discussed in this chapter.

CHAPTER 5
SURFACING CONTRADICTIONS FROM THE ZIMBABWEAN NESTED CASE STUDY

5.1 INTRODUCTION

This chapter describes the activity systems and presents analyses of the manifestations of contradictions surfacing from interviews and ethnographic discussions with and observations of research participants in the Zimbabwean nested case study. I worked with research participants from two agricultural colleges (Mlezu and Rio Tinto), the Department of Agricultural Education and Training, small-scale farmers, farmer innovators, extension officers and extension workers. I also interviewed key informants from two universities affiliated to agricultural colleges (University of Zimbabwe and Midlands State University). This chapter attempts to answer research sub-questions (i) and (ii) as presented in Chapter 1. The contradictions emerging from the Zimbabwean nested case study are discussed in a multi-level way starting from the farmers' activity system, followed by the agricultural college lecturers' activity system and then the extension officers' activity system. This mode of analysis was prompted by the desire to learn upfront about the manifestations of contradictions at small-scale farmer level, that is their lived experiences, and then learn about how the agricultural colleges train extension officers and farmers; and finally, how the extension services were responding at policy and operational levels. Engeström (1987) referred to this starting point as a 'need state'. One of the materials recommended by the Water Research Commission (WRC) project that supported this research in South Africa begins in its first chapter with a Zimbabwean rainwater harvesting experience

(Denison, Smulders, Kruger, Ndingi & Botha, 2011) that provides one of the connecting threads between the two country case studies.

5.2 DEFINING THE 'NEED STATE': CULTURE IN CONTEXT

In order to gain a deep appreciation and understanding of the problem jointly faced by the participants in the different but connected activity systems, it was essential for me to, in Engeström's (1987) words, "get a grasp of the need state and primary contradiction *beneath the surface* of the problems, doubts and uncertainties experienced among the participants of the activity" (p. 254, my emphasis). I did this is a number of ways, which included talking to people, working with them, listening to their stories, studying their documents and observing their cultural artefacts in action. By participating in two principals' council workshops, one college curriculum review workshop, a college environmental education implementation review mission and working with farmers in their fields and extension officers in their meetings, I got a glimpse of their needs and gaps. In addition, I was also privileged to access important artefacts such as farmers' fields, granaries and kitchens and agricultural college libraries, farms and curriculum documents. The need for sustainable agricultural water improvement kept emerging as discussed below.

5.2.1 Small-scale farmers as progenitors of the need state in agricultural learning systems

Small-scale farmers' needs appeared to give a good indication of the reciprocal and relational needs shared to some extent by farmers, agricultural college lecturers and extension workers. The farmers' needs were multidimensional ranging from household food security, water and inputs for production to markets for surplus products. These needs are discussed as contradictions in farmers' work contexts in this chapter. Two farmers FZ3 (RWH&C innovator) and FZ5 articulated these needs manifesting as *dilemmas* in their work as follows:

Excerpt 5.1 (Interview #FZ4, January 9, 2014)

1) ***FZ3:*** I farm food crops to *feed my family fully*, and also farm *for the market* and it *helps especially my neighbours* in this village. … However, regarding markets my main challenge with markets concerns onions. The *shops disadvantage us* on onions.
2) ***Researcher-interventionist, R1:*** On pricing?
3) ***FZ3:*** Yes on pricing. ... like this time the *buying price is far too low.*
4) ***R1:*** Is it about too many suppliers?
5) ***FZ3:*** Suppliers may not be many as such but these buyers may just buy your onions for selling in future when there is demand… Sometimes as a farmer you see that it is better to delay selling so that you can get a better price. But they insist on pressing farmers down. Sometimes a farmer may not have transport and you will be in a dilemma about what to do. It needs a farmer to build good sheds if your systems are balancing because you can keep them up to February and then you can get good cash.

Excerpt 5.2 (Interview #FZ5, August 11, 2016)
FZ5: Where I am *there is no irrigation scheme, we depend on direct rainfall. … that's what we use for farming. ... Since 2007 up to last year 2015 rainfall has been inadequate such that the farming has become so difficult, the production is no longer the same. ...* Rainfall patterns have changed also.

In dialogue turn #1 of excerpt 5.1, farmer FZ3 indicated how his farming was feeding his family and contributing to the *coexistence value* within his village community ("it helps especially my neighbours"). This shows the importance of social relations in small-scale agricultural production and distribution (see section 2.4.1). There is a *dilemma* (Sannino & Engeström, 2011), however, that the farmer encountered as he tried to sell surplus garden produce. There are two opposing forces in the object namely producing farm surplus to supplement household income (household income generation) and operating in a market system that is alienated to small-scale farmers because of its commodification value system based on supply and demand forces presenting a high risk of loss of unsold produce (competing on the open market). The latter privileges wealthy and powerful buyers, in this case supermarkets, at the expense of small-scale farmers with low bargaining power regarding pricing of fresh, perishable produce. Highly subsidised farmers in collusion with governments have been known to dump produce to suppress market prices (see section 2.5.2).

The dilemma above was found in other products such as small grains. Market garden production opens up opportunities for improving family income but open market rules impose restrictions that make such farmer efforts not worthwhile. In excerpt 5.2, there is a *dilemma* between rain-fed food production and climate variability. The former requires a minimum standard of water to satisfy crop growth that has been learned by farmers studying their climate over time, while the latter changes the experienced norms of water availability. Farmer FZ5 was normally producing food to feed his family using water directly from rainfall but changing rainfall patterns were producing less rainfall that was reducing food production in ways that the farmer was not capable of adjusting to alone. Reliance on rain-fed food production is incompatible with an unpredictable climate. The lack of a market can discourage small-grain farmers of locally adaptive seed from producing large quantities, which may have the effect of reducing food availability in the community if other staples fail. Such a problem of low prices and poor markets affects the Zimbabwean case study farmers more than the South African counterparts mainly because the latter have largely abandoned locally-adaptive seed practices especially concerning small grain production.

On reflection, it was a learning and refreshing experience on the one hand, and depressing on the other, when I encountered people facing dilemmas in which I could not intervene using change intervention approaches (Virkkunen & Newnham, 2015) that I had learned from my previous NGO work. Ethical reflexivity rescued such situations as a middle ground opened in the possibility of expansive learning to co-engage participants to jointly re-solve these contradictions, acknowledging that the latter do not go away. Before such interventionist resolutions, however, it was clear that while I had a good understanding of the problems faced, I did not feel I had enough of a 'grasp' of them. What was clear was that the problems were contextual, historical and culturally imbued, with significant external and global influence. On the other hand, farmer innovators manifested elements of internal resilience. Farmer innovators exhibited a clearer manifestation of the classical primary contradiction of use versus exchange value and hence this activity system is discussed first. This primary contradiction also exhibits aspects of coexistence value versus commodification value. A thorough interrogation of the observable and experienced manifested on the surface was needed in order to understand the unseen that was lying 'beneath the surface'. For such an analysis, I borrowed some tools of Dialectical Critical Realist ontology to under labour this multi-layered navigational task (Bhaskar, 2009), in particular stratification of reality and absences.

5.2.2 The need state as a problematic boundary across agricultural learning systems

At this point, it is important to clarify the link between agricultural production (farmers' activity) and education in the Zimbabwean agricultural colleges. This can be expressed as a connection in the model of production theory with practice: "agricultural production involves use of basic resources that can be classified as land, labour, capital and organization ... Y = F (Land, labour, capital and organization)" (Mutambara, 2011, emphasis in original). This means economic output (Y) is a production function (F) of or dependent on the production variables in the bracket, where human capital development (agricultural education) is seen as satisfying labour (mental and physical needs) and organisation needs. While this neo-classical macro-economic growth model (Solow, 1957) shows the relationships operating according to economic theory, it seems to be absenting things that cannot necessarily be measured with 'growth' culture lenses. These include proven cultures of production and resilience in traditional farming systems that are reproducible today, and socio-ecological limits to growth that are not adequately represented by the land variable or otherwise (Meadows, Meadows, Randers & Behrens, 1972). Curriculum development is therefore needed to respond to emerging needs and will be successful if these needs are correctly identified and align with small-scale farmer contexts, national food security and delivery to the macro-economy but within an inclusive development model. Another need is for mediated networking of agricultural actors in groups, as observed by an extension worker (AEWZ2) that "if we consider the fruits of rainwater harvesting they see them. The only problem remains at adoption of practices. … So *if they maintain their groups it will help them to lighten the*

labour" (January 7, 2015). This is a *manifestion of a quaternary contradiction* between farmers' agricultural water object and division of labour in a community consisting of innovators and extension workers. Enabling these changes is a potentially challenging task of business as unusual as it transgresses the norm (e.g. of expecting adoption of pre-defined solutions through conventional training). The task in this study begins with analysis of the contradictions in the work of agricultural learning systems and their historicity.

5.3 THE ZIMBABWEAN SMALL-SCALE FARMING ACTIVITY SYSTEM AND CONTRADICTIONS IN THE FARMERS' WORK

This section describes the Zimbabwean small-scale farming activity system in two distinct ways. Firstly, I describe the activity system from the perspective of the farmer innovators who have excelled in rainwater harvesting and are growing in locally adaptive seed and horticulture value chain systems, that is beyond deficiency needs (Maslow & Lowery, 1998). Secondly, I describe the activity system from the perspective of the typical rural small-scale farmer who is struggling with water to fulfil deficiency needs for food production in crop and vegetable production systems. These different perspectives help to show the different challenges farmers face in agricultural water and seed, food production and marketing. They also demonstrate the opportunities presented by real and present innovations to inform new human activity using emergent tools through dialogue (see Chapter 7). These various ways of describing the small-scale farmer activity system emerged from the messy and complex raw data sets that revealed that the research participants experienced agricultural water and seed-inputs in different ways (see Appendix 5). However, there is also unity between these two small-scale farmer typologies being their common use of mixed farming techniques integrating crops and livestock connected by animal-drawn tillage and soil fertility from manure and common socio-historical contexts. Also held in common is land preparation that is mediated by various artefacts and tools including draught power (span of oxen) and ploughs, while seeding is generally done manually using hoes or straight into furrows during tilling, with only a handful of farmers using planters. Several weeding events must take place during the crop growth cycle. This labour-intensive process demands time and effort and lack of adequate weeding labour can result in choking of crops.

In organised communities, the cultural practice of working together in one farmer's field as a community mediates such actions and makes the task more manageable for families with less members or with a large number of tasks to perform. This agri-culture practice called *humwe* in ChiShona or *ilima* in SiNdebele requires that the whole community rallies its energy and works in one family's field(s) for say a half-day or more before moving on to the next family farm. The group farming actions such as weeding are usually accompanied by singing, and the host/ess usually provides *maheu*

(ChiShona), a non-alcoholic starchy beverage, and / or home-brewed opaque beer. The system of working together and exchanging seed strengthens collective and intergenerational learning and is thus a commoning process. It was, however, apparent from the data that while farmers were learning together, agricultural college lecturers and extension officers were not learning collectively with farmers.

The distinction comes in the way some farmers innovate with the tools available or new ones to work with nature and its rules to ensure and improve production against many odds, oftentimes challenging authorities' and the corporation's normative rules and value chains. It lies in the true motive, which is the object of a specific activity and therefore an object of distinction (Leont'ev, 1978). These observations resonate with Sannino, Engeström and Lemos's (2016) observations that the object of activity is a powerful motive at which humans direct their efforts, as evidenced by the innovators' systemic and embodied persistence and resilience.

5.3.1 Small-scale farmer typologies

The different ways of describing small-scale farmer typologies above (that is, small-scale farmer innovators and typical small-scale farmer) were based on the farmers' local contexts of place, spaces, resource capacities, knowledges, skills and agencies. The distinctions are important because they **clarify the boundary** that exists between small-scale farmer innovators who have developed the skills and knowledge practices of harnessing and managing rainwater (taming the water cycle) and typical small-scale famers who are at the mercy of waiting for the rain (depending on the water cycle). This clarity helps to **reveal the zone of proximal development for collective boundary learning** between these farmer groups, and between them and those who mediate between them being extension workers, the farmers themselves through farmer-to-farmer extension and through local marketing committees, and agricultural colleges through the farmer-training programme. This analysis will also help to **identify the joint boundary objects** for possible co-engagement and expansion through voluntary mediated collective learning. Place for these farmers is characterised by historically, politically and climatically marginal dwelling and farming places of which pre-colonial migration, religious and cultural identity, conflict, colonial dislocation and disruptions all had a part to play (Mlambo, 2014, see Chapter 2). Space here refers to the knowledge discourse terrains and how they enable or absent indigenous knowledges and innovations, exercise (rather than accommodation) of African agri-cultures and *Ubuntu/Hunhu* traditions, opportunities for collective transformative learning (ZPD), access to and security of farming land and the commons. Place, space, seed and water resources and exchange value all form mediation tools and artefacts for successful and productive farming. The latter three (seed systems, water and collective work) constitute the joint object of activity. This chapter

explores water for food as the initial joint object and how it connects with seed and collective work, and how these manifest as joint objects in different contexts.

5.3.2 Cultural history of collective work engagement and learning and boundaries in small-scale farming

There is a dilemma in the conceptualisation of the exchange value of the mediation tools of the small-scale farmer activity system in the sense that the traditional collective working of people in *nhimbe* was not commodified in the sense of Marx's (1909) capitalist view of private production. Instead it has a 'commons value' of 'scratch my back and I scratch yours' where people enhance their collective learning and agency through commoning practices in a culturally convivial manner. The Shona proverb '*kandiro kanopfumba kunobva kamwe*' describes this individual agency within social dependence well. Literally, it means that a plate will yield food from others if it goes to them with food, which translated means that one will get remembered by those one also remembers. The plate, a container of food ready for consumption, symbolises the social dynamic of sharing, while eating is considered the crowning event of relations. At inter-generational levels, children learnt about work and relationships through apprenticeship from their parents, parents' siblings and grandparents mainly in gendered ways, and through instruction and stories around a fire, as I also reflected in Chapters 1 and 2.

According to Engeström (2015), human activity is rich in multi-mediational processes that can be captured by analysis of activity systems. In order to capture these mediational processes I had to navigate through the few documents available related to farmers' and extension work, interpret what farmers were saying and doing as close to their perspectives as possible, and relate these to extension officers' and college lecturers' work while following the object. Engeström (2016) warned that "humanity risks its own future if it does not learn to deal meaningfully with runaway objects" (p. 7).

The Zimbabwean small-scale farmer activity system is characterised by the small-scale farmer as subject, and this was usually the household head who was either a man or woman. In most cases the extended family system is the dominant family structure where there is a husband and wife (or wives in some cases), with children from these unions and/ or from other relatives, and elderly grandparents. There are also households headed by an elderly person with grandchildren, or by a child in the case of child-headed households that are a common contemporary feature due to the impact of HIV/AIDS, migration and in some cases, breaking down of the extended family system. In this study, the seven small-scale farmers who were interviewed ranged in age from 43 to 88 years. At the one end of the spectrum were younger farmers keen to learn alternative agricultural water and adopting rainwater harvesting and innovating their own methods, while at the other end there were accomplished rainwater

harvesting and adaptive seed innovators. The contradictions in farmers' work were surfaced from their manifestations, beginning with the farmer innovators.

5.3.3 Description of the Zimbabwe small-scale farmer innovation activity system

The small-scale farmer-innovation activity system was characterised by farmers living in very dry areas but keen to produce crops successfully and leaving the ordinary farming practices to construct structures for harvesting the unpredictable rainwater. In so doing, these farmers were using climate adaptive crops (mostly small grains and pulses) in addition to the normative ubiquitous maize crop. This was not only an act of faith (that it will rain to an extent of harvesting some) but also an exercise of agentive experimentation with available resources (re-imagination of water, land management, human labour and tools). These farmers took advantage of the natural tendency of the water cycle by preparing in advance to receive taking cognisance of the proverb '*yadeuka mukaka haudzoregwi*' (Chishona). This literally means that once milk has been spilled to the ground, it is spoilt and one cannot return it to its container. The deeper meaning of this metaphor is that one must not dwell on a problem but must accept reality and move on, equipped with better wisdom to avoid or address the recurrence of the problem. Their crop production typically used locally adaptive open pollinated varieties (OPV) of seed for crop production, and indigenous and naturalised vegetables for horticulture. Vegetables and fruit trees (horticulture) production typically occurred in integrated agro-forestry systems (see Figure 5.1) or separately, with indigenous vegetables sometimes grown in special places near the homestead or in gardens.

Figure 5.1: *An agro-forestry system combining fruit trees (banana, mango, peach, papaya) and crops in rotation with vegetables in a farmer innovator's dryland fields, in agro-ecological region 4 (note RWH deep contour full of water) [Photo by author January 6, 2015]*

The diversity of small-scale farming systems integrated indigenous and adaptive local knowledges characterised by crop diversity with adapted conventional farming knowledge to suit local contexts. The key distinction between the small-scale farmer-**innovator** activity system and the **typical** small-scale farmer activity system is the intentional and persistent development and use of rainwater harvesting and conservation (RWH&C) systems; locally adapted seed value-chain systems and thoughtful preparation and experimentation by the innovators. The farmer-innovators carried out these experiments over the long term using their own innovations and borrowed ideas around RWH&C and local seed systems, facing and re-solving recurring problems, with much preparation to adapt to context as indicted below:

> *Excerpt 5.3 (Interview #FZ4, January 9, 2014)*
> ***FZ4:*** Before that, I was doing different things but I was *preparing myself* for this farming programme. I realised that in order to do horticulture *I need to first of all fence the garden area*. ... So all these things that you see here are only protected when there is a fence. So this was my preparation all that time, with the aim of doing the farming I am doing now.

In contrast, the farming systems taught in the agricultural colleges were mono-crop systems with food crops dominated by 'improved' maize (and cash crops including cotton and tobacco) (Zimbabwe. MAMID, 2012). A different cultural philosophy obviously informs the teaching and valuing of cropping systems taught in agricultural colleges compared to that in small-scale farming with specific reference to the type of seed systems they use. This difference points to a potential cultural conflict in any relational practices and actions between small-scale farmers and agricultural colleges. A typical place for such potential conflict would be farmer-training sessions facilitated by college farmer trainers and outreach activities by lecturers and students in farming communities.

The photos below (Figure 5.2) show typical mono-crop maize production systems from two of the agricultural colleges in the Zimbabwean case study. The crops are succumbing to moisture stress due to drought as the irrigation systems were struggling to cope.

Figure 5.2: *Typical mono-cropping system of maize at two of the Zimbabwean agricultural colleges showing moisture stress resulting from dysfunctional irrigation systems.*
[Photos by author: left, college A: February 18, 2016; right, college B: February 19, 2016]

The quaternary contradiction between the object of the farmer-innovator activity system and that of the agricultural college lecturer activity system is discussed in Chapter 7 as a mediated expansive boundary-learning endeavour. Figure 5.3 in the next section illustrates a small-scale farmer-innovator activity system.

5.3.3.1 Elements in the small-scale farmer innovation activity system

The elements in the small-scale farmer-innovator activity system are constructed from the idea of collective activity in the model of second-generation activity theory. The object of the farmer innovator is the key factor determining the other elements in the activity system. In this case, the initial object is rainwater harvesting for own successful food production for food security and income generation from selling any sellable surplus as shown in Figure 5.3 below. 'Own' and 'successful' are key states of being here as they indicate freedom or sovereignty in food production and determination, respectively. They are evidenced by farmers' and agricultural educators' agentive and appreciative talk as follows:

> *Excerpt 5.4 (interview #ACMZ2, June 26, 2015)*
> ***R1:*** You told me previously that you have had some encounters with these rainwater-harvesting innovators. What sort of encounters have you had?
> ***ACMZ2:*** I visited Mr Zephaniah Phiri and we spent a whole afternoon with him. He took me round to see what he has done. *He explained how he developed the water harvesting system*. Thinking back now, I also *met a farmer in Rusape who actually went and designed his infield system because he had already marked his collection points*. He built a wall on a hill which had a continuous flow of water. ... to *harness that water* with *an outlet at the bottom of the wall and what he did was take it from there out to the field*. Many years ago, and I never thought of it as rainwater harvesting. ... you know, *that was one innovative farmer* that I saw because it was on a hill and his field was across a stream so we designed the system to take water to the field across the stream.
> ***Researcher:*** So you were actually involved with this particular…
> ***ACMZ20:*** Yes I was actually working with the irrigation department.
> ***R1:*** Because it's definitely water harvesting
> ***ACMZ2:*** It is but I only started calling it that now *but then I just thought "hey, this farmer is clever", because that water was just going down the hill*.

The work of RWH&C farmer innovators has received recognition and appreciation from professionals working in the Zimbabwean agricultural colleges as shown in excerpt 5.4, indicating the presence of boundaries between the two activity systems.

5.3.3.2 Germ cell characteristics in the object and boundary zones

There are important germ cell characteristics that can be identified in the citation above such as farmer rainwater harvesting innovations making good sense and meaning to professional water scientists, such that they identified them as innovations. Germ cell characteristics here include the successful harnessing of adequate amounts of rain and runoff water, its conveyance to the crop or sinking in the soil profile and its management. These germ cell characteristics provide a **symbolic boundary**

between small-scale farmer innovators and agricultural educators that are in the community of the innovators meaning that there is a learning opportunity. **Conceptually**, however, these boundaries become **permeable** because the ideas of water harnessing, conveyance and management are part of conventional irrigation systems management that is taught in the agricultural colleges (DAEZ6). The construction, use and "maintenance of farm dams" (DAEZ6, p. 24) further connects with the ideas of in-field rainwater harvesting employed by farmer innovators. This **boundary permeability** provides points of convergence, affinity and relationality between farmer innovators and agricultural colleges that can jointly be explored in boundary learning change laboratory experimentation as is discussed in Chapter 7.

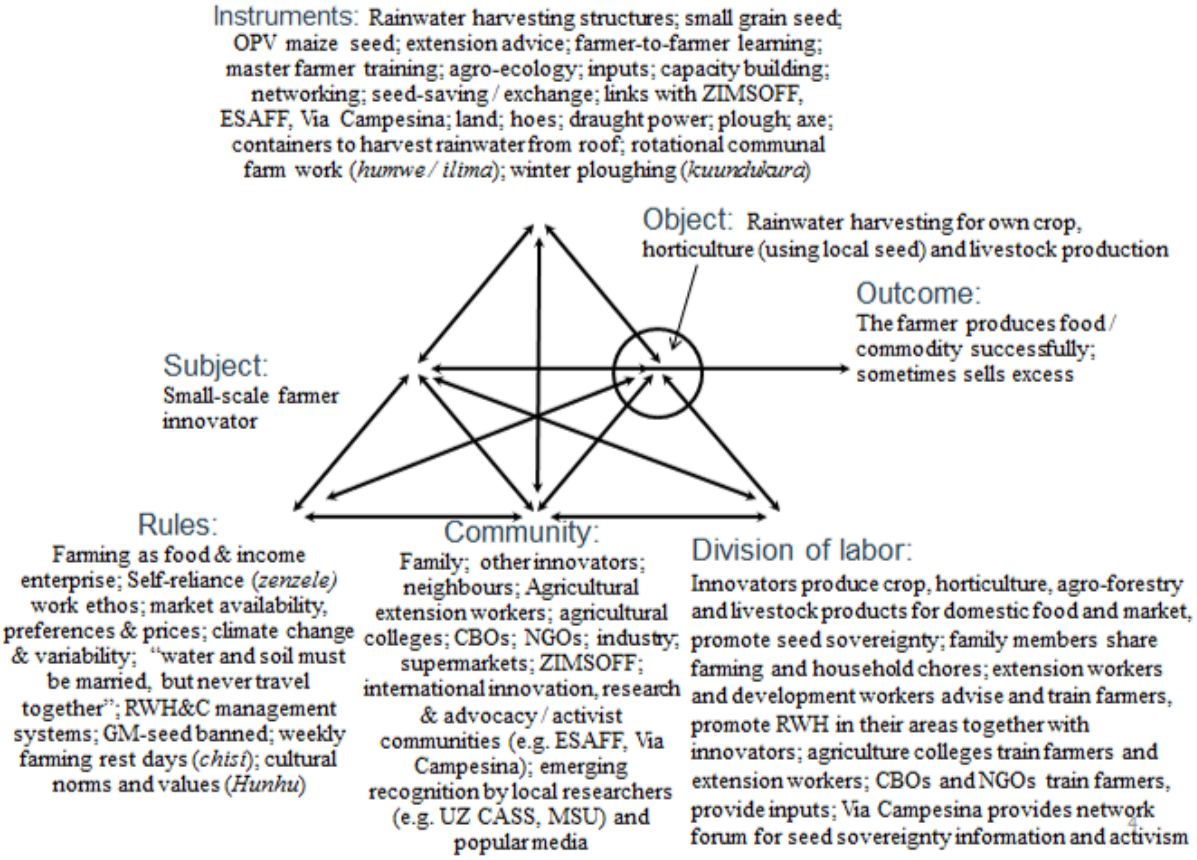


Figure 5.3: *Zimbabwe small-scale farmer-innovation activity system at beginning of research*

In the above activity system, small-scale farming is a family affair, with both adults and youths, male and female in the household participating in various complementary farming actions. The farmer's object is to produce food crops, vegetables and livestock products to feed his or her family, with the excess, together with other commodities for sale to raise household income. Seed inputs vary from saved seed from previous harvests and seed exchange with other farmers and relatives, to buying from seed outlets. The farmers planted seed mostly in traditional mixed cropping systems where a staple grain such as sorghum or maize was combined with a cucurbit such as water melon or pumpkins, and

a legume such as 'cowpeas' (FZ#1, FZ#2, FZ#3). These inputs and systems form the mediating tools for farming. However, the tools of distinction between typical farmers and farmer innovators include well-researched and maintained rainwater harvesting structures and locally adaptive indigenous OPV-seed value chain systems linked to national and international socio-ecological innovation networks. Indigenous leafy vegetables were also found growing in such fields.

The small-scale farmer innovators' activity system shows a high degree of specialised and disciplined division of labour in the community's learning and training for food sovereignty and sustainable agricultural water, starting with the core family and extending to the community.

Excerpt 5.5 (Interview #FZ4, January 7, 2015)

1) ***FZ4*:** So these are some of the activities we are doing? *We also learnt that we must plant seeds that are not GMOs*.
2) ***R1*:** Okay. Who was training you these things?
3) ***FZ4*:** We were mostly taught by [name of lead farmer innovator supplied, FZ2] because *he goes away to learn and returns to train us,* as the leader of the farmer innovators in our area. *He trains us that we must live from our own seeds* so that even regarding vegetables *we have now learnt that we should not plant vegetables using fertilisers*.

It was found that a lead farmer innovator (FZ2) was responsible for mentoring other farmers as testified in citation above, and he himself was connected to a larger national network called Zimbabwe Smallholder Farmers Forum (ZIMSOFF), (see section 2.4.3.3).

Excerpt 5.6 (Interview #FZ2, February 19, 2016)

FZ2: We (ZIMSOFF) are actually a member … ESAFF is a member of La Via Campesina. That's why we were able to host the international office of the secretariat of Via Campesina in Harare.

Figure 5.4 below illustrates a historicity of the objects of agricultural water, locally adapted seed value chains and collective learning in the small-scale farmer-innovator activity system.

5.3.3.3 Historicity of the objects of water for food (M), locally-adaptive seed (S) and collective learning (C) in the small-scale farmer-innovation activity system

In order to appreciate the contradictions in the small-scale farmer innovation activity system, it is necessary to give an appreciation of their farming successes under adversity due to their having rainwater harvesting structures in their fields. Behind these successes is a multiplicity of contradictions that these innovators had to resolve historically, and have to confront in the future with a collective. The citation below shows that small-scale farmer innovators who have implemented rainwater harvesting have been able to survive severe drought periods using rainfall captured by their in-field rainwater harvesting works. It demonstrates the typical water problems that farmers face due to

marginal farming contexts and changing and variable climates, and how adapting through soil conservation and water harvesting measures can make a difference.

> *Excerpt 5.7 (Interview #FZ2, February* 14, 2015*)*
> ***FZ2:*** *For the past three years, our environment here seems to have changed. It is dry*. Rainfall has not fallen to the extent of causing rivers to flow, but *as for us in our fields especially this one where we did soil and water conservation*, all that large quantity of water you once saw before that got finished one year; it got completely finished in 2008 when *we used it to water this whole field.*

Figure 5.4 below documents some of the key historical milestones in the small-scale farmer innovators past and current work.

Object historical layers and changes in agricultural water supply, delivery, storage, use and conservation activity in the small-scale farmer-innovator activity system	<u>Pre-1890s</u> *Cultures of seed saving and exchange (using locally-adapted OPV seed varieties of small grains millet, sorghum, cow peas = OBJECT S[19]1) depending on rainfall and the water cycle (Object M1)* *Before the plough was introduced in the 1920s, agriculture was based on mixed farming, i.e. shifting cultivation and livestock with the latter providing transport and manure. While livestock was not used as draught power, it played an important role in society (Hagmann & Murwira, 1996).* *Indigenous RWH&C and SWC practices (such as 'Kuvundukura') = OBJECT M2* *Culture of collaborative rotational work from one family plot to another (traditional practices of nhimbe = TOOL C1)* <u>*1890s – late 1950s:*</u> *Colonial period: Land Apportionment Act of 1930: Law f****ormally separating of land between Blacks and Whites. High rainfall fertile areas reserved for private large-scale farming by White owners; low rainfall areas for Black communal subsistence farming.*** Dislocation of people in Mazvihwa and Zvishavane (as in most parts of the country or 80% of land area) to marginal areas. *Culture of collaborative rotational work disrupted (individualised family work and poor access to distributed labour and draught power = TOOL C2)* *Cultural disruptions and changes, and marginalisation of indigenous RWH&C practices. Culture of harvesting water from roof tops using various receptacles (buckets, dishes, drums etc. = OJECT M3) [up to present day (-2018-)]* *Maize Control Act of 1931, Maize Control Amendment Act of 1940, Grain Marketing Board Act of 1950: Legislated limitations to Black small-scale farmers' maize production to prevent competition with white commercial farmers* *Indiscriminate introduction of contour ridges for compulsory use in small-scale farming areas (1930s). Enforcement of contour ridges by the Natural Resources Act section 52 in 1941. Genesis of conflict between farmers and extension agents regarding contours ("nhamo yemakandiwa", Shona for the tribulations of forced contour labour)*

[19] In this table, objects and other elements are indexed as follows: Seed object = Sx, where X ranges from 1 meaning initial state in a defined period, evolving sequentially to their states in different periods till a final state. The water object is Mx, where X ranges as described for seed. The same coding applies for collaborative Tools = C

	Land Husbandry Act of 1951: Conservation measures and good conservation practices regulated. Compulsory labour in making on-farm drainage contours to channel out rainwater from fields. Land development Officers (LDOs) enforced these measures, "many of whom behaved as if they were policemen" (Pollak, 1975, p. 267). [many facets of these laws have been carried into post-1980 Zimbabwean independence (Mhizha, Ndiritu, Nyagumbo, 2009)]
	Mid-1960s – late 1990s *Unilateral Declaration of Independence (UDI) of 1965: Independent Rhodesian state rule created by minority without consent of British Monarchy.* Arrest of Phiri Maseko for digging and successfully harvesting and using deep contours in his fields in 1964 (Witoshynsky, 2000). *Farmer-led innovations in rainwater harvesting and conservation merging scientific and indigenous knowledges and own initiatives (transgressive dead level deep contours as objects of prosecution by some Land Development Officers and Magistrates but later accepted by others = OBJECT M4)* *Secondary contradiction: rules (regulation drainage contours for soil conservation) vs object (transgressive labour-intensive deep contours for rainwater harvesting)*
	Early 1980s – present (2016) *Abolishment of the Land Apportionment Act* *Democratic Independence (1980) and National Development Plans:* improvement of education provision and tertiary agricultural education. *Rejuvenation of collaborative farm work / labour pooling (motivated by remnant cultural practices, independence and ujamaa philosophy carried forward from Tanzanian military training camps and local war base camps) = TOOL C3* *Formation of rainwater harvesting NGO (Zvishavane Water project) by Zepheniah Phiri and adaptation and adaptation of rainwater harvesting innovations by farming communities in other districts (e.g. Mazvihwa in Mberengwa) and provinces (Chivi in Masvingo; Chimanimani in Manicaland; Mutoko in Mashonaland East) = OBJECT M5* *Compulsory Land Acquisition and Redistribution Act, 2002:* legislation to compulsorily acquire and redistribute commercial farming land, mainly from commercial white farmers to black farmers. Economic sanctions from UK, EU and USA, reduced economic performance and inflation resulting in economic meltdown and reduced government support to state agricultural education institutions. *Germ cell properties of Zvishavane, Mazvihwa rainwater harvesting innovators accepted by local extension services and noticed by many country-wide = OBJECT M6* 2015 RioZim Ltd. buys small grain seed from a seed and water harvesting farmer innovator in Mazvihwa and distributes to local drought-stricken farmers to plant, but they convert to food as food is scarce and drought strikes again in 2015/2016 season (FZ2, 2016).

Figure 5.4: *Historicity of the objects of agriculture water, seed-based value chains and collective learning in the small-scale farmer-innovator activity system*

The historicity above shows that there has been an evolution of the culture of deliberate soil moisture conservation and water capture. It can be traced from the cultural practices of winter ploughing and capturing of water flowing off rooftops during rainfall events and possibly other previous practices where farmers used sharp wooden sticks to scratch soil surfaces to sink water into the soil (see Chapter

2, section 2.4.2). The principle of capturing, storing and sinking water into the soil or crop-root moisture availability provided a **germ cell** for rainwater harvesting and conservation innovations for small-scale farming in Zimbabwe, not unlike *gelesha* in the South African case study (Engeström, Nummijoki & Sannino, 2012; Pesanayi, 2016a, see Chapter 4). The collection of rainwater using portable containers illustrated the principle of water capture and storage for future use, despite the disadvantage of lacking storage facilities of sustainable volumes. Critchley et al. (1992) regarded Zimbabwe as having a long history of soil conservation measures designed to protect soil from erosion in rural farmers' fields but with no focus on conserving moisture. This history is connected to government policies responding to land degradation in the crowded rural areas known then as native reserves (see Section 2.3.3).

5.3.3.4 Identifying a germ cell in the small-scale farmer innovation activity system and its boundary properties

The nature of the germ cell referred to earlier has been described by farmer innovators using it as the capturing, storing and sinking of rainwater and its use and management (Pesanayi, 2016a). This process was identified as a germ cell exhibiting characteristic properties of the whole agricultural water supply system, and expands towards a solution to water scarcity for agricultural actors. While not necessarily an exhaustive answer, it can be contextualised based on the traditional practices of conservation tillage, moisture conservation and RWH&C innovations. This germ cell has been tried and tested by farmers themselves and also by water scientists in Zimbabwe and elsewhere and recommended for scaling (Critchley et al., 1992; Witoshinsky, 2000; Mhizha, Ndiritu & Nyagumbo, 2009; Denison et al. 2011). It has been shown to be scalable vertically and horizontally, and in the case of farmers or agricultural educators new to it, it is often an abstract starting point especially when applied in-field and can expand to a concrete object. Examples of vertical scaling include the use of rainwater harvesting innovations by many rural small-scale farmers in Runde (Mazvihwa), Chimanimani and Mutoko rural districts of Zimbabwe with varied adoptions and adaptations but a common recognisable scaling object being the germ cell described above (Pesanayi, 2016a; ZIMSOFF, 2016). In this case, the scaling was a geographical spread in numbers of people. This germ cell has conceptual and symbolic properties that draw boundaries between small-scale farmer innovators' agricultural water activity and those advanced by the normative agricultural education activity. These boundaries therefore warrant exploration in order to understand the relational issues between the interacting activity systems.

According to Lamont and Molmár (2002)

> Focusing on boundaries themselves may generate *new theoretical insights about a whole range of general social processes present across a wide variety of apparently unrelated*

> *phenomena*—processes such as boundary-work, boundary-crossing, boundaries shifting, and the territorialization, politicization, relocation, and institutionalization of boundaries. (p. 168, emphasis mine)

Water engineering experiments carried out in similar socio-ecological contexts have also demonstrated that retaining water in the field rather than draining it away improves soil moisture retention, thus providing scientific credibility to this germ cell.

> Draining water away from the field using graded contours results in reduced soil water availability in the field compared to either having no contours or constructing dead level contours. … This indicates that dead level contours retain moisture in the field. (Mhizha et al., p. 12)

This result has however long been 'proven' by smallholder farmer innovators in their lived experiences and own rudimentary citizen science-type [or rather different ways of knowing (Eitzel, et al., 2017)] socio-ecological experiments as shown in Figure 5.5 below. An example of these experiments is described as follows by one of the farmers in excerpt 5C:

> *Excerpt 5.8 (Interview #FZ2, October, 2013)*
> ***R1*:** Could you please explain to me what these water-harvesting contours you are talking about look like?
> ***FZ1*:** These are common contours. …we *converted them from drainage contours … that were meant to channel water out of the field* such that water was not supposed to stand in the contours at all and flow down the field that way. So *we converted them to dead-level contours* with uniform gradient. It *does not allow water to drain out* before saturating the soil.

It can be seen here that the **boundary** separating the small-scale farmer innovator activity system is its embodied germ cell that according to Akkerman and Bakker (2011) is "constitutive of what counts as expertise or as central participation" (p. 312).

Figure 5.5a: *Manure-enriched raised beds clearing vegetable root zone from water logged profile in a RWH&C system (note the wet contour basins between the beds) [Photos by author, January 9, 2014]*

The market (in this case, a town supermarket and farmers' market in the township) dictates certain quantities of particular vegetable commodities per day with the supermarket system in Zvishavane town insisting on its expected quota being met regularly. The market demanding not only the leafy vegetables such as cabbages and rape (Lat. *Brassica napus* in Figure 5.5a) but also tomatoes and onions among others, there is pressure on the farmer to produce quantity consistently in order to meet fixed market demands (economic sustainability) versus environmentally sustainable poly-cropping systems. This is a manifestation of a primary contradiction in the tools of the use value (garden system that maintains the farming base, soil and water) and the exchange value (garden system that meets market demand consistently). The market dictates criteria for a garden system that meets its demand.

Regarding water management, the system of raised beds for the vegetables above is unusual but was used here as an innovation to utilise the water and at the same time, avoid water logging. The farmer indicated that in the late evenings, night and early mornings (the cool of the day), the water table would be high (see Figure 5.5b) and therefore water reaches the root zone, while during the day when there was heat, the water table would be low and almost invisible.

Figure 5.5b: *Farmer innovator showing shifting soil water level, high in the early morning and lowest around midday [Photo by author, January 9, 2014]*

The farmer in the figure above indicates the water level that he watches as he manages water in his garden, again demonstrating the management character of this germ cell. The market also demanded

root tuber crops such as sweet potatoes, which traditionally are grown as a mono-crop under particularly wet conditions (Figure 5.5b).

Figure 5.5c: *A thriving mono-crop system of sweet-potatoes grown on traditional raised mounds (note the moist water harvesting contours between the beds) [Photo by author, June 22, 2014)*

Despite being in the same agro-ecological zone, the innovations above in a waterlogged context differ from those in Figure 5.5d below in a drier area.

Figure 5.5d: *Left: Deep contour rainwater harvesting innovation, showing depth at waist level - about 1m high; Right: Water management valve controlling water movements from one contour to another [Photos by author, January 9, 2014]*

The diagram above shows the water capturing and storage characteristics (left) of the germ cell and its management characteristics (right). In this case, the management function is for shifting water from one contour to another in case of excess water storage or water logging.

5.3.4 Contradictions surfacing from the Zimbabwean small-scale farmer innovation activity system: 'Peeling the onion'

Despite having successfully confronted issues of sustainable agricultural water and locally adaptive seed systems, the small-scale farmer innovators in the Zimbabwean case study were confronted with new problems manifesting within and between some of its activity system elements. Hence, the resolution of contradictions is a continuous process, like peeling the metaphorical onion conceptualised by Sannino and Engeström (2011, see Chapter 3). Figure 5.6 below shows the small-scale farmer-innovator activity system with discursive and concrete manifestations of primary contradictions in each elemental node as described by the farmers and other community members of their activity system.

5.3.4.1 Primary contradictions stemming from their discursive and concrete manifestations in the small-scale farmer-innovation activity system

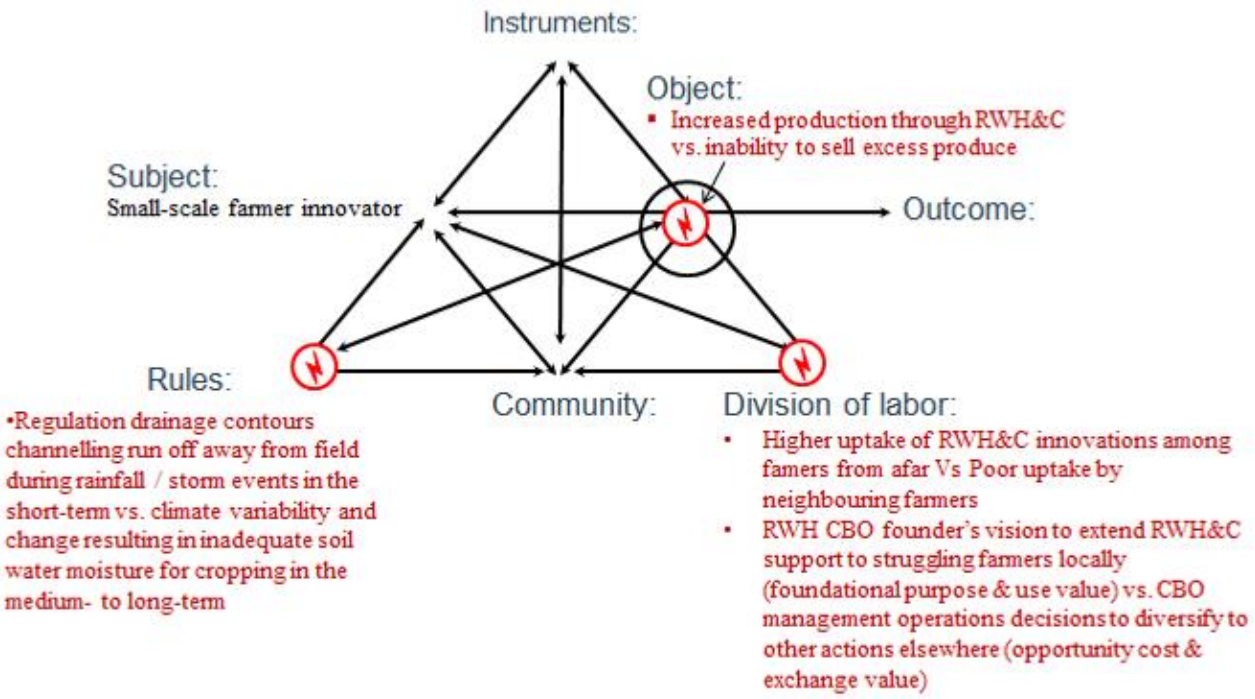


Figure 5.6: *Manifestations of primary contradictions in the small-scale farmer-innovator activity system*

A key **<u>manifestation of the primary contradiction (#MPCFiZ1) in the object</u>** of the above activity system is

Increased production of small grains through RWH&C vs inability to sell or market excess produce

This manifestation presents itself as double bind whereby farmers know that small grains perform successfully in their type of climate and that they can produce more from them using rainwater harvesting than they can from any other crops. However, they also face challenges in marketing the produce once they have excess, which is a frequent occurrence. It may be interpreted as occurring in the empirical domain of reality (Bhaskar, 2008a) as it is experienced this way by the farmer innovators.

There are various dimensions to the problem of marketing small grain produce, that are captured in the citation below from a dialogue between the researcher (author) and a small-scale farmer who had adopted rainwater-harvesting innovations (this dialogue is typical of his group):

Excerpt 5.9 (Interview #FZ2, January 7, 2015)

1) ***R1:*** All right, so this is about finding means to fence your fields?
2) ***FZ4:*** Yes its fences. *If only the government was to encourage companies around us to give us a hand in buying our produce*. These include vegetables, small grains because *we sometimes enter the mine premises here and you can find people having a meal with millet* sadza *[Shona for the main traditional staple starch preparation] sometimes* sorghum sadza. So our wish was that, because *alone our voices are not able to exercise the required power…*
3) ***R1:*** To be listened to?
4) ***FZ4:*** Yes, but if only we could get assistance to access markets around us within the mines near us. If they can find us a market so that we can sell produce regularly. This is what will provide full security for our fields from roaming livestock so that when we plant our crops they do not get damaged.
5) ***R1:*** Okay.
6) ***FZ4:*** These are some of the things that we are wishing council and government to assist with... Once a field is fenced then it is already a sustainable project because nothing will interfere but right now we have managed to fence where we can but there are some places where we have not been able to fence properly.
7) ***R1:*** Is it throughout the year when you have challenges of livestock entering your fields or are there specific times? How is it like these days?
8) ***FZ4:*** These days even if it is a season of herding, cattle get lost but if cattle get lost when fields are not fenced, it follows that you will find the field destroyed. However, what we were thinking as farmer innovators, we were planning that our fields should not be trampled by cattle at any time, we were thinking that because… you will recall that I said in our fields we are planting vegetables because we have water, in our field we are planting fruit trees. So even that time when we have harvested and cattle are normally allowed to roam freely after the growing season we still have challenges because it will be time for those trees to flower. (January 7, 2015)

From the above excerpt the contradictions in marketing small grains are manifested as:

Elaborating #MPCFiZ1: *Critical conflict* in motives aggravating to *dilemma* of markets

There is a *critical conflict* in the production of small grain crops between the rain-fed system farmers' motives to produce food for own consumption and for marketing and the motives to adapt to adverse climate, climate variability and change using small grain seed. This aggravates to a *dilemma* as farmer FZ4 in dialogue turns #2 and #4 indicated that the lack of buying of their produce by an expected local

market leaves them with incomes that are too low to enable them to buy fencing materials to protect their fields – a household economy trajectory that they aspire to. This is due in part to a lack of valuing of local production and poor communication, as corroborated by farmer FZ2, who noted that after two years "we have more than one tonne of sorghum. ... not finding a market to sell to" (October, 2013). The production of traditional small grain crops is promoted by government and NGOs because they are adaptable to changing climates and they have health benefits (see section 2.4.3). But the current market does not value these types of crop as shown by the opposing forces discussed above. There was a cycle of value chain production of climate-adaptable crops where selling of small grain and horticulture produce was expected to generate adequate income for securing the means of production (fencing off crops and protecting RWH&C works) thereby reducing risk vs poor or no sales as an opportunity cost for producing surplus small grains and vegetables for a non-existing market [***high grain and vegetable productivity vs absence of realised market***] (see Figure 5.7 below, contradiction [1a]).

Manifestation #MPCFiZ2 Critical conflict in local markets side-lining local producers

Mines operating in this community providing small grains meals to their workers, bought from elsewhere vs small grains available with bulking capability in local innovative community but not bought by locally-operating mines otherwise consuming small grains [***Potential local corporate market availability vs absence of actual local corporate market accessibility***].

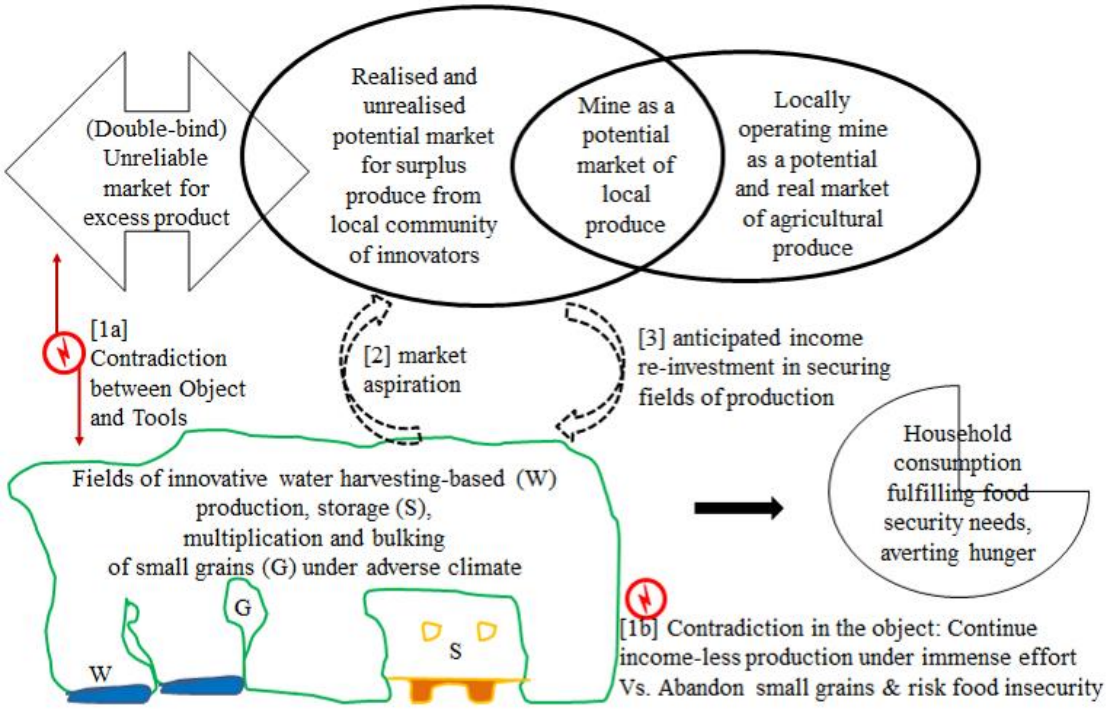


Figure 5.7: *An illustration of the manifestations of primary and secondary contradictions in the small-scale farmer-innovator activity system*

The arrow marked [2] in Figure 5.7 illustrates the need state in the farmer innovator activity system connecting production with marketing which was discussed in section 5.2. Arrow [3] illustrates a responsible business-minded approach to sustainable small-scale farmer development. It is responsible in the sense that the farmers made their own initiative to identify a potential market, and also identified possible solutions locally, namely seeking a collective voice with others to engage with the market (the locally-operating mine). This aspiration for collective activity with others facing common issues of the marketing value chain points to the potential for boundary learning in formative interventionist settings that can lead to expansive learning to model new solutions for the marketing problem and complexities. In ChiShona this is best described by the proverb '*mwana asinga chemi anofira mumbereko'* (literally, the child who does not cry will die in the baby wrap). This means that if a person does not share their problem with others that requires a relational solution, the problem will get worse.

Figure 5.7 above illustrates manifestations of the primary contradiction in the object and the secondary contradiction between the object of rainwater harvesting-supported production of small grains and market dynamics. The manifestation of the secondary contradiction between the object and tools (1a) is a tension between surplus production and an unrealised market. The activity system faces a double-bind in this scenario which is experienced as shown in the empirical data. This manifestation of a problematic market was also echoed by actors in the agricultural education and farmer training activity system. A resource person in an agricultural college curriculum review workshop observed that in the current perception of small grains there was supposedly "no market for the grains: Namibia, Botswana need small grains. Why are we not competitive to export to that market when we have a surplus?" (DAEZ10). This alluded to the possibility of a bigger national problem of lack of a commodity-marketing system for small grain products. This also indicates that the problem of scarce agricultural water is primarily a problem of water for food and nutrition (subsistence) and secondarily, a problem of water for income generation (commercial).

Dialogue turn #8 in excerpt 5.9 shows a shift from seasonal crop farming culture to continuous agroforestry and crop-horticulture cycles combining annuals with perennials that was enabled by improved water availability from rainwater harvesting innovations, hence improving productivity and marketing potential. The problem of finding markets persisted however, and was also identified by two other farmer innovators.

> *Excerpt 5.10: (FZ2, October, 2013)*
> ***FZ2:*** You may have seen those two granaries there as you passed. This year was the worst. But our granaries [ChiShona: "*tsapi"*] have grain. We have more than one tonne of sorghum. We are not finding a market to sell to.

Marketing did not only affect small grains but also vegetables, another product that becomes a possible commodity in dryland areas when rainwater harvesting enables enhanced production (see excerpt 5.1, FZ3, dialogue turns #1 and #5).

Another problem bedevilling small-scale farmer innovators who have found solutions to agricultural water and therefore enhanced and diversified production of crops and livestock, was that of being targeted by theft and acts of jealousy. "We had a councillor whom the poachers told to 'tell that guy that if he prevents us from harvesting the fish we will kill him'" (Interview # FZ3, February 14, 2015). The roots of this victimisation appear to lie in the wide difference between those having excess food and those who are starving under distressing climatic conditions.

A critical realist analysis reveals that the generative mechanisms for the tensions described so far include a national value chain system that has excluded small grains as a tradable commodity and extension policies that have historically undermined the cultural value of small grains and are only promoting them now as a response to drought but without a reliable market.

Enhanced production of a traditional climate-adaptive crop (millet) in a dryland system under rainwater harvesting and conservation made the farmer resilient, but the multiplication and bulking of the grain was not matched with ability to sell the excess produce. Historically, the growing of millets and sorghums is not an innovation as such but an indigenous culture of the people in the study area (Mazvihwa and Zvishavane), and of the majority of Zimbabweans. The multiple cultural symbolisms of these small grains are evident in the people's socio-cultural practices, in reviving the sick and in the adaptation of the grains to the harsh natural environments where they have a proven record of resilience as a coping mechanism.

However, with the coming of the Portuguese to central and southern Africa in the 1400s to 1500s and the slave trade maize (Lat. *Zea mais*) was supposedly introduced from South America; and later popularised by the British colonial settlers (Mlambo, 2014; Wills, 1985). This was done through legislation, seed 'improvement' at research stations, extension and creation of a national market through the Grain Marketing Board. When Black farmers started excelling in maize production turning it into commercial enterprise, the colonial government was compelled to stop what they considered a socio-economic threat to White commercial farming by limiting tonnage. This was legalised through discriminatory agricultural produce and marketing acts, in particular the Maize Control Act of 1931, Maize Control Amendment Act of 1940, Grain Marketing Board Act of 1950 to establish preferential racial competitive advantage (Mlambo, 2014; Zimbabwe. MHTE, 2002; Mutambara, 2015). According to Pollak (1975), "during the depression-ridden 1930s when the white farmers, a potent

electoral interest, were hard hit, agricultural marketing legislation eliminated African competition in the marketing of maize and cattle" (p. 267).

The introduction of maize and its inter-generational uptake was so powerful that maize replaced millets and sorghum as the preferred staple, with a status attached to it and endorsed by the Master Farmer Training Scheme certification (Government of Zimbabwe. AGRITEX, 1994). However, climate change and variability has exposed the poor viability of maize production in drylands, worsened by the proliferation of highly productive but non-adaptive hybrids that farmers continued to grow out of habit and poor extension advice. However, maize improvement has also involved production of open-pollinated varieties (OPVs).

The **manifestation of the primary contradiction (#MPCFiZ3) in the division of labour** of the above activity system is

> ***Higher uptake of RWH&C innovations among famers from afar vs poor uptake by neighbouring farmers***

People's encounters with RWH&C innovations did not always lead to adoption or motivation to learn to do. Despite innovators' willingness to share, acts of resistance were found among most but not all farmers in their neighbourhoods compared with farmers from afar who were willing to learn and do. Among farmer-to-farmer extension courses and assessments of the farmer innovators were requirements for their farmer candidates to describe the following: contours, storm drains, sand traps, mulching and to critically think about and write down the causes of drought, how to fight it and what farmers could do to enhance harvesting of water (DFIZ01). The small-scale farmer innovator activity system differs considerably from that of the 'typical' small-scale farmer at the mercy of waiting for the rain as usual.

5.2.2 Description of the Zimbabwe typical small-scale farming activity system

This section describes the Zimbabwe typical small-scale farming activity system to clarify its differences from the Zimbabwe small-scale farmer innovation activity system and to clarify its need state relative to the other activity systems of interest in this study. Figure 5.8 gives a detailed description of this activity system through its elements.

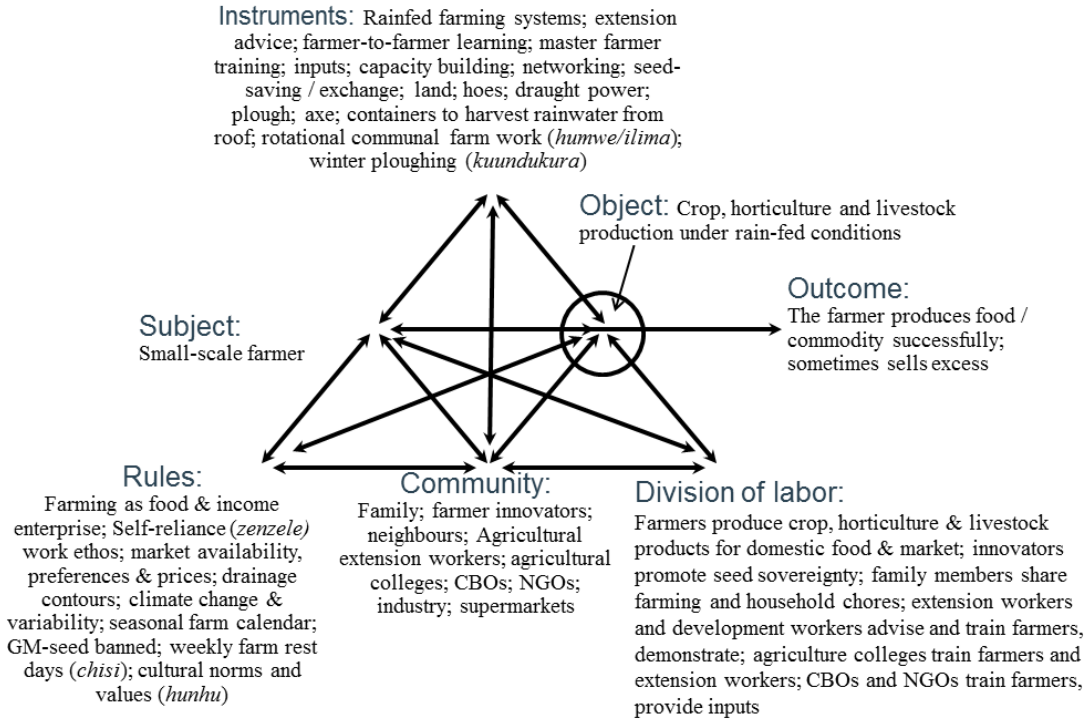


Figure 5.8: *Zimbabwe typical small-scale farming activity system*

The activity system above typifies the majority of small-scale farmers in the study area in Zimbabwe. These are the previously marginalised farmers with histories of exclusion, who have sustainable agricultural water as one of their greatest needs and are at risk of further marginalisation by neo-liberal agri-cultures. These farmers have in common with farmer innovators, most of the traditionally developed agri-cultures such as inter-cropping, rotational communal farm work, vegetable garden and crop fields, working together in the village commons such as the chief's fields to help with feeding the poor and helpless (*zunde ra mambo* – ChiShona).

The object of the above activity system is crop, horticulture and livestock production under rain-fed conditions as one of their mediation tools. Their aspiration for more reliable water supply may become an object of activity when they pursue it. One such farmer from Empress Mine area, Zhombe described this need as follows:

> *Excerpt 5.11: (Interview FZ5, August 11, 2016)*
> ***R1:*** OK thanks. What is the situation with rainfall…?
> ***FZ5:*** Rainfall patterns?
> ***R1:*** Yes rainfall patterns, I am wondering whether you have irrigation here? Water for your crops to grow and flourish. How do you go about it?
> ***FZ5:*** Where I am *there is no irrigation scheme, we depend on direct rainfall. …that's what we use for farming.*
> ***R1:*** Suppose we look back from 1999 when you started farming, which is about 17 years to today in 2016, how do you see trends in rainfall pattern and performance of crops?

FZ5: Umm I can see that there is a huge difference. From especially 2007, all the way before that from 1999, rain was falling well and we were harvesting quite well. *Since 2007 up to last year 2015 jaa rainfall has been inadequate such that the farming has become so difficult, the production is no longer the same*. ... Rainfall patterns have changed also. Here we used to look out to receive rainfall from around 15 November when we knew that it would rain and we would be planting seed. But now as the years have passed by we have started seeing rain for cultivation stating to fall around 30 November. Lately we have observed that we are receiving rainfall only in December. So the rainfall pattern keeps changing with dates shifting to later and later.

The excerpt above shows how the typical Zimbabwean small-scale farmer in a rain-fed dryland area is susceptible to climate change risk. The section below identifies the manifestation of contradictions at play.

5.2.3 Contradictions emerging from the Zimbabwean typical small-scale farming activity system

From excerpt 5.11 above a primary contradiction (#PCFZ1) in the object is manifested as follows:

Poor institutional support and inadequate policy implementation to support farmers producing food in dryland, marginal areas due to focus on commercial faming (use value as commodification value) vs need to adapt locally through collective RWH&C solutions to increasingly erratic and variable rainfall patterns producing risk (exchange value as co-existence value)

The dialogue below between the researcher and a farmer innovator shows that the problem of not capturing rainwater is not simply an absence of knowledge and skills but has deeper generative roots that touch on agency and commitment, and donor dependency syndrome.

Excerpt 5.12 (February 14, 2015)
R1: All right. So what you did here to enable you to harvest water and conserve moisture, is it something that anyone else can do here in Mazvihwa …?
FZ2: Yes.
R1: … Or is it that you have a special place?
FZ2: At one point we were many. I think our people are destroyed by one thing. When we began, we started together with Mr Phiri when we joined Zvishavane Water Project, which was an NGO. From there we joined Africare, which was an NGO. So with our people once an NGO phases out its projects the people no longer participate even though what they had started was benefitting them. We no longer do…

5.4 THE ZIMBABWEAN AGRICULTURAL EDUCATION ACTIVITY SYSTEM AND EMERGING CONTRADICTIONS

The Department of Agricultural Education and Farmer Training (DAEFT), an arm of the Ministry of Agriculture, Mechanisation & Irrigation Development (MAMID) oversees policy development and

policy implementation in the agricultural colleges system in Zimbabwe. DAEFT oversees the operation of agriculture curricula in 13 government and private colleges and training centres of which eight fall directly under government. The latter are Chibero, Esigodini, Gwebi, Mlezu, Rio Tinto and Shamva all offering Diplomas in Agriculture; Mazowe offering a Diploma in Animal Health and Production, and Kushinga Phikelela offering a Diploma in Commercial Farming. The Department has made huge efforts to introduce sustainability systems and content in the curricula of the six agricultural colleges offering a Diploma in Agriculture. This has included introduction of environmental education and conservation agriculture courses since 2010 (Mugabe, 2008; ACLZ1, 2015, Interview #ACLZ1). Both these courses had elements attempting to align the college curricula with global and climate changes, climate variability and local farmer realities (Nyamangara & Mugabe, 2009). The DAEFT collaborated with several stakeholders (community) from the academic, agricultural, water, environmental and private sectors to come up with the environmental education curriculum. These included the University of Zimbabwe's Institute of Environmental Studies who were managing the DFID-funded 'Development Partnership in Higher Education (DelPHE)' project on 'Strengthening Environmental Education in Agricultural Colleges in Zimbabwe'. Figure 5.9 below illustrates the Zimbabwean agricultural education and farmer training department official activity system providing details for each system element.

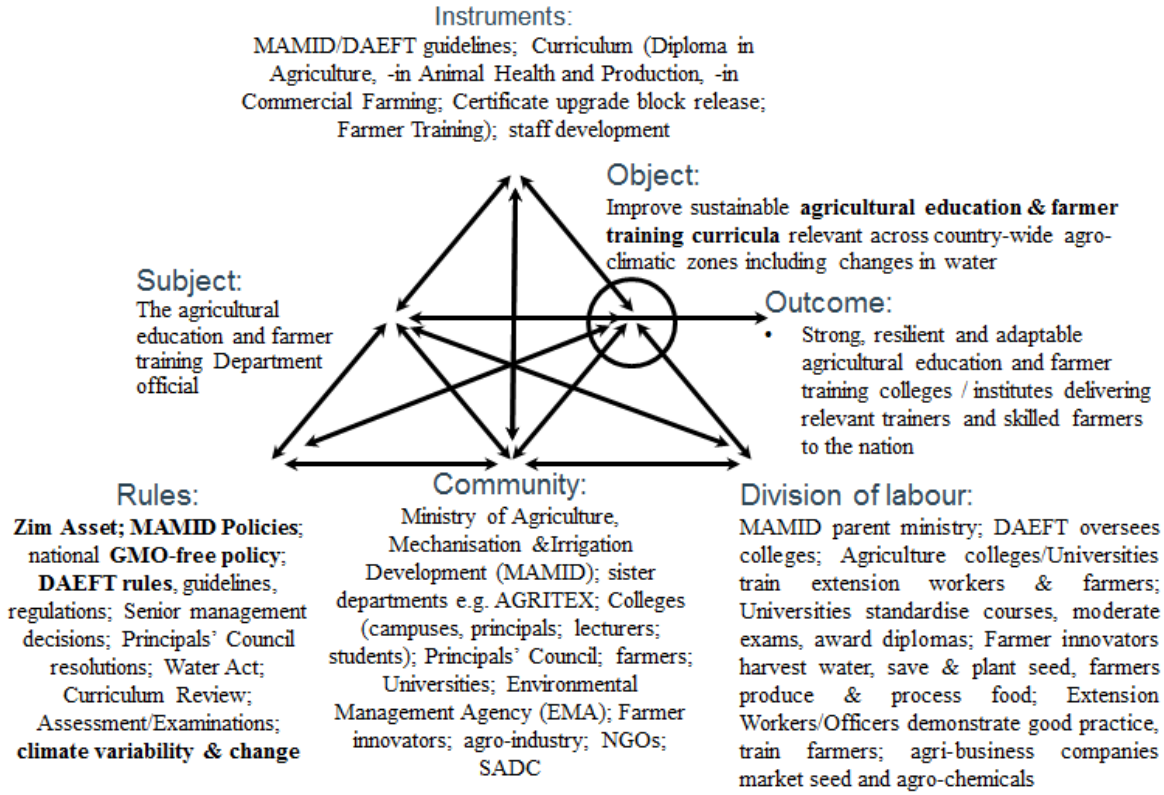


Figure 5.9: *Zimbabwe agricultural education and farmer training department official activity system* ***Rule-producing activity*** *for agricultural colleges)*

Continuing with the community element and its division of labour, the other sister departments such as the Department of Agricultural, Technical and Extension Services (AGRITEX) is a key partner. An important decision-making body is the Principal's Council where principals of all colleges converge at least twice a year to deliberate on various issues including curriculum development strategies. I was privileged to be invited to participate in two such meetings held in Nyanga and at Rio Tinto, where issues of sustainable agricultural water were discussed among others (see section 2.4.4.3).

The rules element in the DAEFT activity system is important because it informs agricultural water possibilities, directs agricultural college curricula and guides engagement. However, interpretation of some of them and business as usual thinking may limit innovation, such as the dogmatic application of normative science without reflection and consideration of indigenous and farmer local knowledges. To this end, the DAEFT activity system is the rule-producing activity system for the agricultural college-lecturer activity system as indicated by the highlighted elements in Figure 5.9. DAEFT is guided by the a policy plan for empowering society and economic growth, the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset) over the period October 2013 - December 2018. Agro-climatic zoning discussed in Chapter 2 and climate change and variability are non-controllable rules of nature to which adaptation is imperative in the agricultural education and farmer training discourse.

To historicise the object of agricultural water in the agricultural education and farmer training activity system, the following timeline of events places the object of agricultural water for the department officials and college lecturers into perspective.

Object historical layers and changes in agricultural water supply, delivery, storage, use and conservation activity in the agricultural education and farmer training department	<u>Pre-1960s</u> *Establishment of skills centres at Tsholotsho and Domboshawa mainly for crafts training in building, carpentry and agriculture, 1923 (genesis of TVET in the then Southern Rhodesia); philosophy transferred from its roots in the crafts training at the turn of the 20th century in Natal (Zimbabwe. Ministry of Higher and Tertiary Education, 2005; Atkinson, 1972, 1985).* *Land Apportionment Act of 1930: Law formally separating of land between blacks and whites.* *Gwebi College opened in 1950 targeting training exclusively to young whites to prepare them to continue the farming legacy of their parents (Närman, 1991, p.43).* *Mlezu (located near modern city of Kwekwe in the Midlands province) opened as a vocational training centre for grade six leavers, in 1959. Training for extension assistants on communal lands; together with agriculture, carpentry and building.* *Rio Tinto established as a skills training centre by Rio Tinto Mining Company in Zhombe.* *Cultural disruptions and changes, and marginalisation of indigenous RWH&C practices (earlier RWH&C practices such as Kuvundukura = OBJECT M1)*

	Preferential promotion by agricultural training institutes of maize seed over small grains in agricultural demonstrator and farmer training (Zimbabwe. AGRITEX, 1994). (Hybrid maize seed developed by research stations = OBJECT Sd1[20]) Mid-1960s – early 1980s *Unilateral Declaration of Independence (UDI) of 1965. Land re-allocated for communal production; system of cooperatives in communal gardens.* *Irrigation systems introduced into agricultural colleges and institutes = OBJECT M3*
	Early 1980s – present (2016) *Abolishment of the Land Apportionment Act.* *Independence (1980) and National Development Plans:* improvement of education provision and tertiary agricultural education (six diploma offering colleges producing extension quality graduates Chibero, Esigodini, Gwebi, Mlezu, Rio Tinto and Shamva). [Rio Tinto was taken over by government in 1984, after closure of Rio Tinto mine, and converted to an agricultural college. Relations continue with the revived Rio Zimbabwe mine, which also has a mine in Mazvihwa, one of the community research sites] Expansion of *Irrigation systems in agricultural colleges and institutes = OBJECT M4* *Compulsory Land Acquisition and Redistribution Act, 1997:* legislation to compulsorily acquire and redistribute commercial farming land, mainly from commercial white farmers to black farmers. Economic sanctions from UK, EU and USA, reduced economic performance and inflation resulting in economic meltdown and reduced support of government agricultural education institutions. *Environmental management education and conservation agriculture modules introduced into Zimbabwean agricultural colleges curriculum in 2009 to respond to the problems of agricultural damage to ecosystems (conservation farming = OBJECT M5)* *Leaking pipes and frequently broken engines from poor infrastructure maintenance, OBJECT M6)* *Mediated Curriculum review workshops and principals' councils from 2013 to 2015 identify rainwater harvesting (OBJECT M7) and OPVs of small grains (OBJECT Sd2) as possible responses to devastating impacts of climate change and water scarcity on production in the colleges.* *Change laboratory workshops in a diverse learning network of agricultural colleges, famers and extension workers among others (2014 to 2016)*

Figure 5.10: *Historicity of agricultural water in the Zimbabwean AET activity system*

5.4.1 Contradictions emerging from the Zimbabwean agricultural education and farmer training activity system

The Department of Agricultural Education and Farmer Training (DAEFT) in Zimbabwe is the rule-producing activity system overseeing training of extension workers, farmers, veterinary technicians and agribusiness operators among others. DAEFT started an environmental education programme in 2009 that opened up spaces for sustainable agricultural water learning in the form of conservation agriculture. This was done in response to gaps identified by a needs assessment that included the impacts of climate change and variability and constrained operations precipitated by the national

[20] The explanation of the codes here are as in Table 5.4 (section 5.3.3.3). In this case code Sdx is for the seed object.

macro-economic recession. The impacts of the latter are multifarious with Figure 5.11 providing a typical example.

5.4.1.1 Contradictions in agricultural water priorities

The Crop Production syllabus used to train extension workers among others treats agricultural water from a technicist irrigation perspective and soil water properties, which is convenient in the light of the availability of irrigation technology. The Agricultural Engineering syllabus (DEAZ6) has made attempts to incorporate conservation agriculture principles, applications, local examples and limitations, but still privileges technicist irrigation without linking it to alternative agricultural water as shown by teaching time allocation and student project focus (Zimbabwe. MAMID, 2016). Sustainable alternative agricultural water such as rainwater harvesting is absent from the water conservation and climate change sections and from the whole document. Unfortunately, the following **secondary contradiction** (#MSCAEZ1) is manifested in the object of agricultural water:

> ***Irrigation technology privileged by Zimbabwean agricultural college diploma curriculum vs unavailability and inaccessibility to small-scale farmer contexts that are served by both extension officers produced by agricultural college curricula and most farmers trained by these colleges.***

Both the Agricultural Engineering (DEAZ6) and Crop Production (DEAZ5) syllabi provide opportunities for alternative sustainable agricultural water. In the DEAZ6 the section on 'climate change and variability' (p. 28) has sub-sections of climate adaptation and mitigation that can bring out more explicitly a link with the practical adaptation measures. This would be in line with practical application points in the background section namely "hands on experience", "hands on training" (p. 1) that are relevant to smallholder farmers such as adaptation to drought through rainwater harvesting, small grains and OPV farming systems. The exclusive pursuit of technicist irrigation is resulting in secondary contradictions between object and tools such as shown in Figure 5.11 and expressed as follows:

> ***Dominant training in irrigation water systems (object) versus aging irrigation systems facing disrepair (tools) in a depressed macro-economic environment***

Figure 5.11: *Typical leaking and derelict irrigation pipes with makeshift maintenance and disrepair in the Zimbabwean agricultural colleges during economic recession (August 2016)*

5.4.1.2 Contradictions linking seed inputs with agricultural water

During a curriculum review workshop for the Zimbabwe DAEFT in March 2015, small grains were discussed as an important consideration in the agricultural college curriculum from the point of view of adaptation to increasing water scarcity. However, a stigma attached to small grains was identified that manifested as "a crop for the poor, not consumed by 'educated' people'; minor crops with no need for practicals; no market for the grains" (DAEZ10, March, 2015). The review participants agreed that the perceptions were all negative and wrong and that colleges contributed to enhancing them. The Crop Production syllabus (Government of Zimbabwe. MAMID, 2012) has the following contradictions with respect to locally-adaptive seed systems (Table 5.2):

Table 5.2: Contradictions in seed systems in Crop Production syllabus: curriculum analysis

Item in syllabus	Element of activity system	Contradictions in work
Small grains (sorghum, and millets) and pulses (bambara nut, cowpeas) (Government of Zimbabwe. MAMID, 2012., p. 17)	Tools	Primary contradiction in tools: Together with five other crops, small grains and pulses allocated 19 teaching hours compared to 24 hours for maize alone.
"**Adaption** (temperature, rainfall and soil); **Uses** of crop and **economic importance** to Zimbabwe's economy" (ibid., p. 17)	Rules	The syllabus assesses crops according to their adaptation to climate (rules) but fails to value the climate-adaptive properties of small grains and pulses in the teaching time and practicals (tools).
Open pollinated varieties (OPVs) (ibid., p. 29)	Tools	Primary contradiction in tools: OPVs play a secondary role to hybrids showing the privileging of scientism in variety selection. This may generate the devaluation of small grains and pulses above.

Basing on the contradictions identified above, I constructed the following questions (Table 5.3) regarding small grains in order to understand the generative mechanisms for their absence.

Table 5.3: Deep ontological questions for critical realist analysis

	Domain of Real	Domain of Actual	Domain of Empirical
Mechanisms (metaphorically, producers of events in the world, Danermark, et al., 2002)	• What structures changed perceptions of small grains as good traditionally to poor people's food in modern society? • What structures and mechanisms influenced agricultural college curricula to downplay small grains compared to maize and cash crops?		
Events	• How do climatic events and climate variability influence curriculum practice for rain-fed contexts with respect to above mechanisms?	• What phenomena and events were aggravated from above mechanisms to absent small grains?	
Experiences	• What underlying meanings derive from the absence of small grains teaching and learning? • How will these meanings affect attempts to improve uptake of small grains?	• To what extent are small grains taught and learnt in agricultural colleges?	• "Why are we not competitive to export to that market when we have a surplus???" (DAEZ10, March, 2015)

These questions were used to inform the dialogues in the Change Laboratory workshops (see Chapter 7) and to continue with the depth analysis of the activity systems. They were helpful in surfacing the contradictions that are reported on in this chapter.

5.4.1 Description of Zimbabwe agricultural education activity system and emerging contradictions

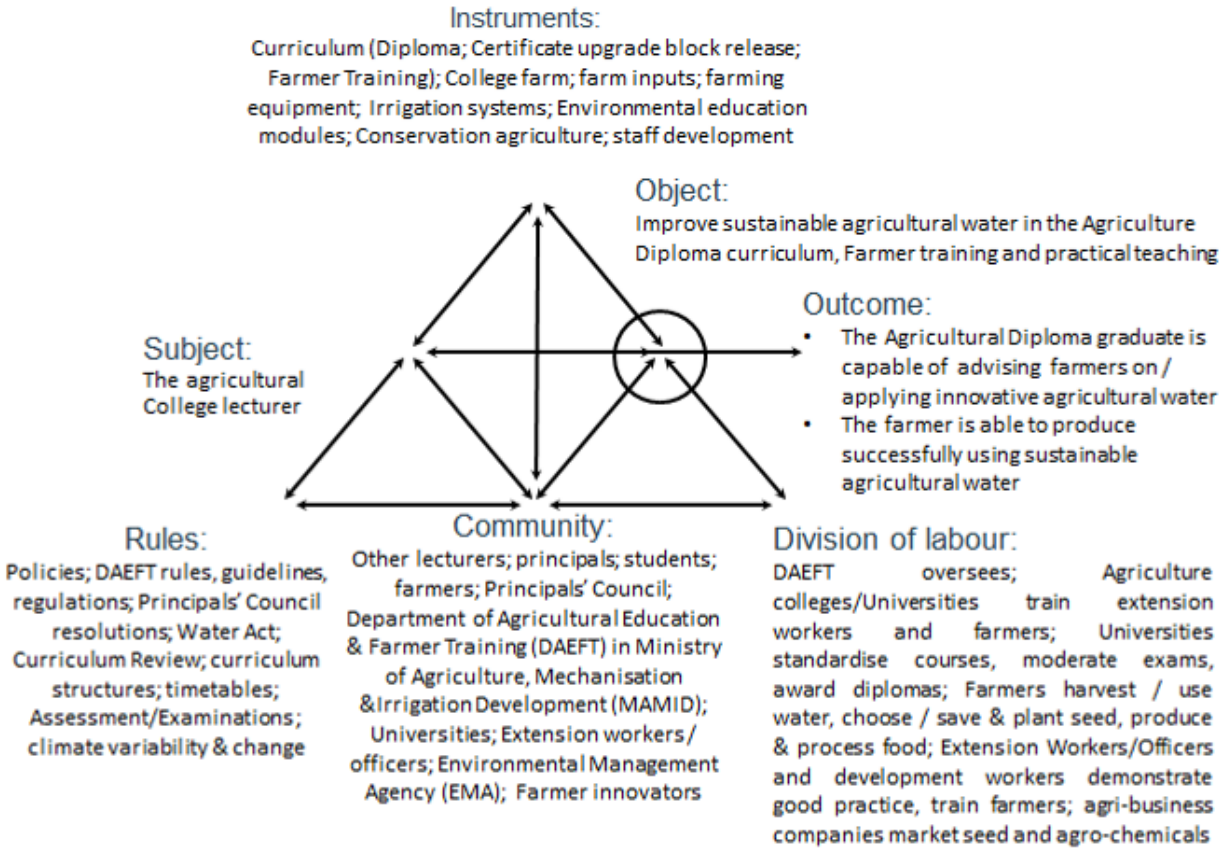


Figure 5.12: *Zimbabwe agricultural education activity system*

5.4.2 Contradictions emerging from the Zimbabwean agricultural education activity system

Having made some good strides in integrating environmental management, climate change and sustainability education in the agricultural diploma curriculum, the agricultural colleges in Zimbabwe can be considered to have made progress against the norm (Nyamangara & Mugabe, 2009; McIntyre et al., 2009). This is because according to McIntyre et al. (2009), integration of environment and sustainability in lecture rooms is a slow process due to initial absence of commitment from agricultural lecturers to go beyond the norm. This was lamented by one lecturer co-ordinating environmental education at one of the Zimbabwean Agricultural Colleges as follows:

> *Excerpt 5.13 (Interview #ACLZ1, February 13, 2015)*
> ***ACLZ1*: *Lecturers are still resisting*** visiting surrounding communities in our EE outreach activities … yet I have found these activities useful in helping extension workers ... to deal with such problems as gulley reclamation and soil conservation ... which they were previously shying away from because they did not learn these practically when they were in college.

Six years after implementation of a newly introduced environmental education curriculum and despite having farmer training and outreach programmes, college lecturers were found to still shy away from reaching out and co-engaging with smallholder farmers. By so doing, they seem to have missed early opportunities of learning from smallholder farmers' real contexts of battling with agricultural water on the one hand, and learning from smallholder farmer innovators' agricultural water innovations that have transgressed the norm of waiting for the rain. Colleges have ironically been forced to face contexts similar to those of resource-constrained small-scale farmers by having to rely on unpredictable and risky rainfall events.

The problem of agricultural water in the agricultural college lecturers' activity system is manifested in the observations made of leaking and inconsistent irrigation equipment and in the feedback from interviews of failing irrigation systems that would otherwise support the teaching and practice of irrigation. This has been compounded by successive seasonal drought events.

Leaking irrigation pipes and wilting crops are symptoms of failing electro-mechanical irrigation systems causing downstream effects in crop, livestock and teaching and learning performance. In turn, they reflect the poor performance of college procurement and maintenance capacity that is responding to a poorly performing national economy despite government's desire to improve agricultural performance and quality training of extension personnel.

The citations and dialogues below clarify the manifestation of this contradiction as dilemmas and double-binds in the activity system. A workshop for the agricultural college principals' council in 2011 funded by the National Manpower Development Corporation (NAMACO) observed a challenge faced

by colleges that "power cuts are frequent, two-thirds of the time (colleges) have no power; this compromises training" (Madzime, 2011). The dilemma between irrigation use and dependence on the electrical grid in 2011 was shown to have escalated into a double-bind by 2016 with colleges wanting to do something about the problem but with a lasting solution evading, as shown in the citation below:

> *Excerpt 5.14 (Interview #ACMZ2, June 26, 2015)*
> ***R1:*** Now, zeroing in on say, maybe irrigation, what would you say are the limitations that you see with the irrigation component of agricultural engineering and maybe other water related sections
> ***ACMZ2:*** *Irrigation does not have adequate equipment*. *We last bought irrigation pipes about ten years ago and we have not been able to buy any replacement since*, so you know it's a system that has become *very wasteful* in terms of water distribution.
> ***R1:*** Is it because of dilapidated equipment?
> ***ACMZ2:*** Yes it's *now old, pipes leak* and *we tried to buy an aluminium welding machine and we couldn't get the funding and that has remained a challenge*. *We once took some pipes to [...place name provided...] for repairs but you know it's really sort of a makeshift system*. We have *flood irrigation and sprinkler irrigation*. Flood irrigation is okay, that is functional but *once there is no electricity both systems don't work and that has always been a challenge.*
> ***R1:*** How often do you lose electricity when you need it?
> ***ACMZ2:*** It's usually about four days a week.

The desire by college management to do something about the problem of water in the colleges was frustrated by failure as they repeatedly faced ever pressing and relentless alternatives in their activity system. These escalating scenarios appeared to present no way out for the colleges as they tried one possible solution after another (e.g. local maintenance, repairs), until the situation aggravated towards crisis proportions (e.g. from systems collapse to crop failure). From the citation above, colleges have been failing to buy new irrigation equipment for college farm operations, crop and livestock production and for students' learning projects. This is a serious drawback as irrigation technology is the main method of teaching agricultural water in the agricultural colleges, yet systems of procurement, replacement and maintenance, whether for flood or overhead (sprinkler) irrigation, are in jeopardy. Irrigation features most in the key curriculum documents as summarised below:

Table 5.4: Representation of agricultural water in key agricultural college curriculum documents

Document and index code	Irrigation content	Other / alternative water content
Crop Production (Document DAECCPZ1) – major course	Dominant	Soil and water conservation; mulching; conservation farming
Livestock Production / Pasture (Document DAECLPZ2) – major course	Dominant (pasture irrigation)	
Agricultural Engineering (Document DAECAEZ3) – major course	Dominant	None
Farm & Agribusiness Management (Document DAECFAZ4) – major course	Dominant	None
Farmer Training (Document DAECFTZ5)	Dominant	Soil and water conservation; conservation farming

The concern in the above citation was also raised by a senior manager in one of the colleges who expressed disappointment at the inaction of college staff after they had visited and seen a rainwater harvesting innovator's farming systems as shown in the dialogue below:

Excerpt 5.14 (Interview #ACMZ2, June 26, 2015)

1. ***ACMZ2:*** I sent staff on three occasions with students and from the general worker to the lecturer and a whole group of students and we tended to send final year students to see.
2. Researcher: Okay, when was this?
3. ***ACMZ2:*** Two and three years ago. *They went to visit and they had a lot of praise for the system that it actually works.*
4. ***R1:*** In total would you know how many people went?
5. ***ACMZ2:*** From the college? I think we're looking at about 180.
6. ***R1:*** That's quite a big number. What follow through has happened since the visit?
7. ***ACMZ2:*** *Not much. That's what I found very disappointing* because I asked the engineering guys who went to actually put up the contour system in the orchard that we have and also at the house where I live because it's on a high place and I thought maybe if they put those contours we could collect all the water that flows from the house to the field area in the homestead but not much has happened. *They just came and dug a small hole and left. So you know it's like people are impressed but you know they are not adopters of technology*, that's the unfortunate part that I have noted...

The following primary contradictions (Figure 5.13) can be identified in the agricultural college lecturer activity system.

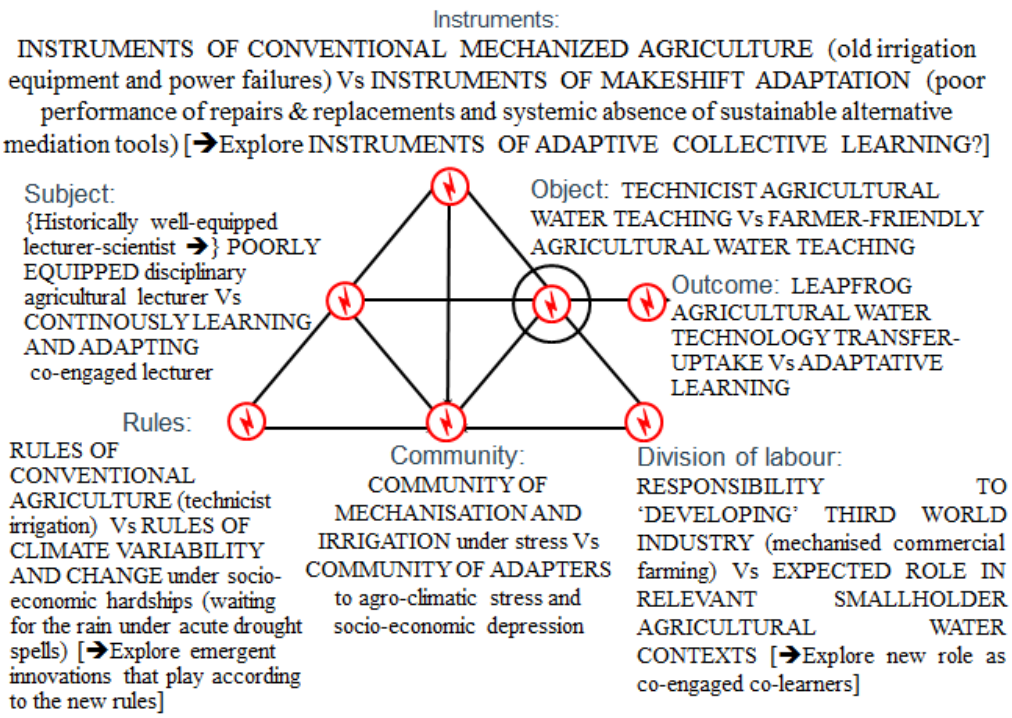


Figure 5.13: *Primary contradictions in the agricultural education activity system*

The ***absence of commitment and resistance to change are manifestations of a secondary contradiction between the subject (agricultural college lecturer) and the object (curriculum innovation for sustainable agricultural water)***.

What this manifestation of a contradiction also shows is that seeing good practice does not always translate to action in professional organisational situations probably because of their complexities. Despite seeing the alternatives to conventional irrigation and ordinary soil and water conservation that are in the curriculum, lack of tangible transformative change resulted that may be caused by lack of applied knowledge and skills, lack of personal agency. It may also be due to lack of connection between applying the innovations and professional key results areas. These possibilities were explored in boundary-crossing laboratory settings (Chapter 7).

The above secondary contradiction also signals a possible conflict between the conventional agricultural conceptual instruments regarding the watering recommended for husbandry of commercially oriented crops on the one hand, and the changing nature of the object, namely the increasingly complex, reliability and ambivalent problems of water security and seed and crop performance under stressful water conditions. Their resolution is an equally complex and contested process requiring integration and collective co-engaged learning of the socio-cultural context of smallholder farmers, extension approaches and a socially just philosophy of agri-business value chains, which may not exist yet.

Below is a summary of contradictions from the various activity systems in the Zimbabwean case studies according to the objects of agricultural water and locally-adaptive seed systems.

5.5 SUMMARY OF CONTRADICTIONS

Tables 5.5 and 5.6 below summarize the manifestations and concretization of contradictions emerging from the activity systems in the Zimbabwean case study.

Table 5.5: Summary of categorised primary and secondary contradictions following the object of agricultural water cross-referenced across different activity systems

PRIMARY CONTRADICTIONS (object of agricultural water)	**Simplified version of primary contradictions as mirrored to participants and forward pointers**
In the object of the **typical small-scale farming** activity system ***Reliance on rainfall for dryland food production in marginal areas vs absence of knowledge to deal with increasingly erratic and variable rainfall patterns producing risk***	*Most small-scale rural farmers have traditionally practised rain-fed farming in marginal areas from historical circumstances of depravation, with no access to reliable water supply such as irrigation. The lack of knowledge of alternative affordable water innovations escalates the farmers' risks in a rapidly changing climate.*
In the object of the **agricultural education** activity system (college lecturer as subjects): ***Focus on conventional technicist irrigation and mechanisation in the teaching of potential extension graduates Vs. Absence of research and valuation of low-tech alternatives such as rainwater harvesting in the agricultural college curriculum***	*The philosophy of agricultural education is science-based and techno-centric such that it fails to consider or see the value in alternative agricultural water knowledge practices coming from farmer innovations even when the contexts of farmers they are serving are different and the economy does not allow maintenance of irrigation systems.*
SECONDARY CONTRADICTIONS (object of agricultural water)	**Simplified version of primary contradictions as mirrored to participants and forward pointers**
Object vs tools in **agricultural education** activity system (college lecturers as subjects): ***Irrigation systems in agricultural colleges installed to demonstrate and serve conventional high-tech agriculture vs absence of maintenance or modification capacity***	*As in left column*
Subject vs object in **agricultural college lecturer** activity system: *The **absence of commitment and resistance to change are manifestations of a secondary contradiction between the subject (agricultural college lecturer) and the object (curriculum innovation for sustainable agricultural water)**.*	*Some college lecturers resisting curriculum innovation in sustainable agricultural water despite gentle motivation from principals in the absence of formal curriculum review and change. (e.g. see excerpt 5.14, dialogue turn #7)*
QUATERNARY CONTRADICTION (object of agricultural water)	*Simplified version of primary contradictions as mirrored to participants and forward pointers*
Typical small scale farmers object of agricultural water vs division of labour in the collective agricultural learning system: ***Desire to improve agricultural water outweighed by labour requirements (object) vs inadequate support from the agricultural learning system within a collaborative network activity system formation (division of labour as co-existence value)***	*(AEWZ2):"if we consider the fruits of rainwater harvesting they see them. The **only problem remains at adoption of practices**. … So **if they maintain their groups it will help them to lighten the labour**" (January 7, 2015).*

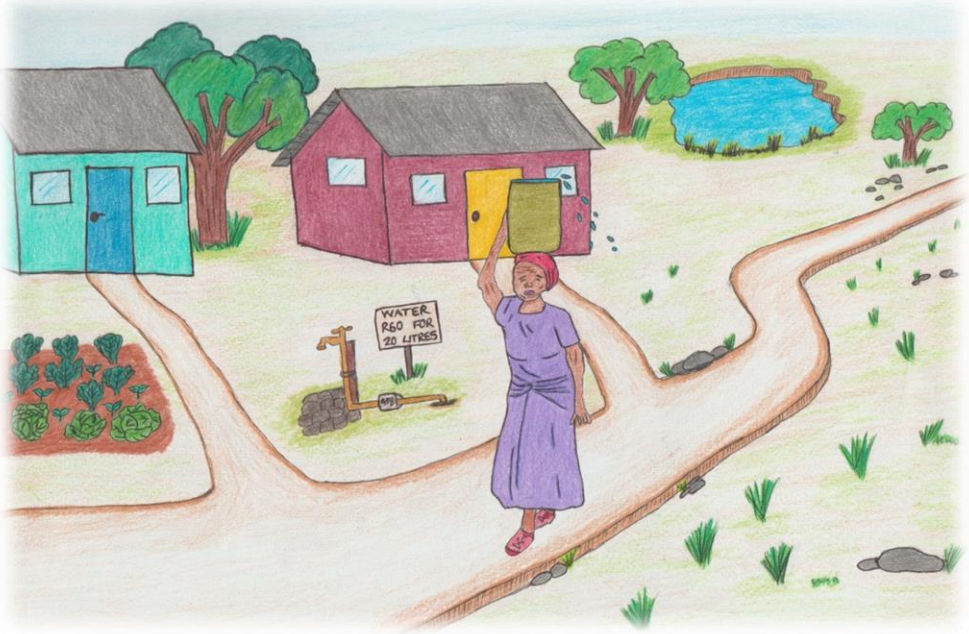
Table 5.6: Summary of categorised primary and secondary contradictions following the object of locally-adaptive seed systems cross-referenced across different activity systems

PRIMARY CONTRADICTIONS (object of locally-adaptive systems)		**Simplified version of primary contradictions as mirrored to participants and forward pointers**
In the object of the **agricultural education** activity system: ***Agricultural Colleges continue to teach, demonstrate and produce maize as a major national staple and for feeding students at the expense of locally-adaptive small grains seen as 'minor crops' vs maize crop failures under drought and irrigation failure***		*As in left column*
SECONDARY CONTRADICTIONS (object of locally-adaptive systems)		**Simplified version of primary contradictions as mirrored to participants and forward pointers**
Object of farmer innovators vs tools: ***High grain and vegetable productivity (Object) vs absence of realised market (Tools)***		*Farmers growing grain crops and vegetables adapted to harsh climates and climate proofed with RWH&C failing to realise markets for their produce.*
Object of farmer innovators vs division of labour: ***Potential local corporate market availability (Object) vs absence of actual local corporate market accessibility (Division of labour)***		*Local mines operating in the community not buying grain and vegetables from local small grain farmers as expected by farmers through corporate social responsibility but instead procuring same grain varieties from elsewhere to provide meals to their workers.* [Possible generative mechanisms: procurement rules, farmers marketing capability and consistency of supply]
Object of farmer innovators vs division of labour: ***Potential local corporate market availability (Object) Vs. Absence of expected actual local corporate market accessibility (Division of labour)***		*Local mines operating in the community not buying grain from local small grain farmers as expected by farmers through corporate social responsibility but instead procuring same grain varieties from elsewhere to provide meals to their workers.*

5.6 CONCLUSION

This chapter described the main activity systems at play in the Zimbabwean case study and provided a scope of historicised contradictions in the small-scale farmer innovation, small-scale farming, extension and agricultural education activity systems, with agricultural water and locally-adaptive seed as related objects of activity. The key contradictions affecting the agricultural colleges were the absence of alternatives to irrigation when the irrigation systems were succumbing to disrepair due to economic recession. For the small-scale farmer innovators, marketing their produce, mainly small grains and vegetables, were the main contradictions in their work, as they were excelling in the adaptive production processes using drought tolerant seeds and rainwater harvesting innovations – lessons in this could prove useful for agricultural colleges. These contradictions were summarised for use in the boundary-crossing formative intervention work described in Chapter 7. Chapter 6 which follows discusses boundary-crossing work in the South African case study.

CHAPTER 6
BOUNDARY-CROSSING EXPANSIVE LEARNING IN THE SOUTH AFRICAN CASE STUDY



"The task ahead of us can never ever be greater than the power within us" Joseph Shabalala

6.1 INTRODUCTION

This chapter describes boundary-crossing expansive learning issues and processes emerging from formative intervention actions involving interactions between four activity systems in the South African case study described in chapter 4. Contradictions surfaced in Chapter 4 on the partially shared object of agricultural water and its related object of locally adaptive seed systems were brought into change laboratory workshops that were situated within an emerging collective learning network (see Figure 1.3 in section 1.5.1). Various boundary-learning actions were used to explore boundary-crossing. These included mediated actions that brought different agricultural actors (subjects) together presenting opportunities for collective co-engaged learning and expanding the joint boundary object. These took place mostly in boundary-crossing change laboratory workshop (BCCLW) settings. BCCLWs were organised mostly within existing or planned activities of the Imvotho Bubomi Learning Network (IBLN) meetings and in Amanzi for Food Training of Trainers' course sessions (see section 6.2). Further BCCLWs were organised at specific sites of action selected by participants namely Lloyd Village garden, Fort Cox College and Matole Basin. Agricultural shows, IBLN community radio shows, course assignments and meetings with key people in between BCCLWs provided key fora and

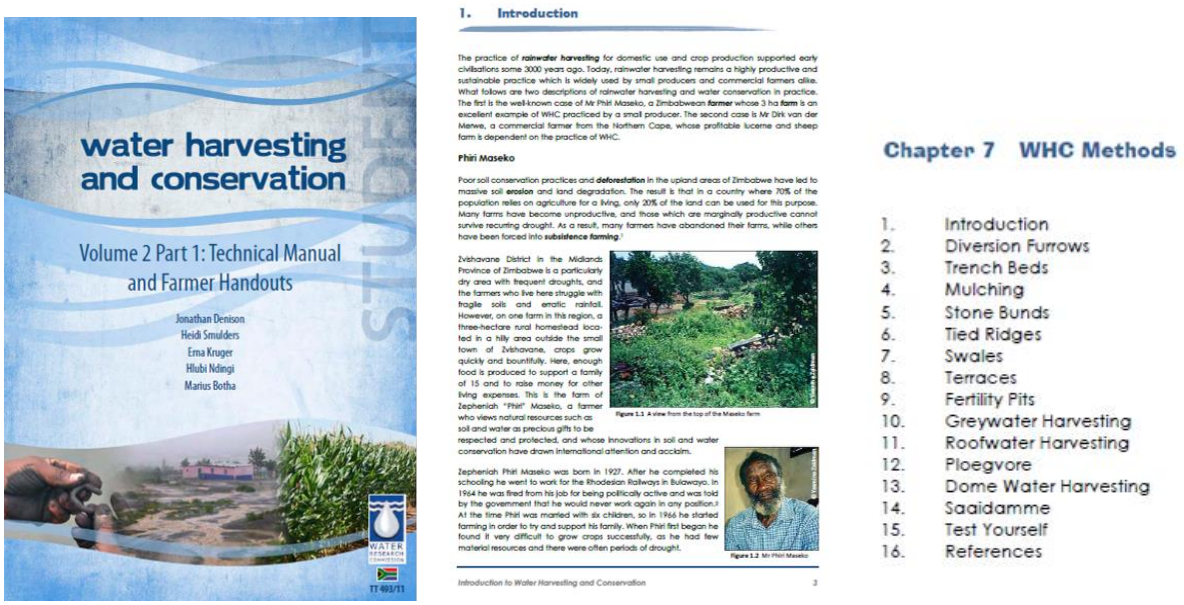
opportunities for expanding learning. I was guided by the expansive learning cycle (Engeström, 1987; Virkkunen et al., 2015), noting participants' agreed and expressed achievements along their emerging learning and agency pathways. Boundary-crossing mechanisms (see section 3.2.1) served as indicators to determine what boundary-crossing had been achieved. The presentation and analysis of data in this chapter is based on six data sources (see Appendix 6.2 and sections 3.5 and 3.6).

6.2 MEDIATION OF BOUNDARY-CROSSING CHANGE LABORATORY WORKSHOPS THROUGH VARIOUS INTERCONNECTED PROCESSES

I used the following interconnected processes agreed on by research participants to discuss common or intersecting matters of concern on water for food and model joint solutions. I first provide a background to the WRC-funded Amanzi for Food project in section 6.2.1.

6.2.1 Background to the WRC Amanzi for Food project: relevance to this study

As mentioned in Chapter 1, I was a project member of the Water Research Commission's Project (number K5/2277//4) entitled 'Action Oriented Strategy (AOS) for knowledge dissemination and training for skills development of water use in homestead gardening and rainwater harvesting for cropland food production' (Lotz-Sisitka et al., 2016). The WRC commissioned Rhodes University to develop an action-oriented strategy to disseminate rainwater harvesting and conservation (RWH&C) materials in the form of two books produced from WRC research work (see Figure 6.1 for book covers and introductory pages). At the top of Figure 6.1 is the Water Harvesting and Conservation (WHC) 'blue book' by Denison et al. (2011), and at the bottom is the Agricultural Water Use in Homestead Gardening Systems (AWHGS) 'brown book' by Stimie et al. (2010). The project began by conducting a scoping study to understand water for food problems faced by research participants and the water for food practices they were using.



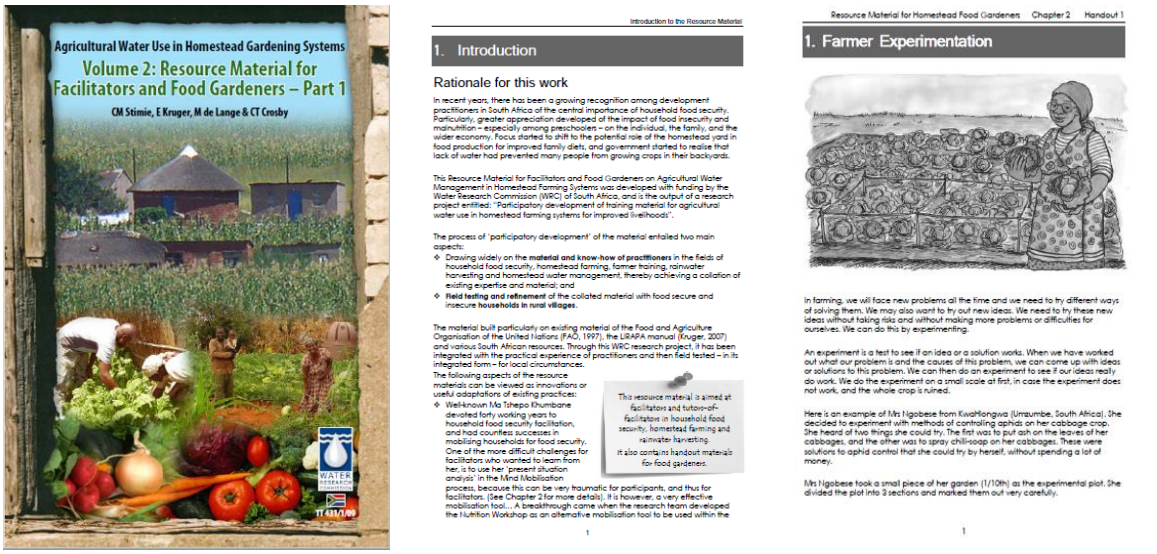


Figure 6.1: *RWH&C sample materials of books provided by the WRC for "dissemination"*

The scoping study concluded that there was little or no teaching and learning of rainwater harvesting in the agricultural colleges and in extension practice (Project deliverable 1, see Lotz-Sisitka et al., 2016). I integrated this scoping study into my research methodology (see section 3.5) and into my activity system analysis (reported on in Chapter 4). It became clear from the scoping study that some agricultural colleges such as Cedara, Fort Cox and Lowveld (now part of University of Mpumalanga, Mbombela campus in Nelspruit), despite receiving the WRC materials, had not yet found ways to integrate them in their work. The materials posted had been kept sometimes unopened, while the majority of staff were unaware of their existence or relevance (Lotz-Sisitka et al., 2016). According to the Chairman of the WRC reference group for this project

Excerpt 6.1 (Personal communication, March 3, 2016)
WRCSA1: We do research within the innovation cycle, creating new knowledge, making sure it is applicable. The intended end-users were involved in the development of the rainwater harvesting and conservation materials and indicated that 'we can use it'.

The well-researched knowledge in the WRC materials and the determination of the WRC, on one hand, and the need for context-specific solutions to water for food problems among farmers, on the other aggravated the contradictions surfaced in Chapter 4. While the "intended end-users were involved", it was not the same people who received the materials in the training institutions, and the blockage in knowledge uptake was not necessarily an issue of knowledge flow but other factors that could only emanate from a specific group working together to solve a common problem. This pointed to the need for a formative type interventionist study with existing knowledge resources and emerging instruments and artefacts serving as mediation tools and stimuli.

6.2.2 Mediation of BCCLWs through a course-activated learning network

A Rhodes University accredited training of trainers' course was designed by the Amanzi for Food project team in consultation with research participants. The Water Research Commission's Amanzi for Food project (see section 6.2.1) provided the course funding. The course was designed to accommodate those whose motivation was to obtain accredited certificates through university assessment and those intending to simply learn more about rainwater harvesting and conservation (identified in Chapter 4 as being of key interest to the object of activity) without formal assessment. In either case, the focus of the course was on changing practices related to RWH&C. The course was accredited with the National Qualifications Framework at levels five and six, with an option of participation with no assessment and certification. An environmental learning and changing practice short course pegged at NQF level five certification was designed with take-home assignments and on-course tasks for farmers and trainers as stream two; this was to support their engagement with RWH&C knowledge in the contexts of their practice (outlined in Chapter 4), offering a means of engaging in more depth with the shared object. The curriculum innovation and changing practice short course pegged at NQF level six certification was designed with take-home assignments and on-course tasks for educators as stream one. As researcher-interventionist I contributed by building in a developmental work research approach (see section 3.4) to the course modules (see Appendix 6.1), thus strengthening their orientation to engaged praxis. Thus, the scheduling of the first learning network meeting and the next five modules of the training of trainers' course was used to host the first six change laboratory workshops for the learning network; in other words, the course was run as a praxis-based questioning and problem resolution process with course participants, along the expansive learning cycle. The participants were motivated to participate in the course to explore solutions together as a result of

interviews and ethnographic work discussed in Chapter 4. This allowed me to align the change laboratories with the course sessions.

A fundamental dilemma was encountered right at the beginning of the intervention process that surfaced a boundary between the intended project mediation tools (information dissemination) and the mediation tools of expansive learning methodology that are emergent. The Amanzi for Food project document (WRC, 2013) described the dilemma as follows,

> It is widely appreciated that *information on its own does not lead to capability development*, and education, training, knowledge dissemination and communication (involving a range of mediation processes) are required… *there is both an urgent need and potential for much greater uptake of available knowledge*. The challenge of achieving traction from research outputs is a global one; and is related to what is now recognised as inadequate Research-Develop-Disseminate-Adopt (RDDA) assumptions of how knowledge is / ought to be mediated in society ... Contemporary theories of learning and change indicate that for knowledge or information to become meaningful, there is 1) a need for the *information to be related to the situation and experience of the user*; and that this needs to 2) be *mediated in context*; in addition to 3) *providing new knowledge* or information that can expand existing knowledge and/or practice. (p. 4)

The dilemma is one of knowledge flow assumptions made from researcher to 'knowledge consumer' versus co-construction of knowledge across emergent expansive agricultural learning activity systems. The Amanzi for Food course was designed to activate and support the learning network formed by research participants within their water for food aspirations. The list in Table 6.1 below shows the boundary-crossing change laboratory workshops conducted in the Imvotho Bubomi Learning Network meetings over two years.

Table 6.1: List of boundary-crossing change laboratory workshops held within the IBLN

Event and hosting venue	Duration	Partially shared object / focus	Core participants	Date
1. Boundary-crossing change laboratory workshop (BCCLWs) 1 at Fort Cox Agricultural College (shortened here to at Fort Cox College), Cwaru	4hr 9min 20sec	Sustainable agricultural water	Agricultural educators (ACLSA2-4) and trainers (ATSA1-3) from Fort Cox College and University of Fort Hare (UALSA1); Agricultural advisors from Middledrift (EOSA1) and Alice (EISA5); farmers from Koloni village (FSA3), Keiskammahoek (FSA7 & FSA17) and Lloyd Village (FSA4); Research technicians (RTSA1&2)	12 August 2014
2. Boundary-crossing change laboratory workshop 2 at Fort Cox College	2hr 15min	Sustainable agricultural water	As above; + LED specialist (NEDSA2)	16 September 2014

3. Boundary-crossing change laboratory workshop 3 at Phandulwazi Agricultural High School, Alice	2hr 10min	Sustainable agricultural water	As above	16 October 2014
4. Boundary-crossing change laboratory workshop 4 at Keiskammahoek Dairy Trust	1hr 10min	Sustainable agricultural water	As above	3 February 2015
5. Boundary-crossing change laboratory workshop 5 at Fort Cox College	1hr 50min	Sustainable agricultural water	As above	17 March 2015
6. Boundary-crossing change laboratory workshop 6 at Fort Cox College	2hr 05min	Sustainable agricultural water	As above	29 April 2015
7. Boundary-crossing change laboratory workshop 7 at Matole Basin	1hr 47min recorded (total time: 3hr 15min)	Locally adaptive seed and sustainable agricultural water	As above + Matole basin farmers (FSA10, FSA18, YFSA2, YFSA3, 2 reseachers) [25 participants]	27 May 2016
8. Boundary-crossing change laboratory workshop 8 at Matole Basin	30min video/audio record (total time: 1hr 30min)	Locally adaptive seed	Matole basin farmers (FSA10, FSA18, YFSA2, 2 reseachers) [11 participants total]	7 June 2016
9. Boundary-crossing change laboratory workshop 9 at Fort Cox College	Ihr 55min	Sustainable agricultural water and locally adaptive seed	Agricultural educators (ACLSA2-4) and trainers (ATSA1-3) from Fort Cox College and University of Fort Hare (UALSA1); Agricultural advisors from Middledrift (EOSA1) and Alice (EISA5); farmers from Koloni village (FSA3), Keiskammahoek (FSA7 & FSA17) and Lloyd Village (FSA4); Research technicians (RTSA1&2); Matole basin farmers (FSA10, FSA18, YFSA2)	21 July 2016
10. Boundary-crossing change laboratory workshop 9 at Fort Cox College	2h 05min	Locally adaptive seed and sustainable agricultural water	As above	7 September 2016

The third column in Table 6.1 shows the nature of the two related potentially shared boundary objects, namely sustainable agricultural water provisioning and locally adaptive seed. The fourth column indicated who attended, showing the core participants who can be seen to be consistent throughout the successive workshops. Matole Basin farmers joined later at the seventh BCCLW workshop and were then consistent throughout. Section 6.3 explores the IBLN boundary-crossing issues through the boundary-crossing change laboratories listed in Table 6.1 and other intervening actions in detail.

6.2.3 Mediating site-specific boundary-crossing change laboratory workshops

Apart from the learning network boundary-crossing change laboratory workshops, specific meetings were organised to carry out change laboratories for tighter sub groups of the IBLN that were going to work together at specific sites on change projects. Change laboratory workshop #3 facilitated the voluntary formation of the change project groups with minimum agreed criteria. Firstly, there was a need for interested leading persons and organisations within the learning network who were keen to jointly model context relevant solutions to actual water for food problems they were facing. Secondly, members had to be in geographical proximity or capability to connect across space. Thirdly, each group had to have a mix of people with different roles, to include at least farmers, agricultural educators, extension workers and/or research technicians. This generally made it easier to schedule meetings. The change project groups selected by participants were Lloyd Village garden site group, Keiskammahoek homestead garden group, Fort Cox farm site group and NEDA's Middledrift field site. The Lloyd Village garden site was selected as the test site where all learning network members would learn and work together. The Keiskammahoek homestead garden site was composed of local farmers together with a Fort Cox AFTI lecturer. Together they recruited local extension advisors. Initially they wanted to work on an RWH&C model for the dairy pastures but decided to change to start small on a homestead plot as they clarified new model solutions. The Fort Cox College was composed of local lecturers, a farmer and research station technicians. NEDA's Middledrift field site included Middledrift Extension Officers and a Fort Cox lecturer. (A fifth site Matole Basin emerged much later from the agency of local farmers and included Fort Cox lecturers and local youths.) In BCCLW4, the groups were all given an opportunity to work as focus groups to plan their change projects as part of their new solution models focussing on RWH&C practices to be tried out in what we later called 'productive demonstration sites'. All these sites were directly connected to and active in the IBLN. The NEDA site group did not engage beyond the learning network meetings except for two site visits due to still to be resolved challenges with securing the site. It is therefore not discussed further in this study.

6.3 CONFRONTING AND TRANSGRESSING BOUNDARIES DRAWN BY QUATERNARY AND TERTIARY CONTRADICTIONS IN THE IBLN

This section describes the processes of formative intervention in developmental work research carried out in the IBLN from its inception to its development as a collective and as sub-units. The learning network was formed through a carefully mediated process. Research participants initially conceptualized the problem of water from lenses of dependence (e.g. Lloyd Village farmers wanted to be assisted only to get back their removed engine, see section 4.2.12), mandate (e.g. agricultural extension advisors focused on inputs, e.g. GM-seed as the sustainable seed solution that circumvents the problem of manual weeding ["*there is no other way I can take you, except for the cropping*

programme" and "…*here are the rules*", EOSA1, 7 September, 2016] and very little on water, and not at all on OPV seed) or curriculum policy (e.g. agricultural colleges focused on conventional irrigation as the sustainable solution to water for food, and the use of 'improved / high-yileding' seed varieties, see exceprts 4.30 and 4.32). The problem of water among small-scale farmers was not reflected in the college curricula. Educators' key knowledge resource on water is the conventional commercial agriculture curriculum that leads them to "teach what we want… it's us who decides" (ACLSA3, August 12, 2014). They conceptualised the water problem as a technical issue.

6.3.1 Confronting and crossing boundaries disrupting co-engagement of agricultural learning activity systems in the agricultural water activity

Figure 6.2 below is a third generation activity model of the interacting activity systems accounting for the four main agricultural learning activity systems in the IBLN.

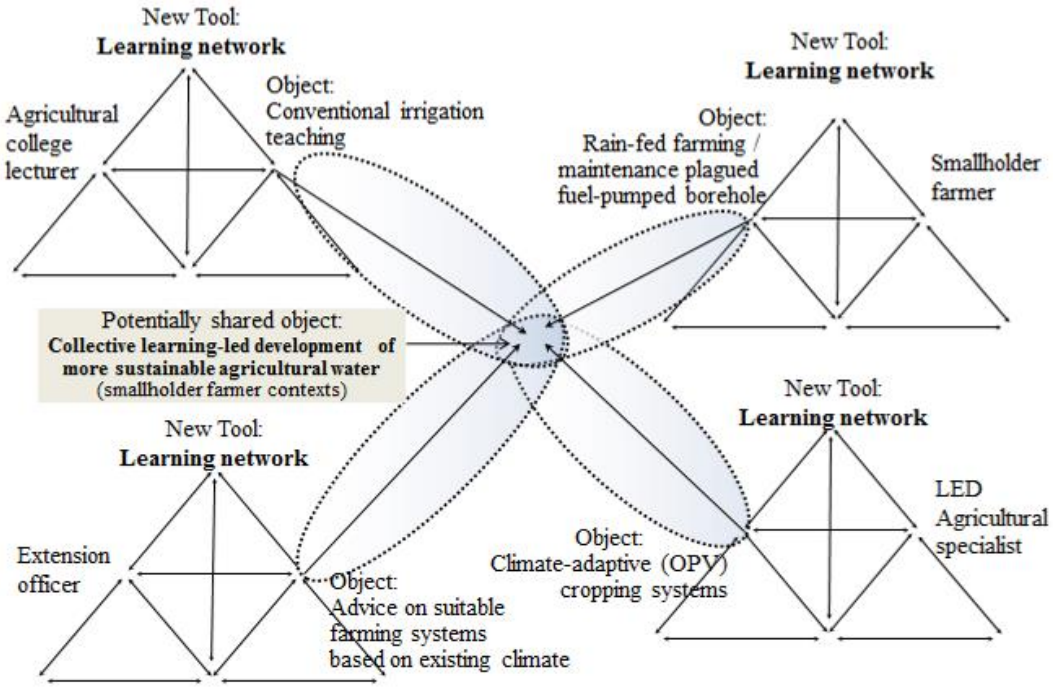


Figure 6.2: *Four interacting activity systems (smallholder farmer, agricultural college lecturer, local economic development [LED] agriculture specialist and extension officer) in the IBLN*

In Figure 6.2 the four interacting activity systems were brought together as they voluntarily formed a learning network. The LED, shown in the bottom right of the diagram, joined shortly after the first two learning network meetings hence its contribution is missing in the latter. The different activity systems have already been described in Chapter 4. Several re-configurations of these activity systems will be described as they interact, with Figure 6.2 showing the initial re-configuration showing a new tool introduced being the course-mediated learning network concept that brought them together. Each

activity system is shown with its initial unique water-for-food object. This object has the potential to expand towards a partially shared object (shown in the centre) via mediated learning.

6.3.1.1 Recognising the problem: Questioning current problems in collaborative and relational work

A distinctive phase of questioning of the collaborative potential and absences in relational work was mediated and observed in the first two change laboratory workshops and intervening activities. There was a questioning of working in 'silos within the agricultural college observed through *immanent critique* by lecturers, and of the meaning of interactions between the local agricultural college and universities with farmers. Data for this was derived mostly from the first two boundary-crossing change laboratory workshops in 2014 and 2015 and from a stakeholder meeting held in May 2016.

The first IBLN meeting was well attended by many people (32) representing the three key agricultural learning activity systems. *Mirror data* was presented as *first stimuli* from primary and secondary contradictions at smallholder farmer, agricultural college lecturer and extension officer levels and then as a quaternary contradictions between the farmer activity system and each of the other two, with the latter two as the tool-producing ones (see section 4.2.1). The mirror data was in the form of excerpts (e.g. excerpts 4.21, 6.2.3) and video / audio material (e.g. excerpt 6.19). The key contradiction brought into the first change laboratory workshop was from the silo work culture (see section 4.2.3). A related example was the expert-driven curriculum development culture questioned by an agricultural college lecturer as follows, "most of our curriculums …it is a Fort Cox thinking, not farmer-based. It's more academic. It's not customer-based, it's house-based" (ACLSA3, BCCLW1 of IBLN, DIBSA1b, August 12, 2014). On the other hand, a farmer expressed a disconnection with extension practice regarding water advice as follows: "the extension officers do not explain to farmers about the practices used to conserve moisture, for example talking about mulching to farmers" (BCCLW2 of IBLN, DIBSA2c, September 16, 2014). These problems led to a double bind.

6.3.1.2 Analysis of relational development of agricultural water and locally-adaptive seed

Upon arriving at double bind situations regarding problems with connectivity across activity systems, the research participants embarked on what Engeström (1987) called historical-genetic and actual-empirical analyses by tracing the origin of their water and seed value chain and the way they were linked to each other around water and seed for food. Researchers and experts also brought in some of the information including past rainwater harvesting initiatives and the traditional cultural practice of *gelesha* (see section 2.4.2). At the beginning of the first IBLN change laboratory workshop a senior agriculture college lecturer (ACLSA1) reported that "we have done a little bit of rainwater harvesting projects here at Fort Cox and it actually amazes one to see the effect of it" (DIBSA1b, August 12, 2014). He was referring to projects introduced by the Agricultural Research Council at the Fort Cox

RDC campus (see Plate 4.5 left) and at the College farm, and by Foundations for Farming (see section 4.2.3). These demonstration sites operated at research level but did not develop into curriculum content for the college or into relational practices with the surrounding farming community but remained with the research participants in the college and the researchers. The problem of discontinuity in agriculture water improvements was further evoked in a subsequent BCCLW as follows:

Excerpt 6.2 (Transcript of Fort Cox College BCCLW #2: DIBSAF1b, July 31, 2015)

1. ***R1:*** There is also another history here at Fort Cox of an attempt to bring water harvesting, am I right? That's what came out of the data ...
2. ***ACLSA2:*** Yes.
3. ***ACLSA4:*** Is that not a research on water harvesting by ARC?
4. ***ACLSA2:*** ARC once set up a demonstration site. ... It died.
5. ***R1***: Do you know about it X?
6. ***ACLSA4:*** Maybe in passing. *I can't say I was involved*, I can't say much...
7. ***ACLSA2:*** Maybe it was not meant to stay. *No one has got that information*.

The dialogue above and previous discussion show lack of coordination within the agricultural college regarding demonstration plots introduced as projects historically. At least two key members of the teaching staff were not involved (dialogue turn #6 'I can't say I was involved'; dialogue turn #10, 'no one has got proper information'). It also shows the problem of "change interventions" (Virkkunen & Newnham, 2015, p. 7) in curriculum settings where "the threat of a crisis" (ibid.), in this case climate change and variability, "cannot be overcome by ... solving individual problems" (ibid.) such as isolated water demonstration projects that are not addressing the reconceptualisation of the whole curriculum activity.

A senior agricultural college lecturer ACLSA1 expressed this lack of transformative agency as follows "although we saw that effect none of us are changing" (DIBSA1b, August 12, 2014). This shows that exposure to information or knowledge without a deliberate mediated learning process does not necessarily result in wilful action. The same lack of agency (EOSA1, excerpt 4.2.4) applies to the extension officers and farmers' activity systems despite exposure to rainwater harvesting practices introduced by the ARC (see section 4.2.1.2), where blame was put on lack of interest when donor funding ends and age of farmers. An extension officer (EOSA1) lamented that farmers "saw the yield; they saw everything … By the time the project went to the fifth year, they were few" (Focus Group Interview #EOMSAFGI1, July 15, 2014) indicating a mismatch between project goals and resources, and farmers' agency. Further historical analyses indicated that the eDikeni Water Users' Association's Business Plan and the NEDA strategic plan (NEDA, 2013a) (see section 1.5.1) recognised the need for farmers to interact and engage with various organisations in the pursuit of improved water for food and food security. According to the WUA Business Plan (eDikeni WUA, 2013),

> The skills development strategy of the WUA is to develop long-term links with neighbouring academic institutions, DWA, Department of Agriculture and Rural Development and the Municipalities. ... A working relationship will be established with Fort Hare University (Department of Agriculture) ... (and) Fort Cox Agricultural College – practically oriented work with farmers, including field trials, demonstration and piloting of different productive water-use methods to facilitate uptake of water by smallholders. The capacity building and knowledge networking activities with these learning organisations would include knowledge exchange sessions, fieldwork planning and piloting of crop-production systems in collaboration with farmers/WUA members. (p. 17)

The citation above indicates aspirations for productive networking between farmers, agricultural colleges and universities and the local municipality for the purpose of improving water for food through productive water use practices, practical demonstrations, knowledge sharing and field work. These aspirations for networked learning linkages had not yet been achieved when the IBLN was formed.

Weak linkages regarding locally adaptive seed and farming systems compounded the weak linkages regarding agricultural water. In section 4.2.1.1 (excerpt 4.16) it was shown that the linkages between Agroecology farmers and extension workers were weak or non-existent with regard to their locally adaptive seed value chain, while those between GMO seed farmers and extension were stronger because of extension "programmes that are tailor-made" (excerpt 4.16, dialogue turn #2) to support the GM-seed value chain.

The first and subsequent BCCLWs for the IBLN brought multiple voices together from diverse agricultural learning activity systems to clarify their common problem and negotiate a joint motive in developing water for food. According to Bakhtin (1984), this mobilisation and connection of multiple voices as 'becoming' is significant already because it is generative, i.e. "to be means to communicate dialogically. One voice alone concludes nothing, decides nothing, two voices is the minimum for life, the minimum for existence" (p. 213). From a social justice perspective, the two and more voices need to be balanced and to include the voices of those significant others for whom the decision is being made or will affect. Some participants from different activity systems also started realising the mutual linkages between their zones of actual and proximal development (Zaretskii, 2016). This is exemplified by the comparison made by an agricultural college lecturer (ACLSA1) discussed earlier in this section. He compared current problematic water practices (susceptible to climate risk, long-term system breakdowns, and irrelevant to most smallholder farmers) in the college (zone of actual development, or ZAD) with new possibilities in RWH&C and no-tillage that were known or new (zone of proximal development, or ZPD), but not adapted. Participants were also able to start negotiating their common motive and made decisions to continue the networked boundary learning with course-activated support

or otherwise towards an unchartered course of a multi-layered zone of proximal development (ZPD) (Vygotsky, 1978; Engeström, Brown, Christopher & Gregory, 1997). Borrowing from Zaretskii (2016)'s model the ZAD and ZPD (see section 3.7.1.3) for the IBLN are illustrated in Figure 6.3.

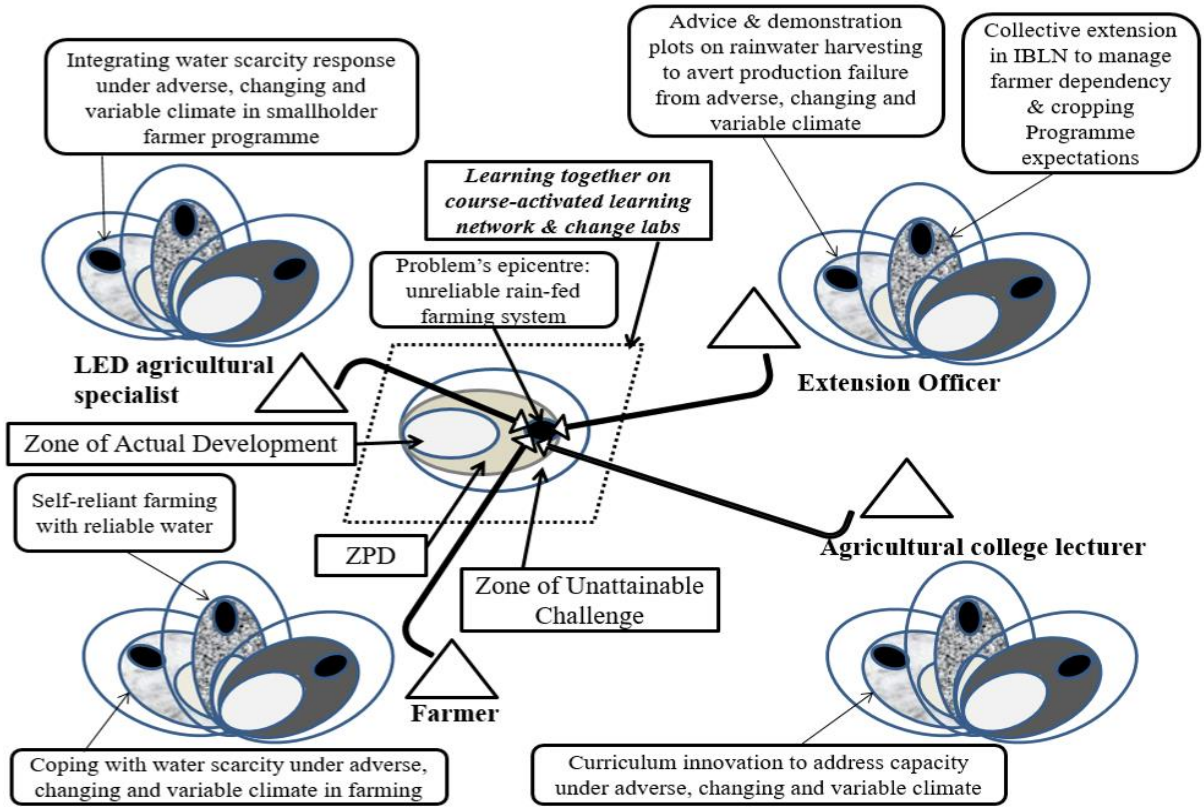


Figure 6.3: *Illustration of the need state(s) as ZADs and the emergent unchartered course of boundary learning towards ZPDs, [Modified for a collective from Zaretskii (2016, p. 155)]*

In Figure 6.3 above the metaphorical 'flower' diagram shows the potential for collective learning out of pursuit of a commonly defined motive of activity to shift different subjects from the level where they are, probably stuck (the zone of actual development) to a better level of development known as the zone of proximal development (ZPD). Figure 6.3 illustrates that there is a process of learning together focussed on the problem's epicentre, in this case a form of 'learned helplessness' in the context of unreliable rain-fed farming; which precedes any development. The multi-dimensional flower petals at each activity system (represented by triangles) represent expansion of the boundaries of the zones of actual and proximal development. The latter is a multi-dimensional space emerging in several vectors simultaneously. The empirical data show potential of a subject "unfolding like a flower" (Zaretskii, 2016, p. 155) into, for example, self-reliant farming with more reliable water and coping with water scarcity, among others, for the smallholder farmer activity system. A simultaneous multi-dimensional development potential (unfolding) is shown in the agricultural college lecturer activity system. In considering Figure 6.3, the reader needs to keep in mind Vygotsky's (1978)

proposition that "what is the zone of proximal development today will be the actual developmental level tomorrow" (p. 87) as boundary learning potentially matures to another level or to boundary-crossing.

To confront the contradictions in disconnected work a series of *second stimuli* were co-constructed and brought to the first IBLN BCCLW. These included a learning network map and the practice of *gelesha*. The Amanzi for Food field research team developed a *preliminary learning network map* based on data generated from the interviews and focus group discussions with all stakeholders (see Figure 1.3). This learning network map was introduced as the first component of a series of second stimuli with the purpose of supporting participants to better conceptualise and reflect on the connectivity of their water for food problems from an activity system perspective. The aim was to support them to reflect on how they needed to work together and engage in order to transform their activities and situations.

6.3.1.3 Expanding the community: How the learning network map was co-constructed and interpreted

In this learning network map Fort Cox College of Agriculture and Forestry was placed at the centre (heart) of the map by the research team because of its role as a community capacity building centre (see Figure 1.3). The college was linked to the surrounding smallholder farmer community via its Rural Development Centre through demand-driven short courses that it conducts under the accreditation of the Agricultural Sector Education and Training Authority (AgriSETA); hence the two way-headed arrows. The college also conducted outreach actions to schools supporting learners with practical demonstrations of agricultural concepts and practices in fulfilment of its mission to "engage in community outreach" (DIBSA10, p. 1). This was contributing to a long-standing need for practical work also identified by an ASSAf (2017) study (see section 2.4.4.2). As discussed in Chapters 1 and 2, I was interested in the relationship between the three main agricultural actors namely agricultural colleges, extension services and farmers as shown in Figure 1.3. The direction of the arrows shows the dominant direction of knowledge flow such that the knowledge passed on to farmers and extension students by the agricultural colleges and university learning systems is the agricultural science valued by these institutions. An agricultural college lecturer ACLSA3 summed it up as "we teach what we want instead of what the extension person needs" (DIBSA1b, August 12, 2014). This is a value chain promoting a "monoculture of scientific knowledge" (de Sousa Santos, 2006, p. 148). There was virtually no inclusion of indigenous and local farmer knowledge. The farmer was therefore at the periphery of knowledge flow. Agricultural extension services have programmes to service farmers and schools through commodity groups and a '4H programme' respectively (see also Chapter 2) as indicated in the excerpt below.

Excerpt 6.1 (Focus Group Interview #EOSA2, July 14, 2014)

> ***EOSA2:*** For the careers, there are days that we invite the University and College (Fort Cox) to come to the schools. *We have a programme where we are promoting agriculture in the schools*.
> ***Researcher-Interventionist, R1:*** Is it being received well in the schools?
> ***EOSA2:*** They doing well, *but* there is a time constraint ... You know it is the teachers that are having an interest … We do school visits and then introduce the programme to them. We present it to the students to try motivate them to do agriculture and we demonstrate to them in a demonstration garden. … and then we monitor them.

Why the learning network map was used as a double stimulation tool:

The initial learning network map was used to show how different agricultural actors were actually and potentially connected or identified with each other's work and to reveal tensions and gaps between and across their activity systems. A concept of connected or co-engaged learning was key in the organisation and development of networked expansive learning within the IBLN in the sense that it checked current and potential learning opportunities, enactments, tensions and gaps. According to Lotz-Sisitka (2013),

> Giving attention to the third discourse on educational quality[21] (i.e. socio-cultural discourses) further deepens notions of inclusivity … so as to be inclusive of culture, local context and issues, and practices that have meaning in local societies, such as environment and sustainability practices… We have called this 'learning as connection' in order to express the relationship between meaning making, context and concept. (p. 30)

From this argument, culture and local context are critical in making meaning, enhancing quality education and developing sustainability with an inclusive agenda (Lotz-Sisitka, Shumba, Lupele & Wilmot, 2017), yet the local socio-ecological context of farmers is often omitted in agricultural college curricula and extension programmes as found in this study.

How the learning network map was used as a double stimulation tool:

The map drawn out from the interviews (Figure 1.3) was brought into the first learning network's change laboratory workshop where the current linkages were confirmed or dispelled and critiqued through questioning (see also Weaver, 2016). Change laboratory participants suggested the addition of more organisations and entities with reasons that followed the object as indicated in the excerpts 6.3 below and in Figure 6.3 and Table 6.2:

> *Excerpt 6.2 (BCCLW1 of IBLN, DIBSA1b, August 12, 2014)*
> ***Youth farmer, YFSA1*:** In my group we have seen that our *traditional leaders* are missing on this programme because they are the people who are working with the community. As we know in this government, everything is done with the traditional leaders. The *politicians* I think we should try and get them together because they are also part and parcel of the South African

[21] This refers to research on educational quality undertaken across ten southern African countries which identified the dominance of efficacy and participation discourses that were driving educational quality praxis in African contexts, due to historical influences of World Bank and International Organisations respectively. Excluded from this was local socio-cultural discourses which were identified as being central to meaning making in an African Education context (Lotz-Sisitka & Lupele, 2017).

economy. We also identified that the *Department of Water* must be part and parcel of this. And Amatola Amanzi (*Amatola Water-Amanzi*) the guys who are working with water all around in this area. …

Research Technician, RTSA1: In trying to address … who is missing, we have identified the community leaders … traditional leaders and … there should be representation from the local municipality …*local economic development*. We have also identified the *early childhood development centres* should be part of this. In *that diagram* [referring to learning network map] we have got *high schools* and tertiary institutions, so in isiXhosa we say '*bagotywa ebatsha'* so we believe that the young people and the people who train them from the early stages to teach them to go about *conserving water and making effective use of water*. And then skills development centres, we felt that even though Fort Cox is mentioned we felt that *FETs [Further Education and Training Institutions]* should be mentioned. … We said it is important to have a learning network because *that is where we share experiences as the group*. …We view networks as an affordable and effective way of sharing experiences and knowledge. And we also think that it also helps in informing or assisting to accelerate the outreach programmes and also *inform the learning institutions on the relevance of the learning curriculum*.

From the excerpt above, participants added traditional leaders, local economic development agencies in municipalities, Amatola Water – a water supply company servicing the Amathole region, Further Education and Training (FET) colleges and early childhood development centres. Other members suggested adding the Water Users Association whose business plan happens to incorporate rainwater harvesting objectives (see section 1.5.1.2). The proposed purpose of the learning network as a forum to "inform learning institutions on the relevance of the learning curriculum" (excerpt 6.2 above) was indirectly confirmed by an agricultural college lecturer in the same workshop. "When we are networking like this it will have to define … what is needed by the farmers … *they know what they want… But we teach what we want…* Because it's us who decides, it's not them" (ACLSA3, BCCLW1, August 12, 2014). The resulting learning network map (Figure 6.4 below) was more complex and messy.

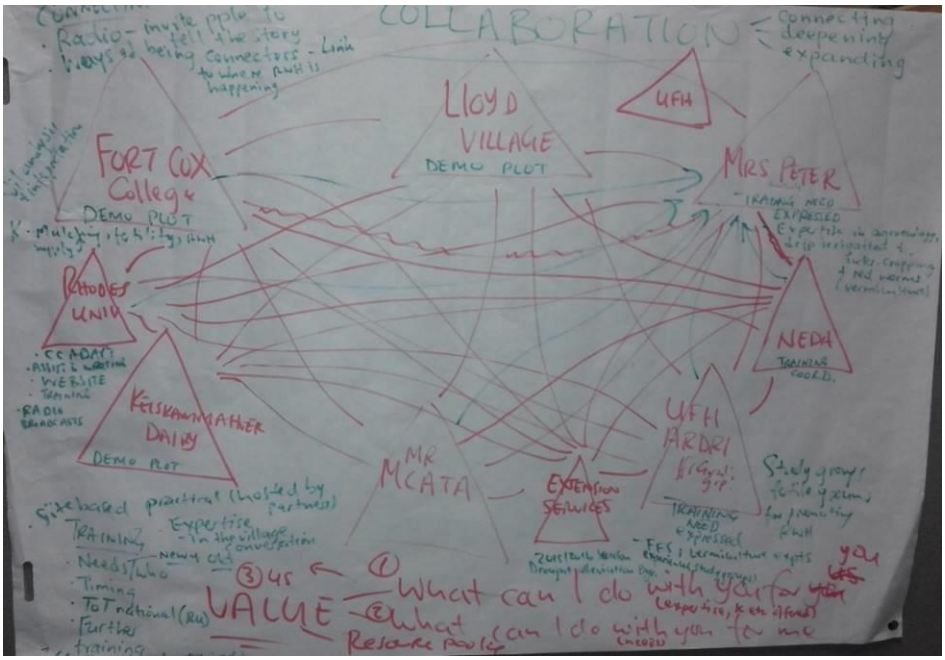


Figure 6.4: *A more advanced learning network map showing complex linkages between various organisations and entities constructed during BCCLW6*

Participants made the input summarised in Table 6.2 as they built up their learning network.

Table 6.2 Research participants' initial co-construction of their learning network

1. "Is everyone who needs to be represented here in this picture as well as in the people that are present? Who is missing?"	**2. "Why do you think the learning network is important?"**	**3. Proposed name of learning network**
Group 1: "Social Development, because they have got projects. …also DWAF, and the Water Users' Association. Then Rural Development and Land Reform they have land reform projects. Then Heifer an NGO that trains and funds farmers, then Bengu Siyakholwa an NGO around Amahlathi, then Bengu local municipality LED, councillors and the traditional leadership CONTRALESA (Congress of Traditional Leaders) and the chairperson of the village." DIBSA1b, August 12, 2014.	"For information sharing, networking and to bring change; sharing experience; information dissemination"	"And then our name is Agents of Change."
Group 2: "As we know in this government everything is done with the Traditional Leaders. … Department of Water; Amatola Amanzi (Amatola Water-Amanzi)" YFSA1, see excerpt 6.2	"To share the ideas and *look at the gaps* to ensure that the programme is implemented. Water harvesting *to promote integration among the relevant stakeholders* to ensure the sustainable and economical use of water for future purposes"	"Amanzi aBubomi Learning Network" literally meaning Water for Life Learning Network
Group 3: "FETs; World Vision; Early Childhood Development Centres" RTSA1, DIBSA1b, August 12, 2014. See also Excerpt 6.2	"An *affordable* and *effective* way of sharing experiences and knowledge; It also helps in informing or assisting to accelerate the outreach programmes and also *inform the learning institutions on the relevance of the learning curriculum*"	"Umthombo we Lwazi" literally meaning Wellspring of Life.
Group 4: "Municipality, the Department of Water Affairs, Water Users Association" DIBSA1b, August 12, 2014.	"Capacity building and development; indigenous information together with the scientific research information."	"Imvotho which means water, indigenous water"

The formation of the IBLN was a transgressive learning action as traditional silo boundaries entrenched by mandates were perforated to allow for new relational connections enabling learning together in a network. Kerosuo and Toiviainen (2011) reported the pursuit of a similar object of

learning in a network as joint activity. Participants were now ready to view themselves in relation to others in new ways as activity systems.

6.3.1.4 Modelling solutions: Introducing the activity triangle as a second stimulus in the IBLN

Participants were introduced to the activity triangle at BCCLW4 on 3 February 2015 (see excerpt 6.3). An example of a smallholder farmer activity system that all would relate to was introduced (see appendix 6.1) and discussed following a group reflection on expansive learning thus far.

> *Excerpt 6.3 (BCCLW4 of IBLN, DIBSA4a, February 3, 2015)*
> ***R1:*** Now we want to work with the idea of farming as an activity system. …outside we had water reservoirs, tools to turn the soil, we had manure, we had mulch and so forth. … Sometimes we need resource materials like the WRC books.
> ***EOSA1:*** It is true…. You need equipment to work on the soil.
> ***R1:*** Language also becomes a tool. …

The change-project action groups formed in BCCLW3 then each worked on developing their activity triangles, considering their joint object of activity, how the different agricultural actors were connected and intended to work with each other (see Figure 6.5 that follows).

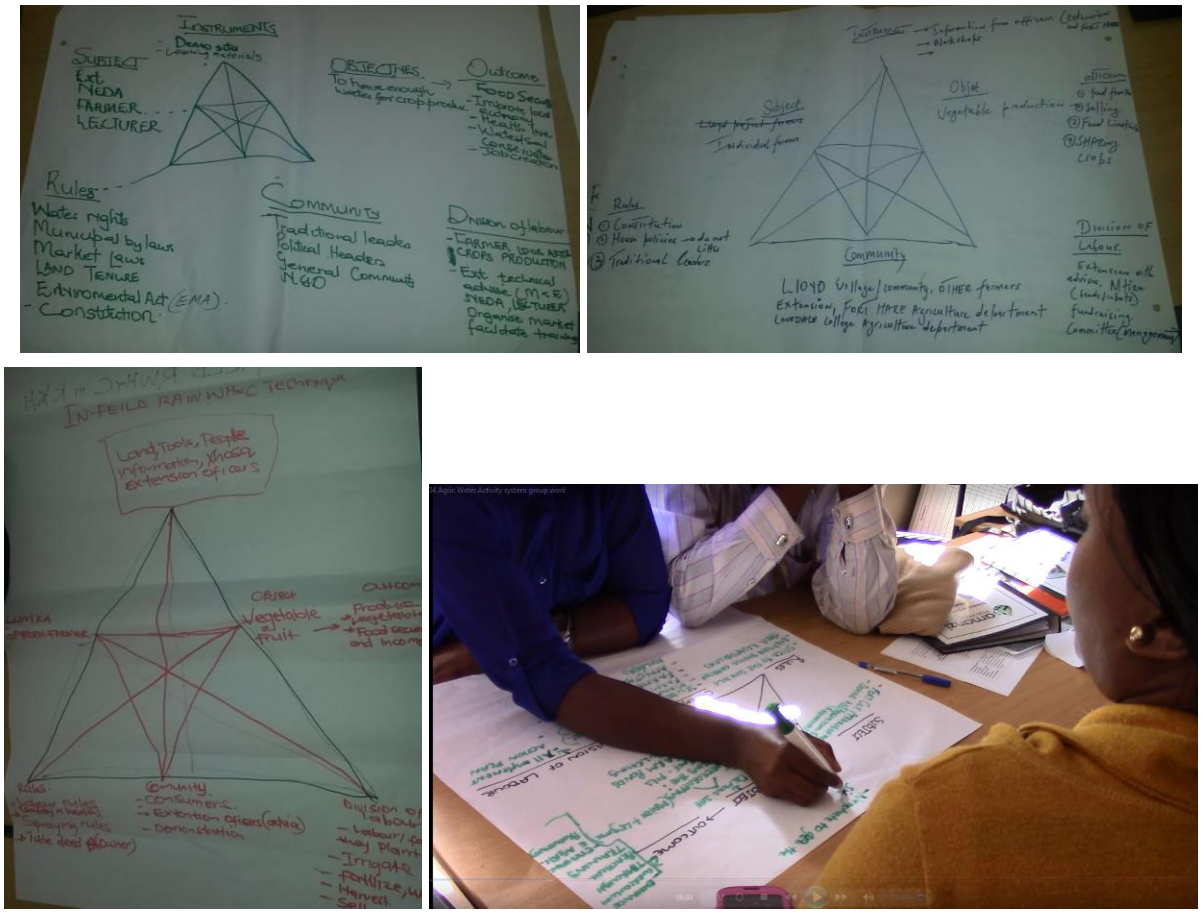


Figure 6.5: *Top and bottom left: Activity triangles developed by action groups at BCCLW4; Bottom right: Fort Cox College site team modelling solution using activity triangle*

Figure 6.5 shows the activity triangles drawn by the Lloyd village site group at the top left, the Middledrift NEDA site group at the top right and the Keiskammahoek homestead garden group at the bottom left. On the bottom right the Fort Cox College site group is completing their activity triangle. Details for selected sites will be discussed in relevant sections.

The drawing out of the activity systems per change project group provided the participants with the stimulus to have a focussed dialogue on what they wanted to do together to solve a specific water problem at a specific site. Excerpt 6.4 below from the Keiskammahoek group, indicates that they changed from the original dairy site to an individual homestead garden producer's plot at which they identified an appropriate solution to the water scarcity in the garden site.

Excerpt 6.4 (BCCLW4 of IBLN, DIBSA4a2, February 3, 2015)

1. ***ACLSA3:*** Clearing the bush… everybody?
2. ***Keiskammahoek farmer 2:*** Jaa [Yes] everybody.
3. ***ACLSA3:*** [reading from the discussion guide in the ToT materials] "Identify how you intend to ensure the sustainability of the site". It means we need to talk to monitoring; maintenance of the structure ... isn't it our structures is only earth furrows?
4. ***Keiskammahoek farmer 2:*** Yes
5. ***ACLSA3:*** Because sometimes *i mulch iya phela* (Xhosa, meaning: 'at some point the mulch will be depleted'). This is infield and this garden is producing always, season by season. How are we going to do that?
6. ***Keiskammahoek farmer 2:*** We need to monitor what we do.
7. ***ACLSA3*** (writing down group's ideas): Monitoring... I'm just thinking.
8. ***Keiskammahoek farmer 2:*** Write it...Write it. *Siyayi monitor* [we will monitor]
9. ***ACLSA3:*** We will put a monitoring tool. Which means we will also be having a timetable? ...
10. ***Keiskammahoek farmer 2:*** Yes.

Excerpt 6.4 shows model solutions that the group were examining and planning to implement that included clearing the garden site identified (dialogue turn #1), digging earth furrows, monitoring and maintenance (dialogue turns #3 and #7), in-field rainwater harvesting practices and mulching (dialogue turn #6). The mediating tools that they intended to use included a monitoring tool and a timetable (dialogue turn #9).

6.3.1.5 Summary of evidences of boundary-crossing learning in the IBLN water activity

Using Akkerman and Bakker's (2011) boundary-crossing mechanisms, it was seen that agricultural educators started *identifying with* dryland farmers' water contexts ("when we are networking like this it will have to define … what is needed by the farmers, ACLSA3, BCCLW1, August 12, 2014) which they did not do before the formative intervention (see section 6.3). In addition, a communicative connection between diverse water practices was established as a form of *coordination*. A learning network was established which allowed for multi-stakeholder teams to work together to develop

demonstration sites. It can be seen from the previous section that farmers' voices were well represented in dialogues as much as the agricultural college lecturer's voice. The next section also shows further evidence of the inclusion of farmers' voices in this case registering their preference of locally adaptive seed. The response of agricultural colleges and extension officers, as well as decisions made for developing productive demonstration plots on this type of seed, are also discussed.

6.3.2 Boundary-crossing issues in the locally adaptive seed activity

This section introduces the climate adaptive seed object, tracing the origin of the object and how it was confronted in tense encounters. Farmers expressed it as seed saving and exchange.

6.3.2.1 Introducing traditional OPV seed maize as a second stimulus in the IBLN

BCCLW #7 in the IBLN introduced the object of locally adaptive seed into the common space occupied by extension officers, agricultural educators together with farmers as tertiary and quaternary contradictions (see section 4.2.1.1). The past and current history of this object was provided in Figure 4.12 in Chapter 4. The object was first worked on collectively in BCCLWs that took place at Matole Basin. Participants included the local farmers and youths, extension officers, LED agency officers, representatives of Alice Farmers Association and eDikeni Water Users Association, Ilizwi Lamafama (literally meaning 'farmers voices') farmers association, a permaculture trainer, agricultural college lecturers and learners and an NGO Zingisa Educational Project on 27 May and 7 June 2016 (register in DIBSAM1). The outcomes were escalated into an IBLN wide BCCLW #7 held on 7 September 2016 and subsequent change laboratory workshops that developed model solutions. The first BCCLW was preceded by a look and learn visit to an agroecological homestead garden and cropland, that was organised by a local host farmer, who also invited Lovedale FET College. The visit stimulated participants to see possibilities beyond conventional agricultural practices that allowed farmers to adapt to climate change and variability through traditional seed and water conservation as a way of producing vegetables and crops successfully in dryland systems. Agroecology farmers introduced OPV seed maize as a symbol of the object of locally adaptive seed (see Figure 6.6). One farmer (FSA11) expressed this stimulus in relational terms ('sharing') thus showing its coexistence value;

> *Excerpt 6.5 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)*
> ***FSA11:*** *Molweni* (good morning). My name is [X]. I stay in Dimbaza. I am a member of Ilizwi Lamafama. I am a *seed guardian*, of course *traditional seed*. Wherever I go, I always carry a seed because *I believe in sharing* because we come from sharing.
> ***Researcher 2:*** Did you bring them today?
> ***FSA11:*** Yes!

The farmer (FSA11) presented the culture of seed saving ('guardian') and seed sharing as a tradition ('we come from sharing'). OPV seed acted as a second stimulus for both networked learning and locally adaptive seed system. This culture was supported by another farmer (FSA10) in IBLN

BCCLW7 who described seed saving as “justice, social cohesion” that has been lost to and created a “capitalist system… in our minds” (DIBSA8a, BCCLW7, July 21, 2016). The photographs in Figure 6.6 shows a high percentage of farmer representation and the presence of seed saving artefacts as part of the workshop ‘archive’ (Engeström, 1987; Virkkunen & Newnham, 2015).

Figure 6.6: *Top from left: a 'seed guardian' farmer; centre: workshop chairperson exhibiting seed saving artefacts (seeds, regalia, posters) and right: participating farmers raising their hands. Bottom: various OPV seeds used as a second stimulus*

The seed saving and food sovereignty artefacts and regalia spread throughout the workshop room made a statement of grassroots activism seeking collaboration with an educational approach. The discussion of locally adaptive seed widened to include other things observed in the homestead and cropland that contribute to sustainable agricultural water provisioning such as mulching as expressed by an FET College trainer in excerpt 6.6.

Excerpt 6.6 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)
R1: For the benefit of those who were not here …what did you learn in the morning (tour)? …Let's hear your voices.
Lovedale FET College Trainer: I saw a mixture of crops and mulching.

It can be inferred that the expansive learning cycle for the IBLN with respect to locally adaptive seed started at stage #2 with historical-genetic analysis of the cultural origins and subsequent cultural erosion of seed saving blamed on capitalist approaches to seed value chains. This is supported by the literature on the negative impacts of betterment on social cohesion (see section 2.3.2.1) and the link of GM-seed to agro-chemical corporations (see section 2.3.2). The actual-empirical analysis revealed some generative mechanisms for locally adaptive seed in training colleges. An FET college student and lecturer compared the college's agricultural curriculum practice with what farmer innovators were doing and identified gaps in practical learning and innovation as follows,

Excerpt 6.7 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1. ***R1:*** What could be the gaps? Do you think there any gaps at the college, between what you see here and what you…?

2. ***Lovedale FET College student 1***: I think what colleges are doing is going away from actually being … a TVET college and going to the whole sense of being like universities, of being theoretical and *not enough practicality*. The whole stigma … let's down agriculture… I believe that if there is more practical then I think the youth today will be more involved in … agriculture.
3. ***R1:*** So we can see a gap in the practical, too much theory and...
4. ***Lovedale FET College lecturer:*** I think it's quite correct because we have those gaps. Because if you look at what Y [host farmer] is doing. …you have the farm manager, for example, but maybe *you don't have the kind of implementation of different ways of doing things. … even the practical itself it tends to be so academic than looking into much more doable and practical solutions to some of the challenges*. For instance, the issue of water, I think they will know especially in our campus … *you don't really find rigorous implementation of these ideas in order to assist in food production*. There is indeed a lack in terms of practice. In most cases people will cite the resource shortage as one of the issues that makes them to be not so involved in practicals. But … you must use what you have and what is available to you to try and sort out some of the issues that are confronting you. So I think this is where we write innovation … *So the kind of gaps in innovation and practice* is what I think I can identify in practice.

The lack of practical agricultural learning of sustainable agricultural water provisioning and locally adaptive seed system in an FET college was attributed to lack of innovation in using locally available resources. A senior extension officer (EOSA1) agreed with the gaps in agricultural training institutes as de-centred from rain-fed farmers' contexts, and traced them to commodification:

Excerpt 6.8 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1. ***EOSA1:*** I think it's because *the indigenous ways of farming have been suppressed or done away, they have been overtaken by the commercial way of production*. Hence… aligning to what sisi has said there, *the big firms are supported by the commercial farmers which is the one that is more marketed than the indigenous ways of farming*. I think that is the core of it.
2. ***R1:*** Thank you very much. So [EOSA1] if I can come back to you again, when you are saying big firms what are you talking about?
3. ***EOSA1:*** The commercial outlets there, [Z] seeds… you name them.
4. ***FSA10:*** And the milling companies and the seed companies.

Commodification value in excerpt 6.8 ('commercial way of production' and 'more marketed', dialogue turn #1; 'milling companies' and 'seed companies', dialogue turn #4) is blamed for eroding locally-adaptive seed by 'suppressing' (dialogue turn #1) the coexistence value found in 'indigenous ways of farming' (dialogue turn #1) that includes 'seed saving' (see excerpt 6.5). Some farmers went further to confirm that NEDA had supported them in growing a locally adaptive maize seed variety that linked them to an alternative, and local seed value chain with a niche market for OPV seed.

Excerpt 6.9 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1. ***Local farmer 2:*** I know the man wearing a white jacket [NEDA Officer]. So he once gave me seed, this type of seed (pointing to OPV maize seed on the table). And then I

planted it and then got a good crop and out of that I even sent back bags to him for him to sell for me and I got money.
2. [More applause from participants].
3. ***R1:*** What happened after that?
4. ***Local farmer 2:*** *I still have seeds* but last year there was a drought so I couldn't plant.
5. ***R1:*** So now you don't have to go and buy seed, you will just use the same?
6. ***Local farmer 2:*** Yes.
7. ***FSA10:*** Mr X and I also we were together in that programme.
8. ***R1:*** Wonderful. I saw a picture when Mr X was receiving the seeds... So … there is another value chain that NEDA is supporting, and ... what do you call that type of seed?
9. ***FSA10:*** ZM1523.
10. [There is a brief discussion.]
11. **EOSA1:** What is important about that cultivar is it's an open pollinated variety. So that one is different from the hybrid in that *it is more drought tolerant and you can plant seed from a harvest again*.

In excerpt 6.9 two farmers expressed satisfaction in participating in a locally adaptive seed value chain supported by the NEDA (dialogue turns #1 and #7) due to its income generation capacity (dialogue turn #1), adaption to water scarce conditions and ability to save the seed from a harvest for future planting (dialogue turns #4 and #11). Interestingly, a senior extension officer supported the use of locally adaptive seed varieties for their climate adaptive properties and re-use as good attributes (in a later workshop he raised a tension). Having analysed the contradictions by bringing farmers' voices together with voices of

extension officers and agricultural trainers, some solutions were modelled as follows:

Excerpt 6.10 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1. ***Lovedale FET College lecturer:*** *Because this one is more practical, it becomes even more simpler to address at the college level …*when you are planting then say to students in that section of the field we will be using OPV seed; these are the advantages and I think they have been advocated well by the gentleman that they are drought tolerant and require less water and so forth. So at the level of conducting practicals you can inculcate this into the students that you are teaching. ...
2. ***R1:*** Thank you.
3. ***FSA10:*** Sorry Ticha [referring to me as R1], we also as farmers' association have been in discussions with the extension …
4. ***R1:*** Sorry, Y (NEDSA2) needs to leave but before he goes … Lovedale …want to go and put aside a piece of land. I don't know how NEDA, Zingisa, Extension could support…, and food sovereignty farmers…can you say something before he goes.
5. ***Lovedale college student 1***: Thank you so much. Really we are so interested in what is being said here. *We are ready to go and implement whatever we have heard and what we saw there, especially the garden of ma'am X...*
6. ***R1:*** Ok thank you very much. … So when do you want to start…?
7. ***NEDSA2***: Can I assist them? What you can do, when you get organised you talk to Mr Z (Lovedale lecturer), he has all my contact details.
8. ***Some students:*** Thank you.

In dialogue turn #1 agentive talk by an FET College lecturer that *takes the perspective* (Akkerman & Bakker, 2011) of the farmers and is echoed by a student, "We are ready to go and implement… especially the garden of mam X" (dialogue turn #5) leads to modelling of a solution to addressing a conflict between curriculum absences vs farmer needs. Note that there is no definite commitment to actual implementation yet, but the intention was registered by the lecturer and one of the students made a definite commitment ("we are ready to implement", dialogue turn #5), and this intention received a promise of support from the local economic development agency (dialogue turn #7).

The modelled solutions were examined and prioritised, and some taken into subsequent BCCLWs (as discussed in excerpt 6.12 onwards) where it was agreed to implement a climate adaptive seed bank and demonstration plot at Fort Cox College. Within BCCLW7 however, Lovedale College led in examining the new model affecting the college directly and came up with things that were easier to do as top priority (e.g. linking with Fort Cox College, see excerpt 6.11) and others more complex and longer term (e.g. the need to negotiate demonstrations and further consult with the farm manager, see excerpt 6.11).

Excerpt 6.11 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1) ***Lovedale FET College lecturer:*** After we have taken the tour at Mrs X's garden … we sort of had our own chat about these things. … *I would really appreciate if I can see these things happening at the college in practice.* I think it can spice the kind of practical work that they are assisting other students with, because the students that I brought here are actually hands on assisting others with practical work. *So I said you can take some of these ideas back to the college and it will really enhance your current practice and it will stimulate much more interest in the other students* because coming to the garden, going to the crops doing the same thing becomes monotonous and boring. ... So indeed I think with this group and with the students being part of it and going forward there can be more engagements of this nature and they can see even more. … *I was actually talking to Y from Fort Cox and I said we will visit because we are interested in the drip irrigation* that we could not see today. He agreed that he will host us and I will take them down there and have spoken to them about that. So from the students themselves there is obviously an interest in what they have seen today and they have got all the willingness to take it back to the college and to try and cascade it down to others.
2) ***R1:*** That's wonderful. When do you think you want to do this visit?
3) ***Lovedale FET College lecturer:*** When I spoke to X he said in two weeks' time, because he spoke about this tank [part of demonstration site] that is currently not there that he needs to get back...

Excerpt 6.11 shows further that Lovedale FET College exercised agentive talk and agentive actions by deliberating with smallholder farmer innovators and IBLN network members regarding aspirations to implement practicals on RWH&C and climate adaptive seed. Immediate plans were concretised to visit Fort Cox College demonstration plot (dialogue turns #1 and #3) as a site of 'intermediary action' (Elkonin, 2016). By so doing, the boundaries between the FET College and farmers and with Fort Cox College were made much more permeable, increasing chances of boundary-crossing and relational work. This is a form of boundary-crossing that Akkerman and Bakker (2011) called 'coordination'.

Lovedale FET College participants were cautious as they examined their new model, and considered institutional issues as follows:

Excerpt 6.12 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1) ***Lovedale FET College lecturer***: I need to have clarity. I am working as a programme manager for farming management that's why I just brought the students. There are other programmes ... like primary production. And there is a farm manager who works with all the agricultural programmes within the college. *And he is the one who is in charge in terms of what must be planted and what must not*. So in as much as I am saying that the students are directly involved in the planting, and taking care of crops ..., but in decision making my fear is that we not today say that we will be planting *gascekece* [traditional maize] and the next thing the farm manager feels that it's not the thing that he would like to plant so *there is still that room to say let's consult the farm manager* to say whether we plant indigenous or...
2) ***R1:*** So you have an action point already, a very important point. Because you don't come from a workshop and then go ... and say guys in October we are planting OPV seed... So there has to be some discussion... with farm manager.
3) ***Matole Basin Youth:*** I'm thinking ...because they are a college right? *So it could help with research purposes as well as they mentioned the health hazards that the GM has, whereas the indigenous one is healthier*. *So maybe they could flight some kind of a research just to check what is going to happen here and what happens there*.

In dialogue turn #1 an FET College lecturer indicates the need to follow internal protocol in doing experimental demonstrations using a new tool (traditional OPV seed). This form of agency is a type of 'resistance' (Haapasaari, Engeström & Kerosuo, 2012) to swift uncalculated change but sharpening the new model solution by making new suggestions directed at the network and that will be presented to the FET College farm management. Further model solutions proposed more participation of farmers in the NEDA locally adaptive seed value chain system, that was in the process of establishing a stable market for locally adaptive seed based on tried and tested production to marketing trials (see excerpt 6.13).

Excerpt 6.13 (DIBSAM1, BCCLW2 in Matole Basin, May 27, 2016)

1. ***NEDSA2:*** In terms of our farmers what is important is to do things consistently. ... remember our pieces of land are small. So we can only be able to supply Spar, Shoprite, Saverite [supermarkets] if we work together. ... There is very high demand I don't know if there is someone who saw today's paper. ECRDA [Eastern Cape Rural Development Agency] want a lot of white maize … to do samp, mealie meal. Maybe it's going to import actually because … it's not available locally. We have a product. It's called *Community Benefit Brand* that we are doing with iSpaza. And we would love to see our farmers producing local things that will end up in the supermarkets … that we have tried and it has proved that it can be done. So what we need is to come together as farmers and work together and come up with a plan... I think we have demonstrated we can do that. Mr B (Extension Officer) can tell you we have sold the maize from [names known places and families]. We have sold butternut, now we are selling oranges ... so if we work together we can facilitate that you can market your product.
2. ***Farmer from neighbouring Municipality***: I have a question, it's not about getting contacts only. Thank you X for inviting me. I am from Amahlathi Municipality and as

I am standing here a lot just excites me and I feel very much empowered … But the question is whenever someone is ... especially if you are a leader ... Because as I have mentioned I am from an NGO called Kusile Mzantsi Community Development. It's not about me, it's about the entire community which is coming from 7 villages with 720 hectares of land. But the support that you are giving to these farmers, we don't get it over there. Now how can you or your organisation see that you can also support... because the key which is marketing is a problem. …

3. ***NEDSA2:*** We fall under the Local Economic Development Department. But what we can do is to assist you with things like agronomic services. …it's not a problem. We can also facilitate that you also feed into the same marketing channels, it's not a problem. We can facilitate that you participate in the iSpaza brand. … because it's a community-based brand.
4. ***FSA10:*** … I thought she was going into it through Ilizwi, because now *we are in partnership*. So when we are in this forum now we don't see BCM (Buffalo City Municipality), we don't see Nkonkobe, we don't see Amahlathi. We are seeing a community that is in partnership. … But the fact that even Mr B (Lovedale College lecturer) said he is thinking that we have started now a group so we can go further. So if they can align themselves with say *Ilizwi Lamafama* when they are here and stop saying they are Amahlathi, then they can be able to get access to whatever we are doing here.

Transformative agentive talk can be seen in the excerpt above, in dialogue turn #1, where NEDSA2 is '*explicating new possibilities or potentials in the activity*' (Haapasaari et al., 2012) by proposing that "farmers come together and work together" and opening market access for more farmers even from outside the local municipality (last line, dialogue turn #1). '*Relating to past positive experiences or former well tried practices*' NEDSA2 referred to the successful marketing of farmers' seed produce, "we have demonstrated we can do that" (dialogue turn #1). This coming and working together is also confirmed as a new solution by another farmer FSA10 in dialogue turn #4 who *identified with* a like-minded farmer from outside the local municipality by encouraging her to align with the local brand, "if they can align themselves with say Ilizwi Lamafama". This is supported by the new tools shown in Figure 6.4b. That way the relatively 'borderless' learning network would be "a community that is in partnership… we have started now a group" (ibid.) that opens new possibilities for learning and development in locally adaptive seed production and marketing.

On the side of extension, key transformative agency expressions were focused initially on *resisting* the proposed change (Haapasaari et al., 2012) to incorporate locally-adaptive seed systems as seen in excerpt 6.14 below:

Excerpt 6.14 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1. ***R1:*** So what is extension's role in all this? Mr X said we dish out inputs. What kind of inputs, let's talk about seed, what kind … do you dish out, maize?
2. ***FSA10:*** Yes GM.
3. ***EOSA4:*** Isn't it he [EOSA1] was saying we dish out inputs in homesteads and gardens? So we usually assist farmers with vegetable inputs, not maize.

4. ***R1:*** And what kind of seed is it, it hybrid seed or OPV?
5. ***EOSA4:*** It's hybrid and the GMO.
6. ***R1:*** Earlier on, we noticed that [between] colleges and the farmers there is a conflict. There is also another conflict here, between extension and farmers.
7. ***Some farmers:*** yes.
8. ***FSA10***: That's what I wanted to say … *as a farmers' association we have been in discussion with extension to say that they need to develop a plan of making farmers to choose what seed they want. They mustn't make a one for all…*
9. ***Agroecology NGO Officer, ZEPOSA:*** One size fits all.
10. ***FSA10:*** Yes. Because there are those that don't want those GM seeds. Then they could make them to choose.
11. ***EOSA4:*** The GM seed we are using, it's because *the farmers these days … they are no longer prepared to work hard especially in the fields*. ... The *GMOs do not need much labour* as the farmers these days are no longer prepared to work hard on the fields. So with *the GMs they just use herbicides* and *the maize grows on its own*.
12. ***R1:*** So can we see something here? *There is also a conflict within the farmers*.
13. ***Participants:*** Yes. …
14. ***R1:*** So … the farmers are saying is it possible for extension to work with both ways, both approaches?
15. ***EOSA4***: But *that idea we have to sell to our managers* because idea of using these GMOs came with them because *they wanted* to produce commercial.
16. ***R1***: What could be the action point here? Is it possible for you to… giving feedback from this meeting to the managers… or is it too difficult for you?
17. ***EOSA4:*** *It will be too difficult because even there were trials which were made before the department chose these GMOs.* The trials were made by these seed companies like the Monsanto, the Pannar, you name them. So it was agreed that we must use these GMOs because of the issues of … labour.

Excerpt 6.14 indicates several transformative agency boundary-crossing issues. Farmers FSA10 proposed *a new model to reframe and navigate power relations* between the extension service's strategy of imposing the GM seed programme and considering Agroecology farmers' choices of OPV seed as a way of resolving this (dialogue turn #8). In examining the new model, a tertiary contradiction emerged between the distorted culture of farming labour when using OPV seed versus what extension considered a culturally more advanced system of spraying weeds using GM crops. Extension workers therefore exercised *resistance* to locally adaptive seed (dialogue turns #11, #15 and #17) giving reasons that farmers no longer want to weed manually, and so round-up ready GM-crops solve this. There were generative mechanisms at the socio-ecological level (weeding culture, dialogue turn #11), science level (experiments, dialogue turn #17) and institutional level (mandate, dialogue turn #15) that drove extension officers to promote GM seed with determination.

The private companies that convinced the government extension department (*"trials which were made before the department chose these GMOs"* EOSA4, dialogue turn #17) that this would be a good solution to its food security drive include Monsanto (ibid.), which is known to be marketing agrochemicals and GM-seed (see sections 2.3.2.4 and 2.4.3.2, and Chapter 7). There is a power issue

of extension as government over smallholder farmers in need and operating in a dependency mode. Bhaskar (2008a) called this relation power$_2$ (see sections 3.8.6.1 and 4.2.1.1). It can be seen that power$_2$ yields relational evils (Donati, 2013; see section 2.2.1) such as imposition (e.g. extension managers "wanted to produce commercial" products out of smallholder farming, EOSA4, excerpt 6.14; "there is no other way I can take you, except for the cropping programme… "*here are the rules"* excerpt 4.16, EOSA1, BCCLW9).

During the second BCCLW in Matole Basin an exercise was carried out with participants to find out what their preferences were regarding seed types and soil fertility applications despite the government extension programmes. The pairwise matrix compared two different alternatives at a time and recorded the score of the preferred alternative. The results are shown in Figure 6.7a.

Figure 6.7a: *Scores of pairwise rankings to assess priorities for soil fertility (left and top right) and seed preferences (bottom right), (DIBSAM2, June 7, 2016)*

A) Fertiliser – Manure pairwise ranking		
	Fertiliser	**Manure / compost**
Fertiliser		Fertlizer = 0
Manure / compost	Manure/compost = 11	

B) Seed type pairwise ranking			
	GMO	**OPV**	**Hybrid**
GMO		GMO = 0	GMO = 0
OPV	OPV = 11		Not compared
Hybrid	Hybrid = 11	Not compared	

Figure 6.7a shows that farmers in the workshop preferred using manure and / or compost to inorganic chemical (mineral) fertilisers as they felt the former nourished and sustained their soil. The same farmers also preferred using open pollinated varities (OPV) of seed compared to genetically modified seed because they felt the latter undermined their rights to land and seed ownership. Where OPV seed was unavailable, they opted for hybrid seed. Despite such clear preferences by agrocecology farmers, government programmes sidelined them. Participants analysed the power problem as follows, looking at the source and evolution of the problem:

Excerpt 6.15 (DIBSAM1, BCCLW9 in IBLN, September 7, 2016)

1. ***ACLSA3:*** ... what they are saying is you cannot come with your rugby boots and play soccer. Now my question is, *it started somewhere; someone has marketed GMOs, which is based on the research findings*. Where I am going is *it means the same can be done, through the institutions that can influence government based on qualitative or quantitative scientific research*. ... I believe that farmers and the extension officers, it's like the department is the parent, so he is maybe the uncle of the farmers that are the children. *Whatever they say it might be heard but not be implemented. You are saying it's for years now, you can be going back and forth*. But if there is also a link wherein people can … the research done, can be presented directly to the farmers, with the impacts of your GMO and the OPV and also the potential of your OPV as an institution that runs with research. I think that can also influence something, because ... I believe that numbers came from somewhere for them to end up saying "No, this GMO can do better." So it means that *numbers again need to come back again to them through the channel that they use to listen*.
2. ***FSA10:*** Yes, I hear you X, but one other thing that we are overlooking here is that, be that as it may if people researched that GMO was good, they have not researched to say, will on the third or fourth year be producing that seed. Will you be producing the same as we were producing the previous year, which will not be. So it means that even if we go, and say to the government, you can go and check whoever started with the GMOs, are they still producing? Yes, it was said it is 'massive' when you produce, only on your first, second. On the third year your produce drops. It goes down and down and down because the earth and the soils have been depleted. So, if then, I understand, I am with you X, to say that ask farmers who want to plant OPVs. We know there is a reason why, then there is extension that is only implementing the policies that are put by government. So, the route now of the farmers together with these institutions engaging the government to say "we are not stopping those that are doing GMOs, but let them pilot this group that is saying we don't want OPV's", but my point is then, we need to research this and go to the government being sure of what we want.
3. ***ACLSA2:*** So, going to the government cannot happen anytime very soon. ...
4. ***EOSA1:*** And one other thing, we are talking about one programme here, that is the cropping programme, and the farmers it's not their only request or query that it is only maize. They want also other crops, but it is theoretical, it is said that "this programme is not confined to maize production" *but all the workings around it even the production plans are talking to maize*. But if one will come and say that "why are other crops not catered for", it will only be said that "if you want other crops come, then we will prepare the production plan for that". *It's been sad, it's been years, but every time anything that is being worked out, it's worked out based on maize*.

Dialogue turn #4 in excerpt 6.15 under EOSA1 shows an immanent critique of the internal contradiction in the extension officer activity system (see section 4.2.1.2) showing the power of the commodication value of GM maize discussed under excerpt 6.14 above. It aggravates to an immanent critique of the quaternary contradiction between the extension officer activity system and the smallholder farmer activity system (ibid., dialogue turns 7-8). Figure 6.7b shows a documentation of the new tools and new model during the BCCLW.

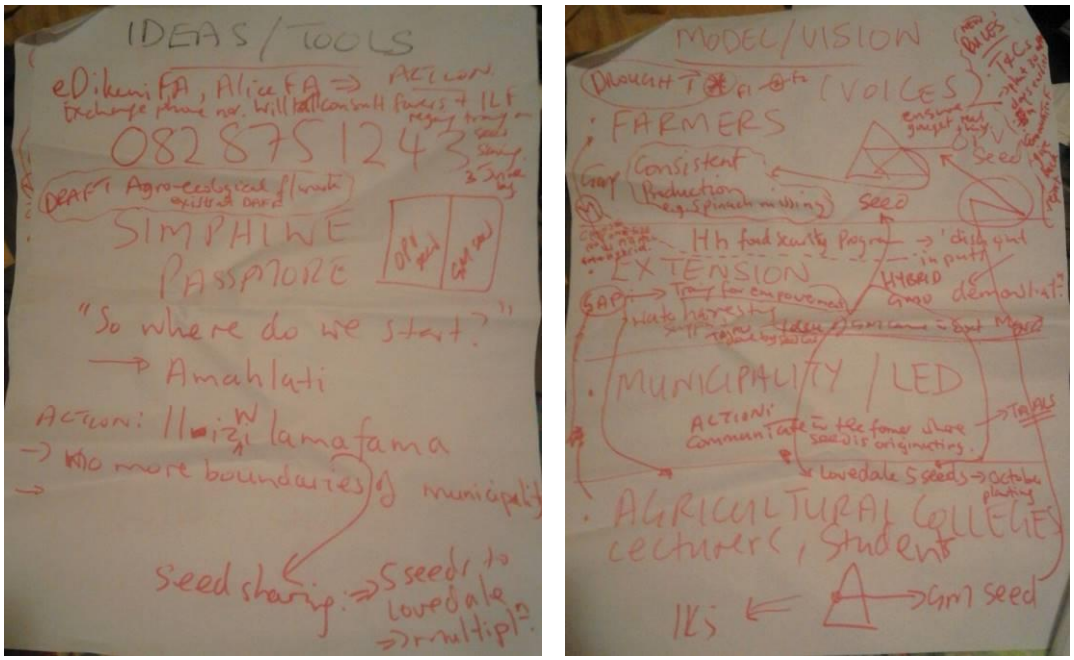


Figure 6.7b: *Documentation of new tools and models in the Matole Basin BCCLW*

In Figure 6.4b a summary is provided of new tools in the left chart that include use of the NEDA smallholder farmer development programme's value chain to include more farmers in the IBLN thus enabling them to access a niche market for locally-adaptive seed produce. In the left and right charts, a model solution for Lovedale FET College was proposed whereby seed and planting support would be provided freely by Agroecology farmers. This would follow a seed sharing protocol adhering to terms and conditions stipulated by the Ilizwi Lamafama seed sharing systems and Lovedale College's farm management systems (see section 6.3.2 and excerpt 6.11). Other models agreed upon were to conduct trainings in seed saving and seed banks, and to conduct trials for OPV seed involving extension and the IBLN. Table 6.3 provides a preliminary analysis of emerging boundary-crossing issues, mechanisms and agentive trials.

Table 6.3: Emerging boundary-crossing issues, mechanisms and agentive trails in the IBLN

Boundary-crossing mechanisms experienced	**Nature of boundary issues concerned**	**Agentive trails**
'**Identifying with**'[22]	Agricultural college lecturers identified with smallholder farmers' and household food producers' contexts	Realisation of curriculum absences from lecturers' interactions with farmers and WRC RWH&C knowledge materials in IBLN→*critcising the current curriculum activity* within a learning network forum*:* immanent critique of curriculum absences (e.g. ACLSA3) →modelling new curriculum solutions→*commitment to action* and implementation (see section 6.4 below)
	FET college lecturers and students identified with household food producers' contexts.	Realization of curriculum absences from farmer practice→ *criticising the current curriculum activity* within a learning network forum*:* immanent critique of curriculum absences (excerpt 6.7, dialogue turns #2 & #4) →commitment to conduct a demonstration plot to trial locally-adaptive seed (excerpt 6.10)→(*resisting the change* and *explicating new possibilities*): plan to negotiate climate-adaptive seed demonstration plot with farm manager (excerpt 6.12, dialogue turn #1)→(see coordination below…)
	A smallholder farmer FSA10 already involved with an LED market access facility aligned with the RWH&C learning network empathised / *identified with* another farmer outside the local municipality (LED)	FSA10 realised locally adaptive seed system benefits from IBLN→took perspective of neighbouring farmer with no market opportunities→proposed membership of learning network by farmers in neighbouring municipality as a way of learning together and breaking barrier to market access (excerpt 6.13).
Coordination	*Boundary permeability* between an FET college and farmers was increased through networking and deliberation in a learning network forum (see excerpt 6.11)	
	An FET College recognised the curriculum problem space shared with an agricultural college, and coordinated with the latter to learn together using the latter's demonstration plot as a site of intermediary action (see excerpt 6.11).	(…from identifying with above)→*explicating new possibilities* that are more easily doable and therefore prioritised (learning at an existing demonstration plot with others who underwent a curriculum experience)
Transformation through reframing power relations	Extension Officers supported the idea of using OPVs as having climate adaptive properties advantageous to rural smallholder farmers (excerpt 6.9, dialogue turn #11) and to conducting trials (DIBSAM1) within the IBLN context.	*Resistance* (sticking to mandate as rule from higher offices based on agronomic experiments [chemical weed control] and social science [weeding labour issues])→ aggravation of resistance as power over farmers [mandate as an exclusive rule akin to soccer vs rugby (DIBSAM1)] → negotiation of power ['a plan making farmers to choose' EOSA10, excerpt 6.14] and terms [ACLSA2/3, DIBSAM1]→ reconsideration of mandated script in IBLN environment → *reframing power relations:* collaborative extension for climate adaptive seed possible within IBLN (commitment to demonstration trials and plan for IBLN to visit senior Extension management)

[22] The process of 'identifying with' was identified in this study as one whereby participants, through mediation, were able to actively and reciprocally link their aspirations and problems to those of others as a way of absenting absences in new solution models.

Reflection	Extension Officer empathises with smallholder farmer recognising her cause has taken at least three years, and within his limitation he takes the farmer's perspective and suggests how to model a solution to the dilemma: **"… Otherwise, they can channel that through us, to say that, "we have been talking to our officers, we then *Thina sivume lonto bayitsho* [Then we can agree on to what they are saying] that** we have been faced with this for many years, because I think this is the third year now that Mrs. X has been raising this". pp. 9-10	

The next section discusses the agricultural educators activity system and how it implemented some of the new model solutions.

The consolidation of the IBLN is shown by its ability to maintain coordinative boundary-crossing actions on its own via such regular meetings (Appendix 6.4A), substantive discussions on WhatsApp social media (Appendix 6.4B), and community radio (Appendix 6.4C) even when the WRC project which helped to establish the IBLN via use of the double stimulation tools as outlined above, had ended. The foundation was laid by BCCLWs (see Appendix 6.4D). The next section analyses boundary-crossing issues in the agricultural educators' activity system.

6.3.2.2 Summary of evidences of boundary-crossing learning in the IBLN seed activity

The most significant evidence for boundary-crossing learning in the IBLN seed activity is seen in the transformation in the extension adivisors' attitude towards open pollinated seed varieties, which they had initially indicated they could not support due to their mandate (see section 6.3). At the end of formative intervention, extension advisors were prepared to recognise the shared problem space they had with Agroecology farmers. The extension advisors also continued to engage in *continuous joint work at the boundary* (engagement in IBLN meetings) where *real dialogue and collaboration between flesh-and-blood partners* (e.g. working together in *ilima* activities) were happening at either side of the boundary. The educators at Fort Cox College agreed to host a community seed bank (see section 6.3.2.1) for traditional and OPV seed, and to use it as a sourse of seed for trials at the college farm and in the ecommunity.

6.4 BOUNDARY-CROSSING ISSUES IN THE AGRICULTURAL EDUCATORS' ACTIVITY SYSTEM

The participating agricultural educators at Fort Cox College together with those from University of Fort Hare, University of South Africa, Lovedale FET College and Taung Agricultural College (who joined into the programme via a national BCCLW) confronted contradictions regarding absences and disruptions in agricultural water, locally adaptive seed and food security in diverse ways and contexts (see Table 6.4 below).

Table 6.4: Engagement of agricultural educators in BCCLWs and other boundary activities

	IBLN BCCLWs	IBLN training of trainers' course	Curriculum-focussed BCCLWs	MoU monitoring, implementation	Amanzi for Food national BCCLW
Fort Cox Agricultural College lecturers x4	✓	✓	✓	(including management)	✓
University of Fort Hare lecturer x1	✓	✓	✓		✓
Lovedale FET College lecturers and students	(1 lecturer, 3 students)	(12 lecturers, 5 students)			(1 lecturer)
University of South Africa Agriculture lecturer x1					✓
Taung Agricultural College lecturers x2					✓

Five boundary-crossing change laboratory workshops (BCCLWs) and other boundary-crossing activities are named in the columns in Table 6.4. (These BCCLWs are part of those in Table 6.1). The shaded area in Table 6.4 indicates activities not engaged in. The table shows that Fort Cox College had the largest volume of engagements (five out of five), numbers of people involved and follow through in the expansive learning process. It is therefore the primary focus of the agricultural educators' activity system. However, the other institutions bring in supportive data relevant across all agricultural training institutions. The memorandum of understanding (MoU) referred to in column #5 is the one entered into by Fort Cox College and Rhodes University on "Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food in 2015, 2016 and 2017" (see Appendix 6.7A). It was used as second stimulus for generativity of curriculum innovation as discussed later in this section, and mediating tool catalysing learning for change in the agricultural college. In

the planning, monitoring and evaluation meetings, the College Principal, Quality Assurance Manager and Heads of Department of Agriculture and Forestry were also involved (see Appendix 6.8A).

6.4.1 Analysis of agricultural water as a boundary issue in the curriculum

Research participants experienced diverse opportunities to analyse the agricultural water object in various boundary-crossing change laboratory contexts over an extended period of time. Figure 4.16 in section 4.2.2.1 presented a summary of the historical-genetic analysis that traced the origins and evolution of the agricultural water and locally adaptive seed objects in curriculum contexts. Further analysis from BCCLW #1 and #2 indicate that the curriculum activity's agricultural water object has continued to be out of reach for rain-fed smallholder farmers because of the domineering irrigation models (see section 6.3.1.2). Following these first two BCCLWs in the IBLN, a team of lecturers from Fort Cox College and University of Fort Hare requested a separate workshop to focus on clarifying the meaning and activate actions of curriculum analysis. They scheduled this workshop on a holiday, 24 September 2014. In this workshop the lecturers indicated that the ToT course assignment had stimulated them to clarify and look deeper into their object of curriculum activity and its models as follows:

Excerpt 6.16 (ALCASA1, September 24, 2014)

1. ***R1***: I am very touched and impressed that you have set aside this time during a holiday to go through your assignment for the course…that shows a lot of commitment…But I think we need to clarify why we are here. …
2. ***UALSA1:*** *…my concern was on attempting the assignment*. … From the last training that we had there wasn't any mention of curriculum … when we were given this assignment I thought maybe it was going to be a bit difficult really to be able to bring out aspects … *especially to do with curriculum*.
3. ***R1:*** That is quite true. X [UALSA1] approached me with that concern and then I communicated it to Y [ACLSA2] and then I realised that it was probably a common concern. …
4. ***ACLSA3:*** Yes, *I was trying to identify the elements that are in that ... because as a curriculum I know that we only offer rainwater harvesting as only a part of a course* (gesturing that it is very small). So it's only a section. …

In a curriculum analysis workshop (ALCASA1) an agricultural college lecturer (ACLSA3) *confronted* the absence of farmer-centred agricultural water by observing that the curriculum offers only a small component of RWH&C as part a SWC course (see excerpt 6.16, dialogue turn #4). A curriculum analysis tool (see Table 6.5 and Appendix 6.6) was used to aid the curriculum analysis as a second stimulus.

Table 6.5: Curriculum Analysis Tool for assessing RWH&C content and practice

Name of curriculum document/practice and year	General and topic/s overview, level of implementation	Smallholders farmers' rainfed contexts considered	RWH&C content or issues(explicit)	RWH&C content (implied)	Comments
...	...		...	...	...

Lecturers ACLSA1, ACLSA2 and ACLSA3 used the above tool to analyse and conclude that RWH&C was given very little consideration with no more than two practices mentioned, and no practical teaching prescribed or implied in their curricula (see DIBSA4d and 4e). Appendix 6.6 summarises their analysis. This analysis at the same time indicated that there was a level of recognition of RWH&C that could form a foundation for curriculum innovation (see also section 4.2.1.3 and Figure 4.15). This analysis helped the participants to face the secondary contradiction (#SCAESA2) of:

> ***Irrigation systems as the dominant <u>mediating tools</u> in the water curriculum versus the <u>object</u> of training students and farrmers to be competent extension advisors on water amongst rainfed small-scale farmers and to be able to farm under rain-fed conditions respectively***

This contradiction aggravates from primary contradiction #PCAESA1 (section 4.2.1.3). A university agriculture lecturer (UALSA1) *identified with* the context of rain-fed farmers in his analysis of this contradiction as follows, showing further how the analysis was helping the agricultural lecturers to jointly position themselves as agentive subjects of curriculum innovation. The deliberations and debates enabled the lecturers to face the secondary contradiction themselves and aggravate the *double-bind* to a quaternary contradiction (see Engeström, 1987, p. 252):

> *Excerpt 6.17 (ALCASA1, September 24, 2014)*
> ***R1***: So there is a lot of water shortage especially for people who are in the rural areas, …who are resource-poor, they don't have that access. … How about climate change, does it fit into the agro-meteorology knowledge (needs)?
> ***UALSA1:*** I think it has to fit… The issue of the water resources is also important, *somebody might think that I have an option to irrigate yet once you have the figures and see you will say that maybe irrigation is not an option.* So *one should be aware also of the water resources that are available for them* for use.

By recognising that 'irrigation is not an option' for resource-poor farmers not affording the commodified value, this lecturer (UALSA1) connected the curriculum's absence of coexistence value with the smallholder farmers' context. A similar curriculum analysis was conducted by lecturers at University of Mpumalanga on 3 July 2015 who were participating in the wider Amanzi for Food scoping research[23] (which I contributed to), which found that the curriculum had "nothing on rainwater

[23] The Amanzi for Food programme in Phase 1 involved a national scoping of all agricultural education and training institutions for use of the WRC materials, as well as inclusion of RWH&C in agricultural curricula (Lotz-Sisitka et al.,

harvesting", "it is not broad enough especially indigenous knowledge", "not fully represented / explored in the university curriculum" (see charts in Figure 6.8 below):

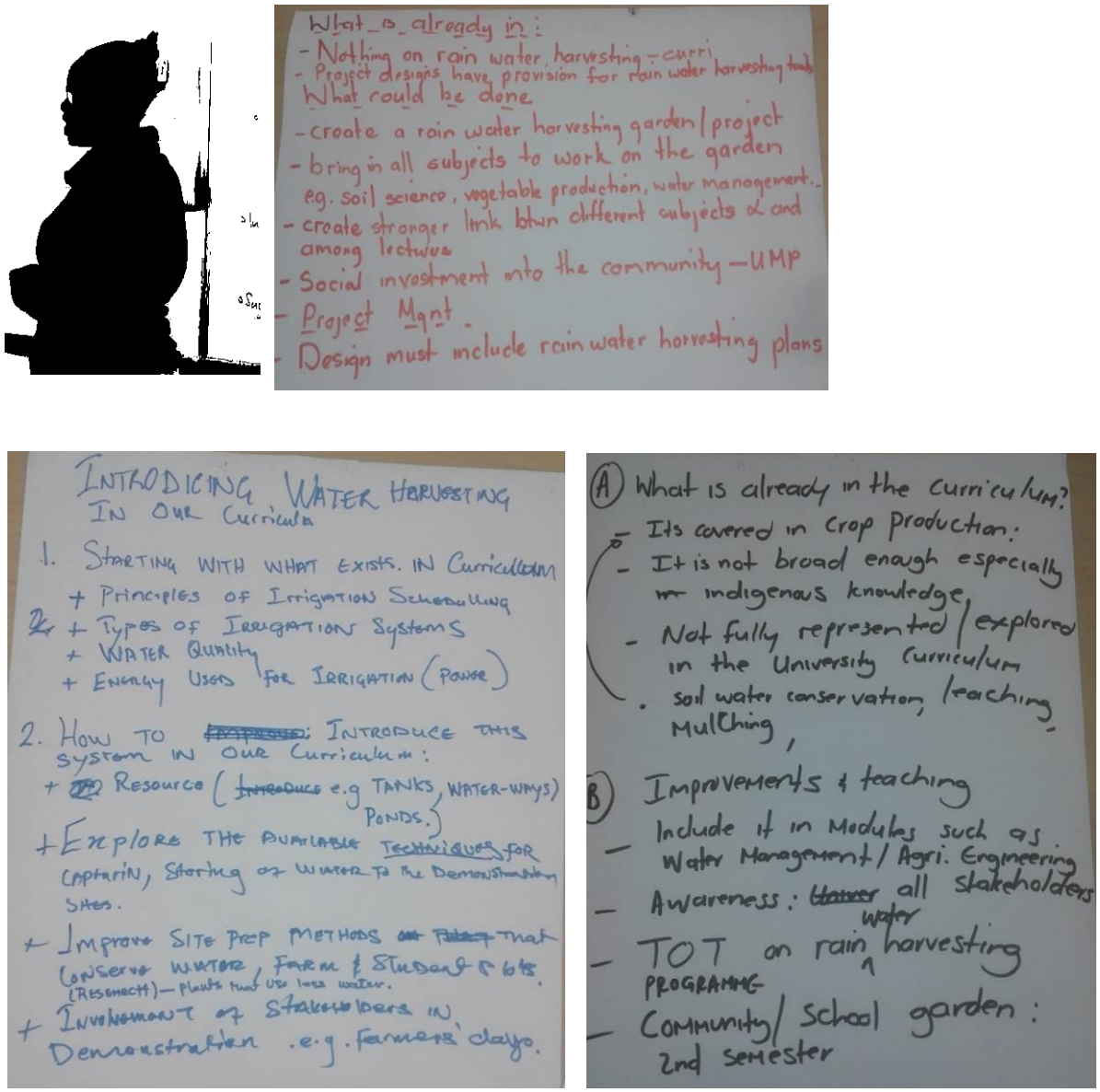


Figure 6.8: *Outcomes of curriculum analysis task at University of Mpumalanga showing curriculum gaps [top and bottom right] and aspirations [all three charts], July 3, 2015*

The above discussion serves to show the institutional spread of the contradictions in agricultural water curricula, showing similarities across agricultural training institutions involved in the wider Amanzi for Food project, which link this case study site (Eastern Cape institutions: Fort Cox College, Lovedale FET College and the University of Fort Hare in the IBLN study site) to the wider system of Agricultural Colleges and Universities offering agricultural education and training (amongst others University of

2016). This scoping process involved workshops with the University of Mpumalanga and Taung College of Agriculture. The main focus of the project was, however, the Eastern Cape site around the Fort Cox College and the IBLN formation as described in this chapter.

Mpumalanga and University of South Africa) (see Appendix 6.2). The wider consultative processes involved in the Amanzi for Food programme, and especially a national BCCLW helped the Fort Cox and Eastern Cape agricultural education and training institutions to see that they were not facing an isolated problem, but that the issue of failing to take account of smallholder farmer needs was more widespread nationally (see also Chapter 2).

On July 31, 2015 three Fort Cox College lecturers participated in their second institutional BCCLW where further analysis of the curriculum showed the persistence of the double bind both in Crop and Animal Production, as shown below:

Excerpt 6.18 (Transcript of Fort Cox College BCCLW #2: DIBSAF1b, July 31, 2015)

1. ***R1:*** What are the issues around water in your area? What is your area X?
2. ***ACLSA5:*** I teach Pasture and also Animal or Beef Production courses, so *we don't touch anything on water harvesting* because we are using ... you see there's a rangeland, which I think water harvesting applies mostly to ... and then there are cultivated pastures which are supposed to be irrigated. So, when you're teaching pasture, it's basically cultivated, and you're supposed to fertilise and irrigate. It's basically like cropping.
3. ***ACLSA2:*** ... I think it fits more under cultivated pastures.
4. ***ACLSA5:*** Oh yeah, because ...this guy where you dropped the student in Plettenberg, he does *dryland pastures*. He plants grass but he depends on rain, probably because he is next to the coast.
5. ***ACLSA2:*** Then if you can put some structures that make sure that water infiltrates rather than running off then you are doing rain water harvesting.
6. ***ACLSA5:*** They call it cultivated because it's introduced grass, it's still cultivated. A rangeland is the natural one. *So even here there are no concepts of water harvesting in our curriculum. There is nothing*.
7. ***R1***: X, maybe the issue is, is agricultural water adequately addressed in your curriculum of animal and pasture production or on the other side?
8. ***ACLSA5:*** No. There are no topics on…
9. ***ACLSA2:*** Maybe the next question would be do you think it is important for animal production students to learn something about agricultural water?
10. ***ACLSA4:*** In terms of harvesting the water.
11. ***ACLSA5:*** Yes.
12. ***R1:*** Why is that?
13. ***ACLSA5:*** You know ...even our natural rangelands come winter there is a problem because their growth is affected. I think it's the water level that goes down. ...it affects even the pasture species, the grass species... So, at our diploma curriculum, even degree, we're not addressing those issues.

A video of *saaidamme* (an indigenous dam walling to divert runoff water) presented in the WRC materials as a possible RWH&C practice,[24] was used by one of the lecturers as a second stimulus (see dialogue turn #1, and activity turn #4, excerpt 6.19) to confront the double bind.

[24] The WRC Materials contain information on 16 different RWH&C practices which were mediated into the ToT course via use of a 'navigation tool' to access information on these via the WRC materials or Amanzi for Food website which

Excerpt 6.19 (Transcript of Fort Cox College BCCLW #2: DIBSAF1b, July 31, 2015)

1. ***ACLSA2:*** There's something they were doing in the Northern Cape. They would harvest water into a veld and that was enough to sustain the pastures for the whole season. ... you know this video, yeah?
2. ***R1:*** In terms of the future, ACLSA5, what future are you seeing for water in pasture and animal production... in the diploma course?
3. ***ACLSA5:*** You see, *I want to see these issues being addressed in the diploma course, but I don't know how*. I'm trying to think. Because maybe, I wasn't in the workshops. You have different methods of harvesting the water because it affects our pasture production. The grass growth is basically related to water, if we do not have enough water that means we've less forage and it affects our animal production...
4. (Participants view a video playback at spool run 25min 08sec on RWH&C in the Northern Cape as a second stimulus and start discussing it)
5. ***ACLSA2:*** You see that Doc, that was purely rainwater harvesting. These are pastures for sheep ...
6. ***ACLSA5:*** How did they conserve the water?

This led to critical analysis of current curriculum practices and commissive speech acts expressing agency and a need for collective learning ("I want to see… but I don't know how", see dialogue turn #3). The actual-empirical analysis is summarised in Table 6.6.

Table 6.6 Summary of the actual-empirical analysis

Empirical data	**Actual-empirical analysis**	**Thematic clusters of systemic relations**
ACLSA3: "**we teach what we want instead of what the extension person needs**" (DIBSA1b, August 12, 2014).	Agricultural college curriculum for extension graduates and farmers is not based on farmers' contexts.	The actual rain-fed contexts, climate uncertainties and agricultural water needs of *farmers are not placed at the centre* of agricultural curriculum practice in extension and farmer training. [**Position of farmers in curriculum knowledge production-theme 1**]
ACLSA3: "Most of our curriculums… it is a Fort Cox thinking, **not farmer-based**. It's more academic than the practicality…" (DIBSA1b, August 12, 2014).	Agricultural college curriculum not practical yet it produces farmers who need to be hands-on and extension practitioners who need to advise farmers.	
UALSA2: … if extension is to address the issues of small-scale farming and household gardens… **But are we trained to look into that or are we trained to be more specific in terms of our expertise**? (DAfFS2, May 11, 2016)	Lecturer's pedagogic practices based on the expertise that they were trained in, which is not small-scale farmer centred.	As above, *famers are decentred from agricultural college curricula and pedagogy*. [**Position of farmers in curriculum knowledge production-theme 1**] University agriculture *curriculum privileges and reproduces expertise and knowledge of lecturers*

was constructed around to provide access to knowledge on these 16 practices (see www.amanziforfood.co.za). Saaidamme was one of these practices.

		which does not take account of smallholder farmers' circumstances and knowledges. [**Position of farmers in curriculum knowledge production-theme 1**]
UALSA2: We design courses according to our expertise, and they are approved by Higher Education in terms of those expertise. ... I am to teach what is approved, then **I cannot come and change the curriculum as X and say I should put household issues** into that. So that is the major problem. (DAfFS2, May 11, 2016)	While lecturers design courses they are governed by rules of the Higher Education department whose approval processes restrict curriculum change at that level.	**Livelihood issues, climate adaptive practices are excluded from official university agricultural curriculum** due to privileging of 'expert' knowledge.
UALSA2: So if I (as a lecturer) train them (extension learners) to excel in crop production in terms of the production of sugar cane or whatever, ... *I haven't trained them in terms of mung beans, in terms of cow peas, which can actually adapt to these water issues*.	**Agroecological crops that adapt to adverse climate and climate change are excluded from the curriculum due to the privileging of 'high value' commercial crops** that may be inaccessible to capabilities of smallholder farmers.	**Exclusion of climate adaptive practices from university curriculum.**
FCLSA1: *"we have those gaps*. … Because you find *even the practical itself it tends to be so academic than looking into much more do-able and practical solutions to some of the challenges*. For instance, the issue of water, I think they will know especially in our campus, but these ideas of rainwater harvesting even there they are there and there is material that is out there on them, but *you don't really find rigorous implementation of these ideas in order to assist in food production*. (DIBSAM1, May 27, 2016)	Pedagogy in FET colleges is biased towards academic rather than practical learning. RWH is implemented as part of campus management but not in the agricultural curriculum.	The **in-depth pedagogy and practical learning of rainwater harvesting is absent** in the FET college curriculum.
FET College student/youth: "*I think what (FET) colleges are doing is going away from actually being a TVET college and going to the whole sense of being like universities, of **being theoretical and not enough practicality***. … Theory today is something that the youth are very afraid of. … FET College Lecturer: I think ***it's quite correct because we have those gaps***. … ***the practical itself it tends to be so academic*** … For instance, the issue of water, … but **these ideas of rainwater harvesting … *you don't really find rigorous implementation*** *of these ideas in order to assist in food production*. ((DIBSAM1, May 27, 2016)	Both FET college students and lecturers expressed concern over the absence of practical learning opportunities in general and the teaching and learning of RWH&C in particular.	**Practical hands-on learning is absent from the FET College curriculum** and therefore compromises any possible learning of RWH&C.

The analysis in Table 6.6 shows three main themes in the development of contradictions in the work of an agricultural college, which resonated with similar developmental aspirations found in a university and an FET college. These analytical themes were: 1) placing smallholder farmers at the periphery and realisation of the need to place them at the centre of knowledge generation and flow in curriculum practices, 2) poor water and seed practices in agricultural curricula and realising the need for more sustainable agricultural water and seed practices; and 3) the lack of and need for practically-oriented curriculum and training programmes. Such aspirations remained as such until further formative intervention work could be carried out. This analysis provided direction to "the next, more advanced developmental form" (Engeström, 1987, p. 252) of the agricultural college lecturer activity system which was deliberated during modelling of new solutions (see next section 6.4.2).

6.4.2 Modelling and examining curriculum solutions across boundaries: Fort Cox College

Processes of analysing the object of agricultural water led to the modelling of curriculum innovation solutions by agriculture lecturers and farmers. These new models were the teaching of a diverse range of rainwater harvesting and conservation practices and the development of RWH&C demonstration sites for practical teaching and learning. However the models began by taking the perspectives of farmers and placing them at the centre of the knowledge flow, as follows:

Excerpt 6.20 (DIBSA1c, August 12, 2014)

1. ***R1:*** But do you think it is something that is a need in this area, ...water harvesting ?
2. ***ACLSA3:*** *I should think so*. Because my thinking is... you see there are some fields by the road when you are coming from Middledrift?
3. ***R1, R2, R3:*** Yes.
4. ***ACLSA3:*** *Those people I don't know whether it's because they plant late or it's the water issues, but I have never seen a nice harvest or a nice look of a maize out there...*
5. ***ACLSA2:*** Yes they try their best but...
6. ***ACLSA3:*** *It means they have a passion of producing but they are still depending on rain but what is happening to that rain is it's coming but is running off*. And *... the soils here most of them are formed from quartz, therefore there is the effect of compaction* – it means every rain that is coming a whole lot of it is going with *runoff*. *But if we are to harvest that rain infield then there would be a difference*.

In the dialogue in excerpt 6.20 above there was the beginning of modelling a demonstration plot that takes account of farmers' rain-fed and soil type contexts (dialogue turns #4 and #6). An agricultural college lecturer (ACLSA2) in a subsequent curriculum focussed group discussion made the following proposal: "I was thinking that *if we can find a way by which we can involve rainwater harvesting into our curriculum* in such a way that it stands out as a significant component of the curriculum. How we can implement it in the curriculum" (ALCASA1, September 24, 2014). In modelling the possible

'infusion' of RWH&C in Horticulture Production courses, an agricultural college lecturer (ACLSA4) proposed that:

> *Excerpt 6.21 (DIBSA2g, Assignment One, June, 2015)*
>
> ***ACLSA4:*** *The sub-topic water is the most relevant in the content which may be expounded to include RWH&C methods such as mulching, terracing, tied ridges, swales, use of diversion furrows* for waterlogged areas to channel the flood water into trenches or other collection systems for later use. The topics *may translate into practical* where the students *implement the various methods of RWH&C.* ...currently I deal with a practical on layout of vegetable garden where the students are exposed to various methods including sunken beds, and raised beds. *This practical can be developed to include RWH&C practices*. Currently the practicals on this course incorporate mulching for weed suppression and moisture retention.

Excerpt 6.21 modelled curriculum expansion to build on what was existing ('expounded'), increase diversity ('the various methods'), and hands-on pedagogy ('practical'). This model was based on an object-historical analysis of what the written curriculum offered ('currently the practicals ... incorporate') which allowed for curriculum innovation without waiting for official reviews. Yet another agricultural college lecturer ACLSA2, through a boundary-crossing process of *crystallisation* (Akkerman & Bakker, 2011) of emerging RWH&C knowledge modelled an embedding of RWH&C in curriculum practice so that it has *real consequences* (ibid.) for student learning as follows:

> *Excerpt 6.22 (ALCASA1, September 24, 2014)*
>
> ***ACLSA2:*** I am actually doing a project right now with the students on mulching. They are not going to use rainwater to harvest the water but they are going to be irrigating. ... If I were going to do a project whereby I wanted to investigate the harvesting part of it then *it's simply an extension of that same one*. …

6.4.3 Implementation of curriculum innovation solutions across boundaries: Fort Cox College

The curriculum solutions implemented by three agricultural college lecturers at Fort Cox College in 2015 to 2017 were not an isolated event but an off-shoot of the IBLN co-engaged boundary-crossing learning processes and the initial change project discussions in the ToT (see sections 6.2 and 6.3). They consisted of a combination of formative intervention and intravention processes that were substantively informed by the collaborative implementation of a demonstration plot at Lloyd Village cooperative garden that formed a germ cell for the concept and practice of productive demonstration plot development as a process of realising theory and practice *in practice* (Bhaskar, 1998). This was followed by the implementation of productive demonstration plots development and expansion at Keiskammahoek and Fort Cox College, the teaching of classes and practicals, entering into an MoU by Fort Cox College, inputs into curriculum review processes and generativity of boundary-crossing actions (see Figure 6.9).

8. Generative knotworking boundary crossing actions across and beyond IBLN; the IBLN begins to expand to other sites and Fort Cox College

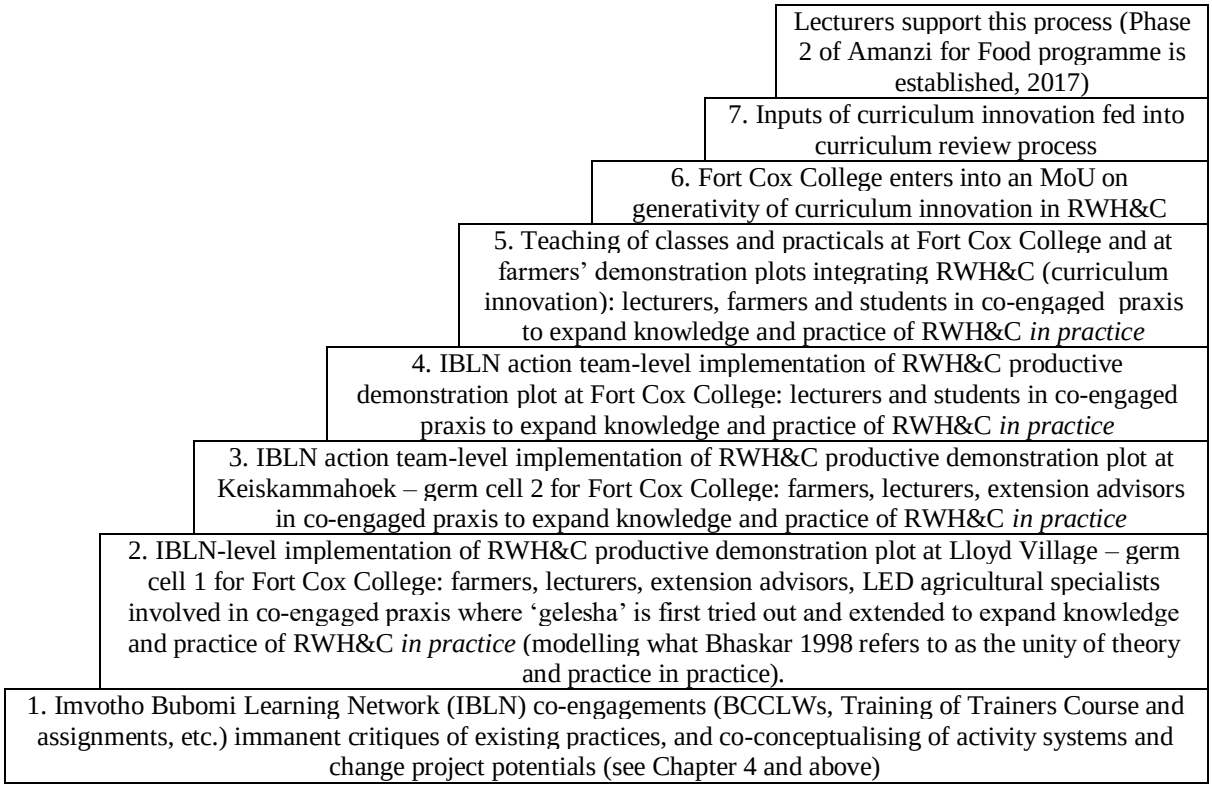


Figure 6.9: *Stepwise development of boundary-crossing agency in the curriculum innovation pathway at Fort Cox Agricultural College*

The process above in Figure 6.9 centres around the emergence of productive demonstration sites as 'germ cell' emerging also in relation to knowledge recuperation of 'gelesha' as a traditional isiXhosa practice which is then expanded to a range of other RWH&C practices. Steps 1 to 2 were discussed in sections 6.2 and 6.3. Step 3 was informed by steps 1 and 2. An example of steps 4 and 5 is ACLSA3 teamed up with farmers from Keiskammahoek in the IBLN BCCLWs and they recruited local farmers and extension officers (see section 6.2.3). ACLSA2 and ACLSA4 had similar experiences (see section 6.3.1). The college's ability to enter into such an MoU shown in step 6 is supported by its autonomy (see section 4.2.1). The following boundary-crossing mechanisms activated curriculum innovation.

6.4.3.1 Agricultural college lecturers and management 'identified with' smallholder farmers – lessons from Keiskammahoek productive demonstration plot

In the excerpts below an agricultural college lecturer, ACLSA3 identified with rural smallholder farmers' and homestead food producers' water contexts through immanent critique of her corporate curriculum practice. In excerpt 6.23 lecturer ACLSA3 described how farmers initially ascribed a

higher status to the lecturer whom they perceived as working 'on them' as an expert rather than the intended 'alongside / with them' as a colleague.

> *Excerpt 6.23: Assignment 3 analysis document #DIBSA4e, July 2015)*
> ***ACLSA3:*** I had also been given a *scribing* role and the *chairing* of the planning meeting due to the nature of work I do. *I think the fact that I am a lecturer has made other members to sit back and judge themselves as being less knowledgeable*, I believe that *my profession has clouded the judgement of other team members*. This in a way might have compromised the strength and potential of other farmers.

The lecturer ACLSA3 above described the persistence of the contradictions manifested and surfaced in Chapter 4 (see case study 4, section 4.2.1.3) and for which Freire (2005b) claimed that "the practice of problem-posing education entails at the outset that the teacher-student contradiction to be resolved" (p. 79). The farmers and agricultural extension advisors virtually wanted the lecturer among them to chair the meeting and to take the minutes at the same time (excerpt 6.23, first line) because they considered themselves relatively "less knowledgeable" (third line). During ACLSA3's joint intravention with farmers and agricultural advisors (in the researcher's absence), they jointly resolved the above tension with the initiative of the lecturer who *resisted the new suggestion* (see Table 3.11). This researcher (R1) probed the resolution of this tension through social media as shown in excerpt 6.24 below ("How did you deal with this tension?", dialogue turn #1), to which ACLSA3 shared her humble expression of agency (Haapasaari et al., 2012, p. 242), "I would be quiet and pose a question to encourage discussion", dialogue turn #2).

> *Excerpt 6.24: ACLSA3, WhatsApp chat transcript #ACLSA3W, December 14, 2016)*
>
> 1) ***R1:*** How did you deal with this tension [citing excerpt 6.19 above] in working with the farmers?
> 2) ***ACLSA3:*** There were times when *I would be quiet and just pose a question to encourage discussions* from the farmers. So I would just take their comments.
> 3) ***R1:*** Okay great. Did you see any changes in their attitudes or perspectives as a result or nothing changed?
> 4) ***ACLSA3:*** Yes, *there was a huge change*. *The set-up of the demonstration plot is a proof*. My wish was for comparison but *the farmers saw no need* and we ended up doing only the trial without comparison. Also *the application of mulch was their idea and they did it on their own*. They also *organised other farmers to help in implementing without any of my intervention*. To date Mrs [X] have infield water harvesting in her garden and she is doing well. I took my students there in late October early Nov this year. She did the teaching. I've just sent you the video. It is still uploading.
> 5) ***R1:*** That sounds progressive. What impressed them most or what do you think they learned specifically?
> 6) ***ACLSA3:*** Wait till you listen to the video. The way the garden looked and how the technique is working. Also *the money she is making* on that piece of land. *She was excellent in her teaching.*
> 7) ***R1:*** OK I will listen to the videos before asking more! One has come through.
> 8) ***ACLSA3:*** I think *the teaching place, who delivers the lesson* plays a significant role in the learner. In a way, it looks as if when they learn in class and through a lecturer is all about assessment but *with farmer base it is a real life applications*.

The transformative agency expressed by ACLSA3 in dialogue turn #2 of excerpt 6.24 apparently led to the taking of "consequential actions" (Haapasaari et al., 2012) that led to change in the joint activity. For example farmers started valuing their own knowledge and aspirations even above those of the lecturer, as shown when they disregarded her preference to do a controlled experiment and modelled their own solutions (see excerpt 6.24, described as "a huge change" in dialogue turn #4). In addition transformative agency was shown when "every activity was given a responsible person" (DIBSA4e, July 2015), and "to specific team members looking at their availability and the transport and skills, e.g. the organiser and coordination role was given to Mrs X [FSA7], technical application [to] Y [ACLSA3]" (ibid.).

Figure 6.10: *Left: Deliberation on site selection and agricultural water solution at Keiskammahoek (February 26, 2015), right: Implementing infield RWH demonstration plot (March 10, 2015). (Photo credit: ACLSA3 and Amanzi for Food)*

The agricultural college lecturer ACLSA3 reported how her teaching strategies were using examples that were *identifying with* local farming practices regarding more sustainable agricultural water provisioning. Referring to the double mediation provided by rainwater harvesting demonstration plots and electronic media, ACLSA3 demonstrated how she had transformed her teaching and students' learning experiences by introducing farmers' voices and practices into the lecture room using electronic media (see amanziforfood.co.za):

> *Excerpt 6.25 (DIBSA8a, July 21, 2016)*
>
> ***ACLSA3:*** *The website is making our lives easier.* ... there are *YouTube videos*[25] *made during the construction of our ponds from these groups* (referring to the learning network). ... videos where one can watch and familiarise themselves with the techniques. *To me it is a good thing*

[25] This refers to You Tube video material that was made with members of the IBLN to demonstrate aspects of the RWH&C practices. The video material can be accessed from the Amanzi for Food website which was also developed as an additional mediation tool in the wider Amanzi for Food project (www.amanziforfood.co.za)

> *because it means I can have my class without me talking* but punching the YouTube for the students to listen and then we ... discuss.

The excerpt above is an agentive expression reporting having taken consequential actions to change the activity of teaching agricultural water after several change laboratory sessions (and enabling 'intraventions' such as innovating practicals bottleneck in the timetable; see earlier in this chapter). It was emphasising the importance of expansive learning in the learning network and why it was important to scale up documentation of productive demonstration plots.

The lessons learnt from implementing the productive demonstration plot at Keiskammahoek were applied to the curriculum innovation process at Fort Cox College as follows. Firstly, ACLSA3 used her assignment 3 as a tool for modelling curriculum planning solutions:

> *Excerpt 6.26: (Assignment 3 analysis document #DIBSA4e, July 2015)*
> ***ACLSA3:*** The planning process that we went through in focus groups worked best in the construction of the RWH&C production demonstration site. *This has inspired me to use the same planning to roll out the practicals for the course I am offering i.e. Soil and Water Conservation*. ... I will divide my students into groups after giving them the theory on the RWH&C techniques, then those groups will have to decide on what technique to implement in a vegetable production plot.

The catalytic implementation of the solution modelled in excerpt 6.26 is described in section 6.4.3.3 and demonstrates the Vygotskian concept of learning leading development (Zaretskii, 2016; see section 3.7.1.3). ACLSA2 went through a similar process working with agricultural research technicians, farmers and RDC agricultural trainers to co-model his. "The group shall make use of the farm pond ... blending of this RWH technique with the grass and plastic mulching technique …" (ACLSA2, DIBSA4d, July 2015).

The process of *identifying with* farmers did not end up with lecturers but was also valued by management. The Quality Assurance Manager at Fort Cox College (ACMSA1) expressed this value through a critique of inappropriate irrigation tools and rather poposing tools that will transform food security and livelihoods (see excerpt 4.34, section 4.3.1). The Head of Department of Agriculture (ACMSA4) also indicated the need to have students spend significant time learning directly from smallholder farmers while staying with them during their college training.

6.4.3.2 Agricultural college lecturers collaborated to establish productive RWH&C demonstration plots in the agricultural college farm

The learning network provided a new tool for collaboration and coordination in the agricultural college curriculum innovation. Lecturer ACLSA2 worked with his IBLN change project action team (see

section 6.3.1.4 and Figure 6.5) to model an integrated system that he further developed using assignment 2 and described using assignment 3:

> *Excerpt 6.27: (Assignment 2 analysis document #DIBSA3d, July 27, 2015)*
> ***ACLSA2:*** Farm ponds are large pits dug near a cropped area ... can be plastic lined, concreted, or without any form of lining. Dimensions can be 8.5m [l], 8.5m [w], and 1.5m [depth]. ...needs to be sited at a place where it is likely to collect sufficient runoff while at the same time ... within the vicinity of the cropped area for ease of irrigation. ... Water conveyance from the pond to the cropped area can be achieved either manually or through the use of mechanical devices. ... [e.g.] a simple solar powered water pump...

The model in excerpt 6.27 was further discussed by the action team and it was agreed to implement a farm pond (10m long x10m wide x1.5m deep) at the base of a slope with a naturally grassed catchment area next to the cropping area, and to line the pond with plastic. ACLSA2 indicated that he walked to the site under an umbrella whilst it was raining and watched the runoff, which showed the best place to site the pond (see excerpt 4.56). The pond was dug in May 2015 taking advantage of a Tractor-Loader Backhoe (TLB) working on campus. Students were involved in installing a raised tank next to the pond (DIBSA4e), laying a drip irrigation kit and feeding the tank manually with water (see Figure 6.11 below).

Figure 6.11: *Top left: Agriculture lecturer showing natural catchment for pond; top right: TLB digging farm pond; bottom left, centre: students constructing tank base (July 2015); bottom right: students filling up raised tank (September 4, 2015). (Photos by ACLSA2)*

The initial plan was that local equipment and labour would be used to dig the pond. Hiring a TLB was not part of the plan as the cost was prohibitive, however the presence of one working on the agricultural college was providential. The college was not able to procure a solar pump hence the manual feed for the tank. A plastic sheet was procured to line the pond to prevent water seepage, however heavy winter

rains that came in July 2015 prevented the use of the plastic lining. This was a blessing in disguise as the pond held the water up to February 2016. The raised tank was connected to a drip irrigation system watering a crop of gooseberries intercropped with spinach, and heavily mulched with dry grass. Due to the drought of 2016 no rains fell in summer, so the demonstration plot had to prove itself. The holiday period of December 2015 to January 2016 fell in the drought period. It also meant that there was no watering. When the students and lecturers returned to the site in February they were surprised to find the vegetables thriving. They noted that the soil surface beneath the mulch was moist, thus demonstrating the power of mulching (see excerpt 4.55, "*the soil beneath the mulch was still moist* meaning there was a very good retention of moisture" ACLSA3). "This is when I realised that mulching was so effective" (ACLSA2, Research journal entry, February 4, 2016).

6.4.3.3 Agricultural college lecturers coordinated to integrate RWH&C in pedagogy

The timetable that was initially an obstacle in that it produced discontinuity in practical work allotments per lecturer at Fort Cox College was used as a coordination tool for allowing team teaching of practical work to a common cohort of students. The lecturers deliberated amongst themselves and negotiated how to utilise the limited time available for practicals to address their different courses. Figure 6.12 and excerpt 6.19 capture a lesson by one of the lecturers ACLSA3, documented on audio (see DIBSAFL, August 25, 2015).

Figure 6.12: *An SWC class integrating RWH&C using WRC's WHC materials: Implementing a curriculum innovation model (Photo by author, August 25, 2016)*

Excerpt 6.28 (DIBSAFL, Lecture, August 25, 2015)

ACLSA3: Those ... that are fetching water from very far. ... you to know that when you come back from school, "I will need to get the wheelbarrow and go to fetch some water", right? And you know it's time for me to do some homeworks, isn't it? What else do we think we benefit from rainwater [harvesting]?

Student: Prevent loss of time of the wastage of water. ...

ACLSA3: In this Fort Cox, when it rains like this, there are areas ... that you find outside wet for some very long time, because water just accumulated right there. This is what she is trying to explain, when she is saying, it prevents water wastage.

Excerpt 6.28 shows how ACLSA3 introduced RWH&C learning in her class, moving from the prior knowledge of water challenges to the need to enhance RWH&C learning and practice. She then connected with agricultural learning and practice (see excerpt 6.29).

Excerpt 6.29 (DIBSAFL, Lecture, August 25, 2015)

1. ***ACLSA3:*** Do you think it is important for farmer producers to harvest water?
2. ***Student:*** Yes
3. ***ACLSA3:*** Why?
4. ***Student:*** For the animals.
5. ***ACLSA3:*** For the animals drinking? So, how should we harvest it? ... so we have another level here, which is? You say, "through ponds". We will deal with it through our next meeting. ...we were talking of rooftop. ... I was saying ... for storage for the animals, talking that *it extends the raining season. So, these are the things you need to look out for, when harvesting water...*
6. ***Student:*** Yes. ...
7. ***ACLSA3:*** ... here we have lots of methods that we are going to deal with. *Do you remember, I told you yesterday that we are going to have these nice books* ... and they are in the library?
8. ***Student:*** Yes
9. ***ACLSA3:*** I am going to ask and inform the librarian, that these books are for this class. This is strictly rainwater harvesting and conservation, alright. ... These blue one's there are five and please guys share them. ... OK, *Tomorrow, we have a practical, we are going to the field, we are going to visit a pond, that was developed here a Fort Cox*. ...
10. ***R1***: Really, I have been filming the lesson also but madam X has been talking about these books. They were developed by the Water Research Commission of South Africa. ... So, the reason why I was taking the pictures and the videos is for educational purposes, so that others could also learn. ... So, I will need your permission, whether I can use your material for educational purposes. ...
11. ***ACLSA3:*** I am going to do is take the books to the HoD to endorse them. ... Sure, then we will go to various areas later.

In excerpt 6.29 lecturer ACLSA3 introduced WRC RWH&C books as resource materials for teaching, students' research, learning and assignments (dialogue turn #7), thus exercising transformative curriculum innovation agency in her implementation of this new model. In dialogue turn #9 lecturer ACLSA3 exercised further curriculum agency by *reporting earlier action taken* (farm pond installed, see Plate 6.6) and *committing to a new action* (teaching and learning at the productive demonstration plot). She also committed to further curriculum action namely institutionalising the RWH&C materials and to later pedagogic work on farmers' demonstration plots (dialogue turn #11).

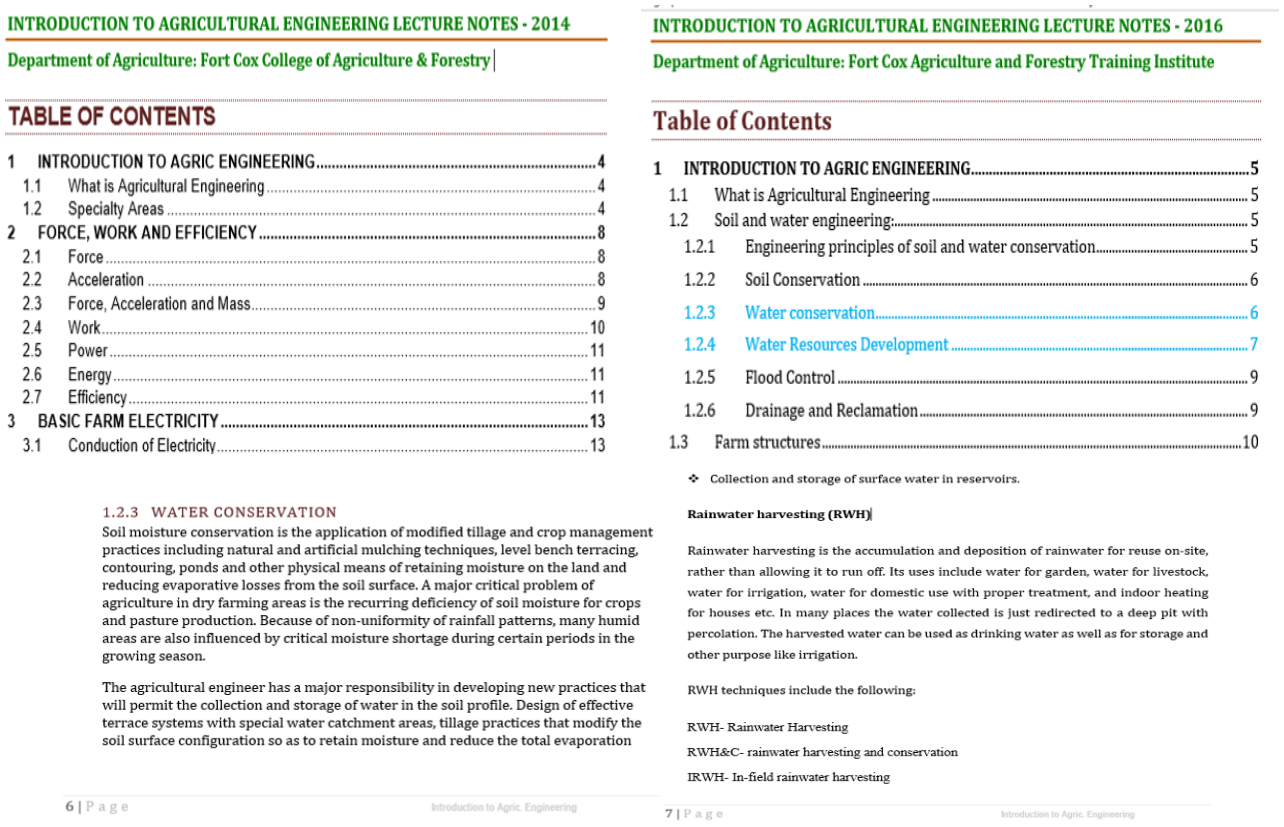
In order to stimulate wider generativity of curriculum innovation, the management at Fort Cox College requested an MoU as a way of coordinating and institutionalising the emerging curriculum innovation in the college with the collaborative work with stakeholders such as farmers. This was a form of transformative agency. This MoU became a new model for coordinating implementation, akin to the

"Care Agreement" described by Engeström et al. (1999) in their boundary-crossing work with health institutions (see section 3.5.8). One of the expected outcomes of this MoU drawn from emerging model solutions was;

> 4.1 *Rainwater harvesting is integrated* into Fort Cox College College of Agriculture and Forestry's agriculture curriculum as a means of
> 4.1.1 Empowering graduates to *better respond to the water and economic needs of resource-constrained farmers* especially at small-scale (transformation) who depend on rain-fed farming in constantly changing climates… (DIBSAF1c, 2016, p. 2; see appendix 6.7A)

The citation above shows management's curriculum innovation commitment placing rain-fed farmers' contexts at the centre of knowledge flow, aspiring to "better respond to … farmers".

Catalytic changes in curriculum practices took place as a result of concerted efforts by lecturers (and their student cohort) who decided to work together as a team across their disciplines, and by so doing overcame problems in their timetable. This change is illustrated in many ways, such as through a comparison of course content of the Introduction to Agricultural Engineering course between the years 2014 and 2016 (see Figure 6.13 below).



INTRODUCTION TO AGRICULTURAL ENGINEERING LECTURE NOTES - 2014

Department of Agriculture: Fort Cox College of Agriculture & Forestry

TABLE OF CONTENTS

1 INTRODUCTION TO AGRIC ENGINEERING 4
1.1 What is Agricultural Engineering 4
1.2 Specialty Areas 4
2 FORCE, WORK AND EFFICIENCY 8
2.1 Force 8
2.2 Acceleration 8
2.3 Force, Acceleration and Mass 9
2.4 Work 10
2.5 Power 11
2.6 Energy 11
2.7 Efficiency 11
3 BASIC FARM ELECTRICITY 13
3.1 Conduction of Electricity 13

1.2.3 WATER CONSERVATION

Soil moisture conservation is the application of modified tillage and crop management practices including natural and artificial mulching techniques, level bench terracing, contouring, ponds and other physical means of retaining moisture on the land and reducing evaporative losses from the soil surface. A major critical problem of agriculture in dry farming areas is the recurring deficiency of soil moisture for crops and pasture production. Because of non-uniformity of rainfall patterns, many humid areas are also influenced by critical moisture shortage during certain periods in the growing season.

The agricultural engineer has a major responsibility in developing new practices that will permit the collection and storage of water in the soil profile. Design of effective terrace systems with special water catchment areas, tillage practices that modify the soil surface configuration so as to retain moisture and reduce the total evaporation

INTRODUCTION TO AGRICULTURAL ENGINEERING LECTURE NOTES - 2016

Department of Agriculture: Fort Cox Agriculture and Forestry Training Institute

Table of Contents

1 INTRODUCTION TO AGRIC ENGINEERING 5
1.1 What is Agricultural Engineering 5
1.2 Soil and water engineering: 5
1.2.1 Engineering principles of soil and water conservation 5
1.2.2 Soil Conservation 6
1.2.3 Water conservation 6
1.2.4 Water Resources Development 7
1.2.5 Flood Control 9
1.2.6 Drainage and Reclamation 9
1.3 Farm structures 10

- Collection and storage of surface water in reservoirs.

Rainwater harvesting (RWH)

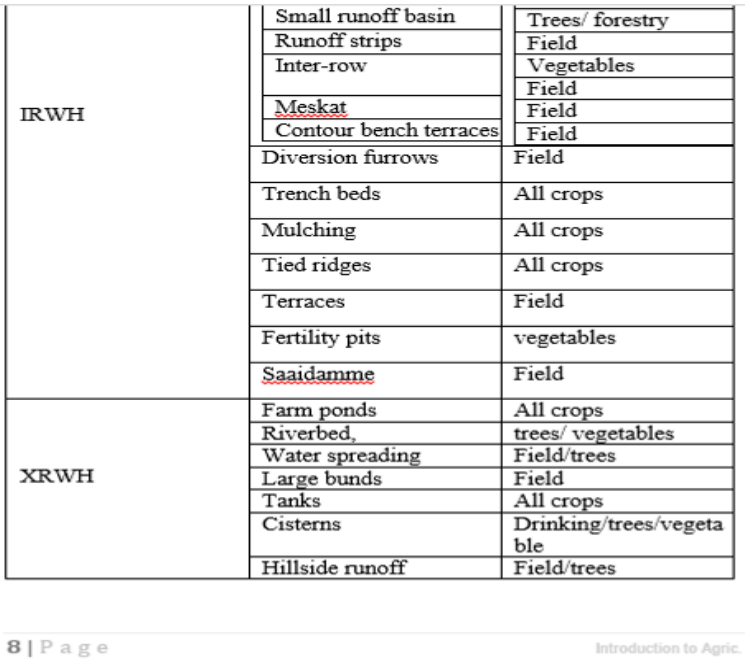
Rainwater harvesting is the accumulation and deposition of rainwater for reuse on-site, rather than allowing it to run off. Its uses include water for garden, water for livestock, water for irrigation, water for domestic use with proper treatment, and indoor heating for houses etc. In many places the water collected is just redirected to a deep pit with percolation. The harvested water can be used as drinking water as well as for storage and other purpose like irrigation.

RWH techniques include the following:

RWH- Rainwater Harvesting

RWH&C- rainwater harvesting and conservation

IRWH- In-field rainwater harvesting



IRWH	Small runoff basin	Trees/ forestry
	Runoff strips	Field
	Inter-row	Vegetables
		Field
	Meskat	Field
	Contour bench terraces	Field
	Diversion furrows	Field
	Trench beds	All crops
	Mulching	All crops
	Tied ridges	All crops
	Terraces	Field
	Fertility pits	vegetables
	Saaidamme	Field
XRWH	Farm ponds	All crops
	Riverbed,	trees/ vegetables
	Water spreading	Field/trees
	Large bunds	Field
	Tanks	All crops
	Cisterns	Drinking/trees/vegetable
	Hillside runoff	Field/trees

Figure 6.13: *Changes in agricultural water content in the Introduction to Agricultural Engineering course from exclusive irrigation in 2014 (top left) to incorporation of RWH&C in 2016 (top right, middle left and right and bottom). (Source: ACLSA2, November 2017)*

The changes shown in Figure 6.13 show that among other innovative modifications, course content on water conservation, water resources development and RWH&C were added to the to enhance pedagogy which previously did not exist in the notes. Curriculum changes were also confirmed by students as shown in the dialogue in excerpt 6.20. The dialogue below with two second-year agriculture students in a cohort taught by the three Fort Cox College lecturers indicates that the students experienced new learning of RWH&C practices as a result of implementation of new curriculum innovation model solutions:

Excerpt 6.30 (FCCSFGSA1, Students' focus group interview, October 27, 2015)

1. ***R1:*** If we are looking at your situation ACSSA1, you are in an area where there is not much water… have small-scale farmers who are not as privileged.
2. ***ACSSA1 (agricultural college student 1 – South Africa):*** Yes.
3. ***R1:*** So, what does your curriculum say about those?
4. ***ACSSA1:*** *They have to harvest the water, collect..., use rainwater and recycle.*
5. ***R1:*** Does your curriculum actually include water harvesting in it?
6. ***ACSSA1:*** It does.
7. ***R1:*** When did you start learning about this water harvesting?
8. ***ACSSA1:*** This year, this semester (second semester).
9. ***R1:*** Do you mind sharing with me, what... you learnt about water harvesting?
10. ***ACSSA2:*** What I have learnt about this water harvesting is that, there are *means of conservation practices* that are included there, ... *what I have noticed from the book that you brought...*, that there are these diversion furrows, and ... *mulching* ... So, *I think that it is most appropriate for one to conserve moisture*.

It can be seen from the dialogue above that in-depth, expansive learning of RWH&C was experienced by this cohort of students at Fort Cox College as a result of formative intervention with their lecturers. This interview (see Figure 6.14) was conducted after the students had gone through some classes integrating RWH&C (see Figures 6.4 and 6.7).

Figure 6.14: *Focus group interview session with two Fort Cox College students (Photo credit: author, October 27, 2015)*

Dialogue turns #1, 4 and 10 indicate that new learning of RWH&C had taken place through expansive learning processes and #10 shows the use of WRC RWH&C books as mediation tools in the first RWH&C lecture the students had from a lecturer who was a key actor in the IBLN and expansive learning process, which I was privileged to attend. The WRC's materials were also used as mediation tools for learning RWH&C by students as they did their assignments and projects. The citation below shows how some students used the materials and the new learning that took place because of them engaging with the tasks given them by their lecturers engaged in expansive learning.

Excerpt 6.31 (FCCSFGSA1, Students' focus group interview, October 27, 2015)

1. ***ACSSA2:*** Because the more you lose moisture, the more you need to irrigate.
2. ***R1***: OK. The book that you talking about can you describe it?
3. ***ACSSA1:*** Yes, I do know the book.... *I did see the book at the library*.
4. ***R1:*** It is the Water Research Commission…
5. ***ACSSA1:*** Yes
6. ***R1:*** So ACSSA1, can you tell me how you were having access to the books.
7. ***ACSSA1:*** I'm accessing the books in a way… OK, maybe you remember the first time you came here for visiting us as a class. After your visit we were told that there are books at the library that are available for the students who want to read more about water harvesting and then we went to the library, and then we tried to get the books but unfortunately we have to bring them back. *There are only few of the books but there are many students*. So, we didn't have a chance to read the book thoroughly.
8. ***R1***: OK. So, you are allowed to borrow the book?
9. ***ACSSA1:*** Yes

What the citation above shows is that the collaborative learning between students and their interventionist-lecturers, between the lecturers and the researcher-interventionist, and between the WRC and the researcher-interventionists had catalytic effects. Figure 6.15 shows evidence of formal institutionalisation and use of WRC RWH&C materials in a college.

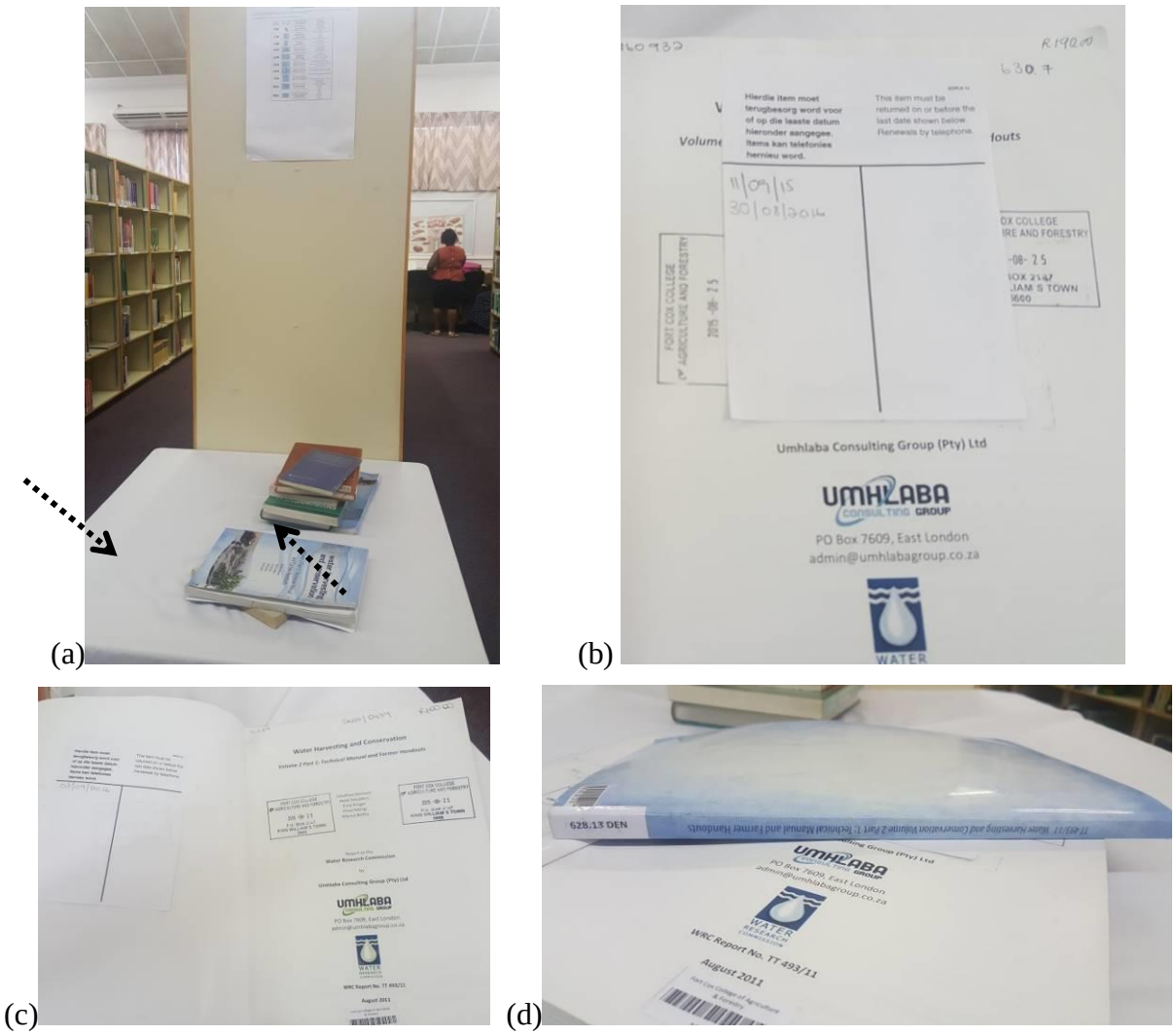


Figure 6.15: *Two sets of one of the WRC RWH&C books (a) showing evidence of incorporation in the Fort Cox College Library (b-d), and signs of borrowing/use (b and c)*

Excerpt 6.32 (FCCSFGSA1, Students' focus group interview, October 27, 2015)

1. ***R1:*** ...So, these ones [WRC RWH&C books] ... why do you want [to borrow them] them for longer?
2. ***ACSSA1:*** *...it's a new thing that we would like to read more often*, so that you can familiarise yourself, because there are lots of chapters there that are *really interesting* ... we don't have enough time to sit down and read ... what is it talking about ...
3. ***R1:*** Alright. So, you have borrowed it before?
4. ***ACSSA1 and ACSSA2:*** Yes. ...
5. ***R1:*** When you access the books and borrow ... what do you learn from them? What did you remember most that has made an impression on you and why?

6. ***ACSSA2:*** Firstly, before, *we were introduced about the scarcity of water in South Africa, we were not aware of maybe where water is coming from* ... and ... So, the rainfall is our source of our water. *So, as we studying we came across these concepts of harvesting the water* and then, it gave *an interesting idea of to carry on and do water-harvesting.*
7. ***R1:*** OK, and ACSSA1, how would you say you have learnt from there?
8. ***ACSSA1:*** In my case, I would like to relate to my grandmother at home, since she has this garden of hers, *I learnt there about the importance of mulching, to conserve water, to keep the water in the soil*. So, since I, when I get home, I get very busy, we all busy actually, *so I introduced this thing of mulching, I taught her about mulching. She did it, and we do not have to irrigate that much*, because the water is conserved to the mulch. *She used grass to mulch*, and then we also used the *roof-top harvesting*.
9. ***R1***: Did you use [Jojo] tanks?
10. ***ACSSA1:*** Yes. We did roof-top water harvesting. In my township actually, we didn't do roof-top water harvesting for the garden, *but we do for home consumption*, and sometimes the water get cut.
11. ***R1:*** The municipal water?
12. ***ACSSA1:*** Yes. So, we can actually use the water for our self.
13. ***R1***: Ok, that's good. So, now you are finding yourself using the harvested water also for flowers. Has the mulching been helping?
14. ***ACSSA1:*** It's helping. ...
15. ***R1***: What about you [Student 2]?
16. ***ACSSA2:*** I'm not sure if it is new because I think we are all aware like when we were growing up, but [now] we are not using it, when we are planting, but *we notice that this thing is working*, because when I grew up at home, when we are just weeding we used to lay down the weed in the middle of the plants, ...it was working because when we are checking underneath its always wet.
17. ***R1:*** OK.
18. ***ACSSA2:*** So, like I wasn't aware of what is going on, but it was a thing I grew up seeing. ...
19. ***R1:*** OK, so what has made you to understand better?
20. ***ACSSA2:*** *When I was reading that book* it says it conserves moisture and..., when it comes to soil erosion, it also reduces its impact and then evaporation.

Excerpt 6.32 shows two students' perspectives on the impact of implementing the new curriculum innovation model. In dialogue turn #2, student 1 acknowledges that RWH&C is a newly introduced topic in the curriculum, which student 2 concurs with in dialogue turn #6 indicating interest with intention to put it into practice ("do"). Student 2 also made better meaning of mulching practices, from the classwork and studying WRC RWH&C books (dialogue turns #16 and #20) introduced by their lecturers. Having demonstrated the formative intervention process up to implementation of the new model, I provide in Table 6.7 a summary of the application of second stimuli in the agricultural college educator activity system and how this brought about the above results. The four columns show the situation obtaining from the conflict of motives, second stimulus tools used, the results of the latter and the supporting empirical data.

Table 6.7: Application of a series of second stimulus tools and learning outcomes

Situation from Conflict of motive	**Tools of second** stimuli and their evolutionary phase in the Vygotskian model of double stimulation	**Results** and evolutionary phase of second stimuli in the Vygotskian model of double stimulation	**Excerpts from data**
Action paralysis; dissatisfaction; business as usual	-	Lecturers at mercy of motives (Phase 2)	ACLSA3: "… *the farmers and extension officers they know what they want* because they go to the ground and apply. *But we teach what we want instead of what the extension person needs.* ... Because it's us who decides, it's not them. (BCCLW1, August 12, 2014)UALSA2: "*We design courses according to our expertise*, and they are approved by Higher Education ... *I am to teach what is approved*, then *I cannot come and change the curriculum* as X and say I should put household issues into that. So that is the major problem. (DAfFS2, May 11, 2016) Farmer leader: "*there must be something that is **relevant** from these institutions (referring to ATIs) to what we are doing*. That is what we are crying for from that workshop" (DIBSA8a, July 21, 2016)
Decision process	WRC materials on rainwater harvesting and conservation: RHW&C practices with a focus on *gelesha* (tool I) – see excerpt #1	**"Decision forming" apparatus**: Improved knowledge and understanding to enable tackling of the water problem collectively, epistemologically and ontologically (A).	ACLSA3: "Now we have *gelesha* that is being used in emerging farmers. I was hearing it for the first time so that's why I will be limited on it". (IBLN BCCLW2, DIBSA2c, September 16, 2014)
	Amanzi for Food course assignments (tool II)	Transformative agency, improved knowledge of RWH&C practices and developing volition to change (B)	ACLSA3: "The current curriculum had limited or very brief information on the RWH&C, therefore *there will be a need of addition of the practice*. This implies that the *RWH&C will be covered as the main broad content*…in depth. The practical will now be offered as a continuous demonstration plot and assessed as such than for a 3hrs one day practical". (Assignment 4, May 2015)
	Rainwater harvesting demonstration plots (tool III)	New knowledge practices of RWH&C practices and gaining confidence to change (C) (see expressions of agency below).	
	Conversion of stimulus to auxiliary motive (Phase 3)	Deciding to convert joint timetable conflicts to joint relational actions for enhancing RWH&C teaching and learning in	

		student practicals. Lecturers begin to control and use their timetable conflicts to their advantage (D).	
	'Real' conflict of stimuli (Phase 4a)	Occurrence of neutral stimulus. Restricted time for practicals in timetable is overturned through alignment of practicals to each of the courses demanding practical attention, using RWH&C as an organiser (E).	
	Closure of conditioned connection (Phase 4b)	Lecturers jointly decide to use jointly planned practicals to teach RWH&C when they learn the converging water connections in their practical teaching activities (F)	
	Activation of the conditioned connection	**"Decision implementing" apparatus**:	
		Volitional action: using demonstration plots for team teaching and student learning (G)	ACLSA2: "Now we have *new curriculum content* in form of enriched teaching notes, videos and photos … together with demonstration plots to teach our students on relevant water for food. We are *now doing more practicals* with students". (Researching Work & Learning 10 Conference paper, December 7, 2017)
		Farmers' contexts placed at the centre of pedagogic actions in lecturers and practical work as part of curriculum innovation (H)	ACLSA3: "I think *the teaching place, who delivers the lesson* plays a significant role in the learner. In a way, it looks as if when they learn in class and through a lecturer is all about assessment but *with farmer base it is a real life applications.*" (WhatsApp chat, December 14, 2016)
	MoU and M&E Plan between Fort Cox College and Rhodes University (tool IV)	Agricultural College management demanding concrete results and wider involvement (see Appendices 6.7 and 6.8), (I)	ACMSA1ACMSA1: "We need to read the MoU. I will develop a template … to action what is there" (Appendix 6.8A, FCCMESA1)

Table 6.7 traces the application of double stimulation tools and what they yielded in the decision-forming and decision making apparatuses (Sannino, 2015a). Three main second stimulus tools that participants worked with in response to the conflict of motive were case stories of small-scale farmer innovations in RWH&C provided in WRC materials, the practice of *gelesha* among other RWH&C practices, Amanzi for Food course assignments, RWH&C productive demonstration plots and an MoU. These tools were used as a series of mutually-reinforcing second stimuli in succession as shown in Table 6.7. The diverse range of particular types of double stimulation tools used in the BCCLWs

and summarised in Table 6.7 was needed to assist participants to confront absent discourses and contradictions in agricultural water relevant to small-scale farming and to generate action. Boundary-crossing expansive learning processes were able to transgress some of the historically entrenched curriculum boundaries biased towards conventional agriculture (see sections 2.4.4.1, 2.4.4.2, and 4.2.1.3) as discussed in sections 6.4.3.1, 6.4.3.2and 6.4.3.3, and 6.4.4 below. It has been demonstrated that agricultural lecturers experienced a shift in their sense of being, starting to seriously view smallholder farmers not as object of science knowledge banking but as co-creators of knowledge with their contexts at the centre of pedagogy. Agricultural college lecturers thus journeyed through a *transformative curriculum innovation pedagogic pathway*. The latter included collective learning with farmers, observing and understanding the farmers' rainfed contexts, realising curriculum deficiencies and their histories, developing empathetic agency, modelling new curriculum solutions and implementing examined new models.

6.4.4 Reflection on the implementation of boundary-crossing curriculum solutions and summary of evidences for boundary-crossing learning

One of the tools used for joint reflection on the curriculum innovation process in the agricultural education activity system was a monitoring and evaluation plan for the MoU between Fort Cox College and Rhodes University (see Appendix 6.7B). In jointly developing the monitoring and evaluation plan, a Quality Assurance Manager at Fort Cox College committed to developing a tool for shaping it as follows;

> *Excerpt 6.33 (DIBSAF2, June 8, 2016)*
> ***R1:*** What kind of preparation are we looking at? Obviously we need to read the MoU.
> ***ACMSA1:*** We need to read the MoU. What I will do is to develop a template that we will use to learn what is in the MoU to action what is there. ...we will then input ...

Figure 6.16 is an extract of the MoU monitoring and evaluation plan (DIBSAF1d), showing five main columns: obligation, activity, leader, timeframe and expected outcomes.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
MOU Obligation	Activity	Leading institution	2015				2016				2017				Expected outcomes
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
			FQ1	FQ1	FQ2	FQ3	FQ4	FQ1	FQ2	FQ3	FQ4	FQ1	FQ2	FQ3	
1. Collaborative learning (RU i; FCC i)	A1. Facilitate agriculture curriculum expansion to include / integrate rainwater harvesting and conservation	FCC; RU													Expanded curriculum; Topic specification in course outlines with Amanzi for Food website links; Portfolio of Evidence (evidence into student learning)
	A2. Adapt & adopt exisiting WRC rainwater harvesting materials	FCC			1				1						WRC rainwater harvesting materials and Navigation tool in FCC library used by students and lecturers; **Teaching notes** on RWH&C (part of tools to implement curriculum) to be **kept in libary every year**; Amanzi for Food website accessed and used for teaching and learning

Figure 6.16: *Extract of MoU monitoring and evaluation plan used in the refection process*

One of the activities in the monitoring and evaluation plan was to establish a teaching and learning garden. This was enacted through an experiment carried out during a BCCLW and implementation of the teaching garden model. One of the models developed by agricultural college lecturers to ensure proximity of demonstration plots was to plan for implementation on campus next to classrooms and laboratories, with the blessings of the College's top management. In one of the MoU monitoring and evaluation meetings it was decided that a BCCLW and seminar be conducted to examine this solution (see MoU obligation 3, DIBSAF1d). The activity planned for under this obligation was "A9. Facilitate capacity development and buy-in seminars on RWH&C teaching, learning and integration... with Academic, HR, Finance & Farm Management staff, support staff and students" (DIBSAF1d). In this meeting, one of the lecturers ACLSA3 indicated that it was crucial to include the learning network, "we will not do field day activities without our farmers" (ACLSA3 in R1's Research Journal entry, June 8, 2016). It was agreed to implement the model the following August 2016. A site visit was carried out by lecturers and researchers to the site in advance. Figure 6.17 shows the examining and implementation of this model.

Figure 6.17: *Lecturers, students and farmers preparing a RWH&C demonstration planting site near lecturer rooms (top left); preparing compost (top right); experimentation with RWH&C conveyance led by Professor Rob O'Donoghue (bottom left and right) (August 1, 2016)*

The experimentation with a teaching garden above demonstrated how water harvested from lecture room roofs can be captured and stored in tanks and how it can be conveyed to a cropping area, mimicking what could be done at a household level. Participants included four Fort Cox College lecturers, several Fort Cox College students, two Matole basin farmers and youths, two farmers from Khayalethu and Mpundu villages and other visiting farmers. This experiment was useful in examining the solution modelled in a previous BCCLW and showed that it was possible. The local lecturers continued with the implementation after the experiment (until counter internal management decisions later relocated the site to the RDC).

In a reference to the emerging *new boundary practice in the college's transforming curriculum work*, ACMSA1 later described the monitoring plan as "the document that we developed together. We worked on it very well. … so that we can identify activities that are actually going to help us to achieve the obligations" (November, 2016). As a way of institutionalising the curriculum innovation process, the Quality Assurance Manager ensured incorporation of the RWH&C knowledge flow reporting structure into the Agriculture Department's routine reports in order to capture progress of the MoU and RWH&C integration. Akkerman and Bakker (2011) called this *coordinative* boundary-crossing mechanism a '*communicative connection*' between curriculum innovation practice and emerging

knowledge on RWH&C. During induction of a new Head of Department, ACMSA1 urged colleagues to include RWH&C curriculum innovation in routine reports:

> *Excerpt 6.34 (DIBSAF3, November, 2016)*
> ACMSA1: It will be good also that we bring you in the process … and that we also say in the monthly reports in the departments, in the quarterly ... and in the departmental annual reports *part of what we should be submitting as our community engagement obligations is this. ... that those are flagged out in our reports.*

The Head of Department for Agriculture (ACMSA2) quickly initiated a *crystallisation* process of the emerging curriculum innovation in RWH&C, institutionalising it into the wider college agriculture curriculum as it "represents a very good input directly into the curriculum for rainwater harvesting *so that we can implement it next year*" (DIBSAF3, November 2016). ACMSA2 embedded the crystallisation within the context of placing farmers at the centre of knowledge generation and flow, when she modelled a vision to place students under tutelage of farmers through a six month residency in a farmers' home. In her valuing of the partnership MoU she also *took up the perspective of farmers* from a research perspective thus:

> *Excerpt 6.34 (DIBSAF3, November, 2016)*
> ***ACMSA1***: Maybe while we are still on the curriculum; we have already started the curriculum review process and that is the baby for X [ACMSA2].
> ***ACMSA2:*** *We want to ask you Tich [R1] to be part of our Advisory Committee, we would really appreciate your inputs especially in the research domain.*
> ***R1:*** Thank you.

The aspirations in excerpt 6.34 provide an idea of catalytic curriculum innovation processes that later took place but are not discussed here. However, glimpses are found in section 6.5.

Table 6.8: Summary of boundary-crossing issues, mechanisms and agentive trails in the Agricultural college educators' activity system

Boundary-crossing mechanisms experienced	**Nature of boundary issues concerned**	**Agentive trails**
'**Identifying with**'	Agricultural college lecturers identified with smallholder farmers' and household food producers' contexts. The IBLN helped the agricultural college lecturers to extend their working boundaries beyond the in-field space (silo curriculum actions) to an out-of-field space (inclusive curriculum deliberations), (Star, 1989).	Realisation of curriculum absences from lecturers' interactions with farmers and WRC RWH&C knowledge materials in IBLN→*criticising the current curriculum activity* within a learning network forum*:* immanent critique of curriculum absences (e.g. ACLSA3) →negotiating common matters of concern (see section 4.3.1, DIBSA8a) and "combining ingredients from different contexts to achieve hybrid situations" (Engeström, Engeström, & Kärkkäinen, 1995, p. 319)→*commitment to action* and implementation (see section 6.4.3)

	FET College lecturers and students identified with household food producers' contexts.	Realisation of curriculum absences from farmer practice→*criticising the current curriculum activity* within a learning network forum*:* immanent critique of curriculum absences (excerpt 6.7, dialogue turns #2 & #4) → commitment to conduct a demonstration plot to trial locally-adaptive seed (excerpt 6.10)→ (*resisting the change* and *explicating new possibilities*): plan to negotiate climate-adaptive seed demonstration plot with farm manager (excerpt 6.12, dialogue turn #1)→ (see coordination below…)
	A smallholder farmer FSA10 already involved with an LED market access facility aligned with the RWH&C learning network empathized / *identified with* another farmer outside the local municipality (LED)	FSA10 realised locally adaptive seed system benefits from IBLN→ took perspective of neighbouring farmer with no market opportunities→ proposed membership of learning network by farmers in neighbouring municipality as a way of learning together and breaking barrier to market access (excerpt 6.13).
Coordination	*Boundary permeability* between an FET college and farmers was increased through networking and deliberation in a learning network forum (see excerpt 6.11)	
	An FET College recognized the curriculum problem space shared with an agricultural college, and coordinated with the latter to learn together using the latter's demonstration plot as a site of intermediary action (see excerpt 6.11).	(…from identifying with above)→ *explicating new possibilities* that are more easily doable and therefore prioritised (learning at an existing demonstration plot with others who underwent a curriculum experience)
Transformation through placing farmers at the centre	Diversification of knowledge to incorporate farmers' contexts of knowledge practices and reframing of power as new boundary practice emerged of farmer involvement in teaching students	Expression of farmers' need states→ understanding farmers' contexts through interaction and critique→ lecturers developing empathetic agency→ basing curriculum practice on farmers' rain-fed contexts→ including farmers in teaching around farmers' productive RWH&C demonstration plots
Transformation through curriculum innovation	*Crystallisation* (DIBSAF3, November 2016); Excerpt 6.22 (ALCASA1, September 24, 2014)	The above leading to→ developing RWH&C demonstration plots→ negotiating timetable constraints→ writing course outlines→ integrating RWH&C in pedagogy
Reflection on curriculum innovations	*Perspective taking.* (Excerpt 6.34, DIBSAF3, November, 2016)	Management agency for carrying forward college outreach mission→ signing of an MoU generative of catalytic curriculum innovation→ developing and operationalising monitoring, evaluation and reporting plan to institutionalise curriculum innovations

6.5 BOUNDARY-CROSSING ISSUES IN THE SMALL-SCALE FARMER INNOVATOR'S ACTIVITY SYSTEM: MATOLE BASIN

Section 6.3.2 (excerpts 6.5 to 6.14) documented the need state and BCCLW actions undertaken by Matole Basin farmers. Here, I focus on knotworking boundary-crossing issues, engagement of youths by adult mentors and ongoing collaboration with Fort Cox College. New emerging relational work took place from interactions between a farmer innovator FSA10 in Mqayise village of Matole Basin, an agricultural specialist from NEDA (NEDSA2), a lecturer ACLSA2 from Fort Cox College and the author R1. Subsequently, a permaculture motivator from Khayalethu village (FSA14) and Lovedale FET College students and lecturer also joined in the knotworking process. Also significant in the cognitive and boundary-crossing developments were four youths in the Matole Basin. My interest in following the developments in this knotworking trajectory was driven by research sub-questions (iv) and (v) described in section 1.4. To answer these questions, I followed the co-joined runaway boundary objects of sustainable agricultural water and locally-adaptive seed through the people involved with a farmer innovator at the centre of the learning interactions.

6.5.1 Genesis and pursuit of generative developmental learning 'tentacles'

The smallholder farmer innovator FSA10 in Matole Basin heard about the expansive learning deliberations and initiatives on RWH&C from an extension officer at a monthly meeting of the Middledrift farmers' association in April 2015. With new information obtained from the meeting, she listened to a community radio programme featuring the IBLN's sustainable agricultural water expansive learning work. She became determined to scale it geographically to her own village, homestead garden and fields. The NEDA officer NEDSA2, through his work on the Nkonkobe local municipality's smallholder farmer programme, got into discussion with the Matole farmer innovator about alternative agricultural water deliberations taking place in the IBLN, and then introduced the researcher to her indicating her interest in learning sustainable agricultural water. The farmer innovator explained her entry into IBLN expansive learning as follows,

> *Excerpt 6.35 (DIBSAM3, August 1, 2016)*
> ***FSA10:*** ... and in one of the networks with Imvotho Bubomi with Rhodes (University) and Fort Cox (College) and extension office I heard about them (IBLN) on radio. Our extension officer ... told me that he was going to be on radio that evening. *So I listened to him and was interested. I wanted to follow up,* then X (NEDSA2) hooked me up with these people and I even met Ticha (R1) who came to my house with X (NEDSA2). And from there the rest is history.

This excerpt shows the power of mediated expansive learning as it developed from BCCLWs in the course-activated IBLN to new people and spaces through expansive use of mass media (community radio) and co-engagement of people as they went about implementing solutions they had co-modelled with others. In the process of discussion with the researcher-interventionist the farmer innovator rightly

questioned how she had been left out of the initial formative intervention and training phases of the expansive learning process:

> *Excerpt 6.36 (Interview #FSA10, May 13, 2015)*
> ***FSA10:*** *Are you working with the right farmers?* Because I as a committee member of Nkonkobe Farmers Association don't know the farmers you are working with. You may need to involve the farmers' association.
> ***R1:*** Actually, we are working with the farmers' association chairperson, who led us to some of the farmers we are working with in the network.

This kind of constructive *critique* constituted an act of agentive expression on the part of the farmer that quickly ushered her into the IBLN, and it helped the author to identify gaps in selection of participants leading to transformative change in that respect (Haapasaari et al., 2012). The importance of the farmers' association regarding its replication potential is further seen in the conversation below (excerpt 6.37):

> *Excerpt 6.37* (Interview #FSA10, May 13, 2015)
> 1. ***NEDSA2:*** (introducing R1). They are training ... It's called Amanzi for Food.
> 2. ***FSA10:*** *Amanzi for Food, okay the one X [talked about] ... X is our Controller*.
> 3. ***R1:*** Ahh, he is in the project, talk to him about it.
> 4. ***FSA10:*** I am an *executive for Nkonkobe Farmers Association*. … We usually meet with him every month. I know Mr X a lot, because we work together.
> 5. ***R1:*** All of us that is what X was saying ... we link with each other as partners.
> 6. ***NEDSA2:*** *Together we can do more* ... There is that statement. *If you put it into practice …, it works*.
> 7. ***FSA10:*** It can change the mind-set of the rural community people.

The deliberations in excerpt 6.37 indicate the farmer innovator's links with people in her network who were active in the IBLN, the knowledge flows within the combined networks and expansive learning possibilities based on the belief that co-engaged learning can 'change the mind-set' (dialogue turn #7) of rural smallholder farmers. The self-introduction in dialogue turn #4 indicates connectedness and influence.

Furthermore agro-ecological knowledge practices acquired and applied from an agro-ecology training course the farmer FSA10 participated in the previous year was evident in her garden as shown in Figure 4.9 (section 4.2.1). Despite the above innovations, the farmer innovator experienced the need for more sustainable agricultural water as she felt the area was no longer receiving as much rainfall as before and the usual rains were no longer coming at the expected time. The farmer's induction and settling into the IBLN were therefore swift.

The development of the expansive learning tentacles from the IBLN in the direction of Matole Basin and the development of the latter as a nucleus of growth can be explained by the metaphor of a growing amoeba, as illustrated in the figure below.

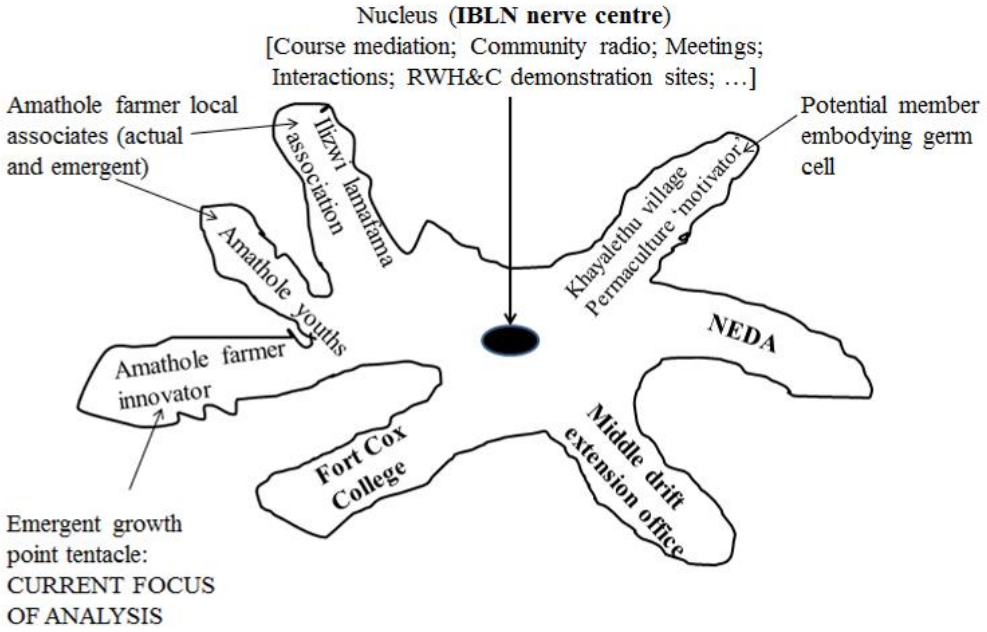


Figure 6.18: *Growth of the IBLN in Matole Basin (mediating IBLN partners in bold font)*

With the IBLN acting as the nucleus of activity in terms of organising the object of focus, the locus of action and interaction started to extend outwards like a feeding and growing amoeba, with the energy coming from participants' energy, positive relational interactions and emerging interest. Like a nerve-centre, the course-mediated knowledge practices and community radio provided the communicative structure leading to extended expansive learning through the mechanism of '*coordination'* (Akkerman & Bakker, 2011). The emerging interest and agency generated by the new entrant into the network, the Matole Basin farmer innovator provided the stimulus for the 'amoeboid' IBLN organism to start growing tentacles in the direction of the farmer's space as shown in Figure 6.9 above. Below I discuss further expansive learning and transformative agency generated from the interaction between the farmer innovator's activity system and others already in or entering the IBLN.

6.5.2 Boundary learning interactions mediated using a productive demonstration site at Lloyd village garden as a second stimulus

Noting the replication potential in the farmer innovator in Matole Basin as a keen farmer and a member of the Nkonkobe Farmers' Association executive committee, the researcher-interventionist organised a workshop at Lloyd Village productive demonstration site with multiple objectives. The primary objective was to support Lloyd Village garden farmers with a reflection session (see Lloyd village case

study above) on their implemented solutions and how to take the learning forward to consolidation and expansion within a wider IBLN community of practice context. The secondary objective was to bring some innovators to meet for the first time, namely the farmer innovator from Matole Village, a permaculture motivator from Khayalethu Village and Lloyd village garden farmers with the hope of:

- mediating sharing of RWH&C principles and motivation in productive farming,
- introducing potential members to the IBLN community of practice on sustainable agricultural water learning and possible expansion of her organic produce market.

Fort Cox College lecturers were part of the group as they were collaborating with the Matole Basin farmer innovator, Lloyd Village farmers and had recently been introduced to the permaculture motivator in whose innovations they were gaining interest. The researcher-interventionist invested time and resources carefully to ensure that all these partners with an obvious affinity could meet at the same time. What emerged from the interactions of course was shaped by the participants and did not always follow the objectives set out initially (see above) for the BCCLW. The interacting activity systems from the perspective of the Matole Basin farmer innovator are illustrated in Figure 6.19 below.

6.5.2.1 Interacting activity systems and boundary learning interactions: Matole Basin farmer innovator with partners at Lloyd Village garden

Figure 6.10 shows the interactions between the Matole Basin farmer innovator, a permaculture motivator, Lloyd village farmers and Fort Cox College lecturers activity systems.

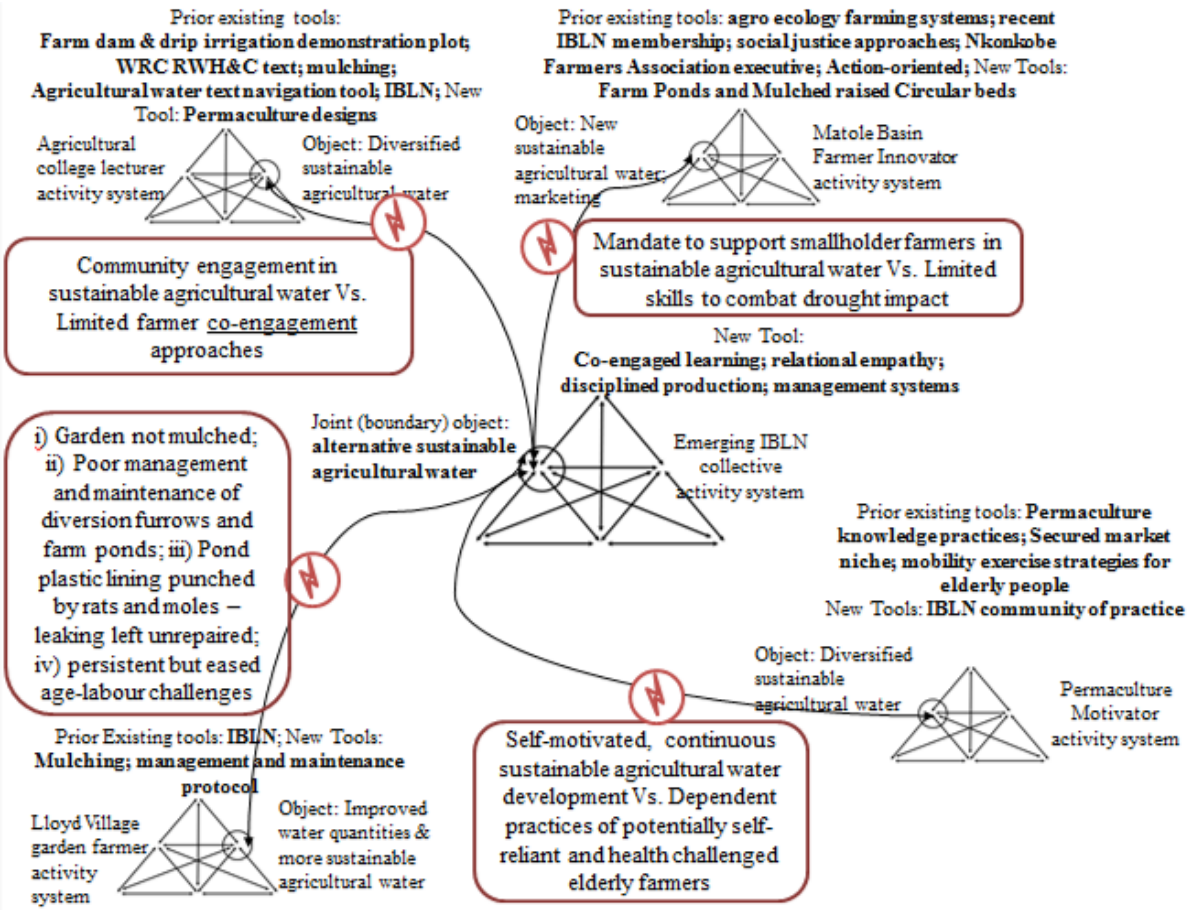


Figure 6.19: *Quaternary contradictions from interactions between the Matole Basin farmer innovator, a permaculture motivator, Lloyd village farmers, Fort Cox College lecturer's activity systems with the emerging IBLN collective activity system.*

Figure 6.19 above shows that the Matole Basin farmer innovator (FSA10)'s activity system encountered three other activity systems each of which had knowledge practices that the former could potentially learn from and model new solutions together with them. The contradiction FSA10 faced was twofold. The first was related to her executive position in the Nkonkobe Farmers' Association where she had the scripted mandate to support farmer development, in this case in their agricultural water; yet she had limited knowledge to do so. However, she had motivational capabilities that she used to promote a simple model that she had experience with, namely mulching that was absent from the Lloyd village garden farmers' practices (see Figure 4.7). The model was improved by input from the permaculture motivator whose design of circular beds provided an added attribute of improving rainwater harvesting.

6.5.3 RWH&C productive demonstration plots emerging as sites of intermediary action

The Lloyd Village garden farm ponds acted as sites of intermediary action and relational agency that local farmers used to share the process of modelling of contextually-relevant solutions. The RWH&C

ponds themselves provided new learning and ideas for the visiting farmers as shall be discussed in section 6.5.4. The visiting farmers were however concerned about the limited diversity of sustainable agricultural water practices including bare un-mulched soil surfaces on the hosting site. Together with the local farmers they modelled a new solution of circular beds made of mounds for planting and trenches for holding and sinking water as shown in Figure 6.20 below.

Figure 6.20: *Experimentation with a new RWH&C model during a BCCLW at Lloyd Village garden, led by a permaculture expert / motivator (Omelela), March 30, 2016*

6.5.3.1 Examining and implementation of new models of sustainable agricultural water practices at individual level in Matole Basin: glitches and triumphs

As a result of participating in the BCCLW reflection activity shown in Figure 6.20 the farmer innovator FSA10 returned to implement similar models adapted to her own situation in Matole Basin, with further support that she sought from the permaculture motivator (*Omelela* in isiXhosa). Using the models she learnt and examined at the Lloyd Village garden, she developed two sets of productive demonstration plots adapted from these models. She based one of the designs on the circular garden demonstration that she observed being mediated by a permaculture motivator.

> *Excerpt 6.38 (DIBSAM3, August 1, 2016)*
> ***FSA10:*** And I learnt from *Imvotho Bubomi* they connected me with X (name of permaculture motivator cited). It's from her that I learnt this method of circular production. Immediately I came from Khayalethu I planted it there at my yard.

The Matole Basin farmer innovator was careful in implementing the circular bed models as she made an effort to visit the permaculture motivator at her village (Khayalethu) some 30 km from her village. They planned together to implement the new model at the Matole Basin farmer's homestead. The implemented structures are shown in the foreground of Figure 6.21.

Figure 6.21: *Foreground: Mulching on new raised circular beds in homestead garden by FSA10 after a BCCLW demonstration session; Background: Emerging farm pond.*

The background of Figure 6.21 above and the structure in Figure 6.22 show implementation of a second model of sustainable agricultural water, a small farm pond as a result of observing similar structures at Lloyd Village garden.

Figure 6.22: *A two cubic metre farm pond at the garden of the farmer innovator in Matole Basin dug in April 2016 as a holding reservoir by the garden edge next to a pathway*

The prototype model for the second structure implemented (the farm pond design) was part of the package of models to be jointly examined with Fort Cox College. However, the farmer felt that the joint venture with Fort Cox College was being delayed (which was the case, due to student protests) and decided to go ahead to implement the models ("when I learn something new I want to implement immediately", Personal Communication #FSA10, Research Journal entry, May 27, 2016; see also excerpt 6.36). However, the siting had some critical but remediable design flaws as seen with the farm

pond in Figure 6.21 located too near to the homestead garden shade with little catchment, and the one in the larger garden (Figure 6.22) lacked a diversion furrow to channel runoff into it (see excerpt 6.39):

> *Excerpt 6.39 (DIBSAM3, August 1, 2016)*
> ***FSA10:*** *We have also dug in a water pond there but unfortunately, we haven't received anything. I don't know what we can do to it*.
> ***Visiting participant:*** *Road surfaces are such a good water-harvesting structure*.
> ***FSA10:*** So we need to dig a furrow…
> ***Visiting participant:*** To divert a furrow that leads to that. … You might have to dig a lot bigger. When it rains it brings all that water. Maybe dig another one a bit lower to capture all the water going downhill.
> ***R1:*** That's a good idea X.

The original plans to have a systematic expansive learning process to establish an integrated sustainable agricultural water design were reverted to in order to remedy the design flaws discussed above, and to expand the learning in general in Matole Basin. An *ilima* (farming collaboratively with pooled labour – in isiXhosa culture) approach that was agreed upon between a Fort Cox College lecturer and the farmer innovator was modeled as the delivery method for implementing the sustainable agriculture solutions.

It can be seen in this discussion that a number of events connected to the IBLN boundary-crossing change laboratory workshops and follow ups from them contributed to boundary learning (ZPD) and boundary-crossing (expansive learning) interactions. The generative mechanisms for boundary-crossing learning and agency in this case study are thus complex and beyond a linear cause and effect relation and will be discussed further in Chapter 8.

6.5.4 Catalytic boundary-crossing in the IBLN exemplified by Matole basin farmers acting with Fort Cox College and key associates

The Matole Basin small-scale farmer case study proved to be a generative catalyst for driving the Imvotho Bubomi Learning Network's aspirations for collective farmer-centred learning, substantive curriculum innovation, youth engagement and collective extension support. This section will explore the modes of interaction that enabled boundary learning using the theory and practice of knotworking (see section 3.4.4.2) and the ZPD. Agricultural actors in the IBLN had a certain initial mode of interaction with each other based on their mandates (e.g. Fort Cox College as an ATI with a community engagement mandate) or felt needs (e.g. farmers in need of sustainable agricultural water and seed sovereignty). Extension services were pursuing a Cropping Programme based on a science excluding agroecological farmers. These need states were discussed in sections 4.2 and 6.3 and the boundary-

crossing issues discusssed in sections 6.2 to 6.4. Below I discuss the expansive transitions in more detail.

6.5.4.1 Description of interactions and explanation of expansive transitions

Engeström (2008b) devised an explanatory device for theorising and explaining expansive transitions in interacting organisations that he conceptualised as evolving from teams to more developed groupings that he called '**knots**' and their activity '**knotworking'** (see section 3.4.4.2). I found this heuristic tool useful to explain the development of these expansive transitions, with some modifications informed by the data. According to Korpela (2015) knotworking has advantages over other routine ways of conducting meetings in that it enables "coordinative talk about what is to be done but also about immediate solutions to emerging problems. … designers work in the same place side by side" (p. 211). The two BCCLWs conducted in Matole basin and subsequent formative interventions were decribed as knotworking earlier in section 6.5. The mandate, need or expectation of each actor's activity system acted as a script determining their role as they focussed on successful performance of their assigned actions as they pursued their aspirations (see Figure 6.23 below).

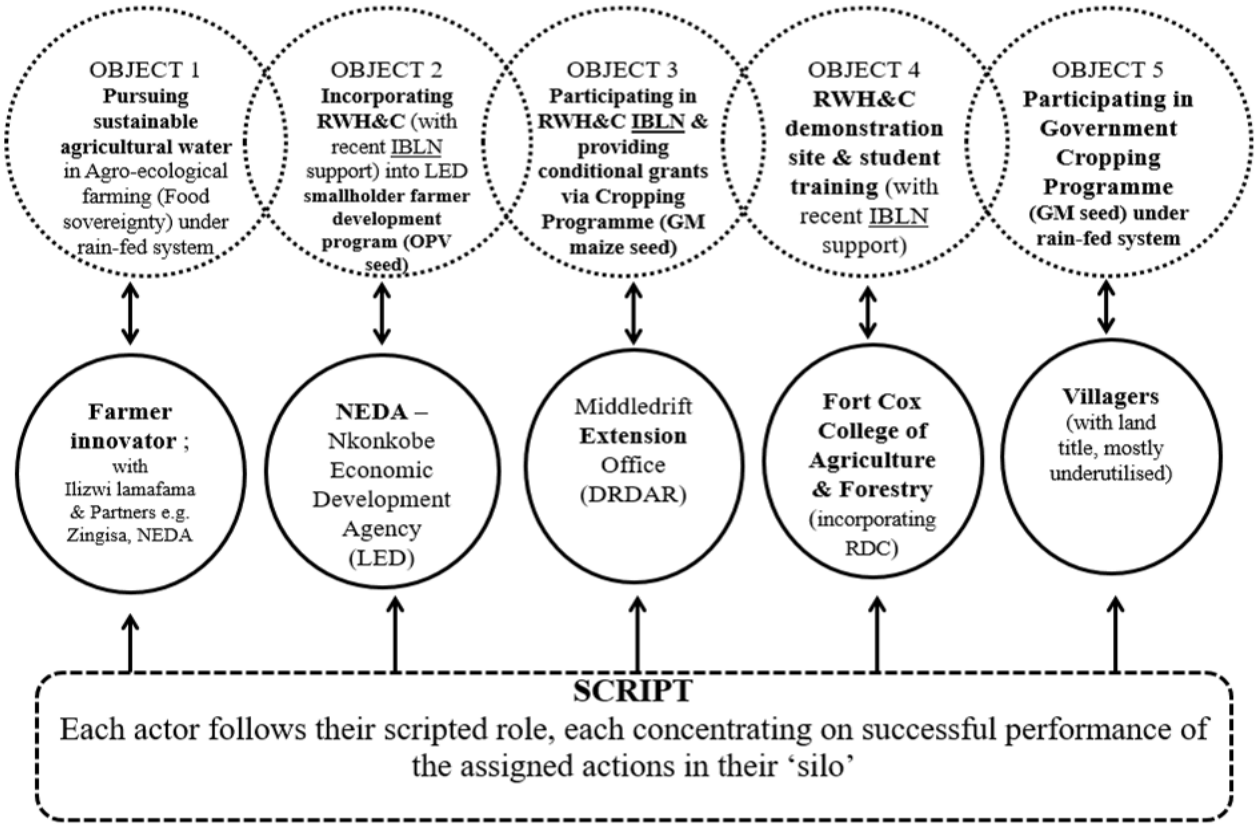


Figure 6.23: *State of interaction at beginning of formative intervention*

Figure 6.23 above shows five actors in interaction at the beginning of the formative intervention process with the joint object of sustainable agricultural water. According to Engeström (2008b), the script functions by coordinating the actions of the agricultural actors "as if from behind their backs, without being questioned or discussed. ... The broken boundaries indicate that the corresponding entities are not the focus of their critical attention" (p. 50). The opposite is true for the unbroken boundaries.

In this case study however, the script was not pushing all actors this way, although this is true in their normative and transitional boundary roles. NEDA and Fort Cox College, for example, were already in a reflexive transitional mode of interaction as they were starting to act more at the boundary due to their immersion in the learning network and visibly out of their silos as evidenced by their agency (e.g. excerpt 4.13). For the agricultural extension officers, the script appears to function as a policy directive without question. Firstly, the extension officers' work using the official Cropping Programme is exclusive in that it only admits farmers willing to plant GM seed. These farmers are in the majority. Farmer innovators using OPV seed are excluded. This exclusion is an absence coded in the business plans at Provincial, District and local levels and in written and unwritten rules and instructions. From the Extension Officers' point of view, the script can be said to be "engraved in tacitly assumed traditions" (Engeström, 2008b, p. 50) such as division of labour with the Food Security directorate responsible for water issues, but with no ground personnel of its own. A senior extension manager expressed this contradiction in the script as shown in excerpt 4.20, which shows that the agricultural extension officer's script in working with a farmer has an absence of integrated agricultural water. Water seemed to become a practical concern for the extension services only when there was a disastrous event such as drought.

The implication here for formative intervention is the question: to what extent are extension officers prepared to support sustainable agricultural water (e.g. RWH&C) demonstration plots in the IBLN? Evidence from two demonstration sites indicates ambivalence on this matter, exemplified by erratic and once-off participation at Lloyd Village garden, on one hand, and full and sustained participation at Keiskammahoek site on the other. It can be noted that there was continuous engagement of local extension officers by local farmers and an agricultural educator on the ground at the second site and none at the first. This can be attributed to individual farmer and educator agency and collective mobilisation and extension. With these attributes in mind, formative intervention processes in Matole Basin worked with the following interacting activity systems and emerging contradictions.

6.5.4.2 Tertiary contradictions and formative intervention in networked activity systems in Matole Basin

The diagram below Figure 6.24 illustrates the tertiary contradictions between the dominant motives in the various activity systems in Matole Basin and the emerging culturally more advanced activity of sustainable agricultural water (RWH&C) and locally-adaptive seed in the IBLN collective activity system. The location of the knotworking BCCLW in a village (Mqayise) actively pursuing food sovereignty through a grassroots social movement, Ilizwi Lamafama was a follow through on solutions modelled in the IBLN. Secondly, it was important to conduct a BCCLW in the emerging knot in Matole Basin in order to support the farmer innovators' enthusiasm and agency as the convenor was clearly on a mission not only for herself but for other agro-ecological farmers in her group and farmers from the local and neighbouring village keen to address agricultural water problems.

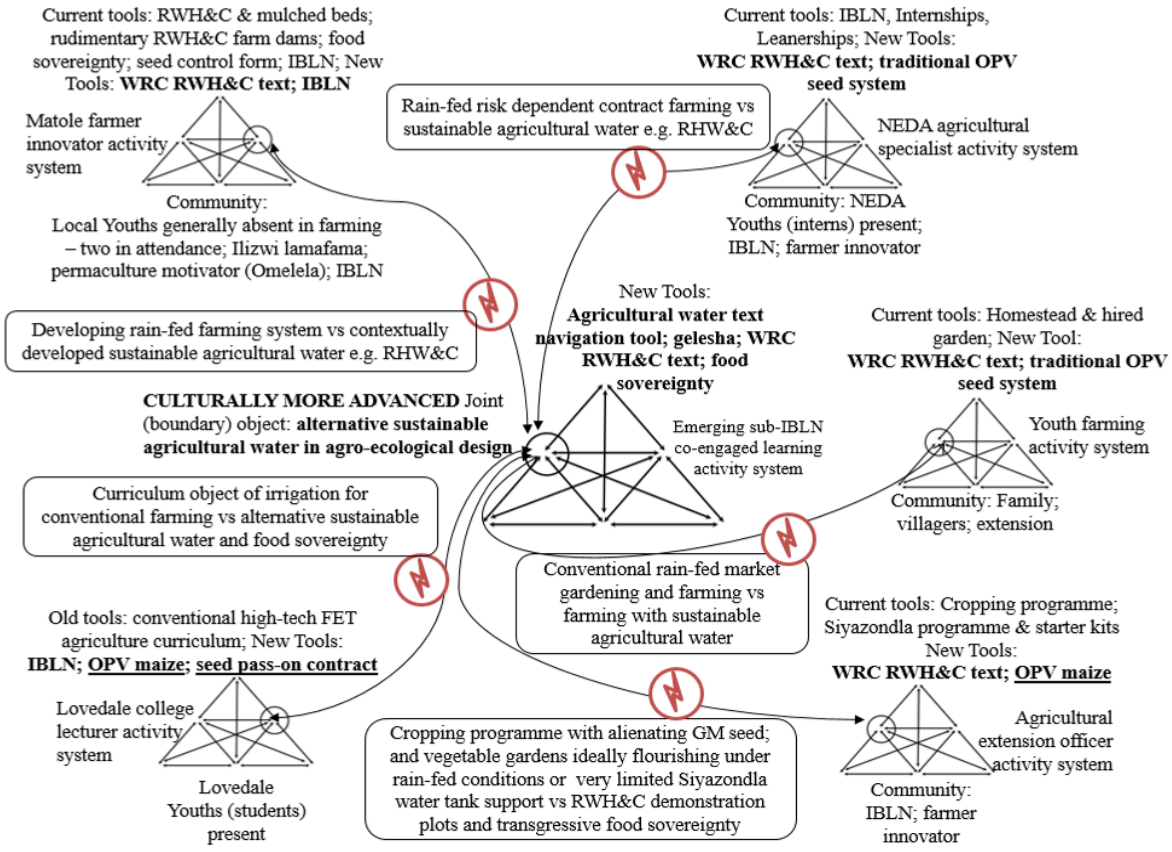


Figure 6.24: *Contradictions from interacting activity systems in the Matole Basin BCCLW*

In Figure 6.24 five activity systems were interacting through joint mediated activity in the first BCCLW in Matole Basin, namely the farmer innovator, NEDA, extension officers, Lovedale college lecturer and local youths. New tools were introduced to each activity system in line with the joint object. In the process, some tertiary contradictions (see Figure 6.24) were surfaced between each

activity system and the emerging networked co-engaged learning activity with a culturally-more advanced object. The three prioritised tertiary contradictions manifested as follows:

- ***#MTCFSA2: Matole farmer activity system's developing rain-fed farming system (tools) vs contextually developed sustainable agricultural water e.g. RHW&C***
- ***#MTCYFSA1: Matole youths' activity system's conventional rain-fed market gardening and farming (object) vs farming with sustainable agricultural water and locally-adaptive seed***
- ***#MTCAESA1: Extension officers' activity system Cropping Programme with alienating GM seed (tools); rain-fed vegetable gardens or limited Siyazondla water tank support vs RWH&C demonstration plots and locally-adaptive seed***

In order to understand the origins and depth of these manifestations, the research participants and I also carried out a historical analysis and an empirical analysis (see Appendix 6.11). Table 6.9 presents the historicity of the object of agricultural water and the associated seed value chain system.

Table 6.9: Historicity of collective learning of agricultural water and seed in Matole Basin

Object historical layers and changes in agricultural water collection / supply, storage, delivery, use and conservation activity AND seed systems in the Mqayise village of the Matole Basin	<u>Pre-1970s</u> *Homeland Act of 1971 – separate racial development; marginal development of Black people. Cultural disruptions; gradual loss of earlier RWH&C practices e.g.* ***Gelesha*** *= OBJECT W1* *Traditional local seed value chain systems based on seed saving and seed exchange (earlier local traditional seed system relational goods such as* ***OPV seed*** *= TOOL S1)* *Traditional practices of people working together in each other's fields to ease division of labour and improve societal relations such as* ***ilima*** *= TOOL R1*
	<u>Late 1970s – early 1990s</u> *Villagers given land titles in Matole Basin*
	<u>Early 1990s – present (2016)</u> *Abolishment of the Homeland Act of 1971* *Introduction of democratic governance in South Africa, 1994* *GMO Act 15 of 1997 implemented in 1999: regulating production and release of GMOs in South Africa. Amended by GMO Amendment Act 23 of 2006. Liability for potential damage by GMO products and responsibility for prevention of damage and remedial action rests on users, mainly the consumers.* *Consumer Protection Act 6 of 2008 (CPA) provides for regulations on compulsory testing and labelling, but has taken many years to implement. Fragmented pieces of legislation still leave consumers with no basic rights (Banking Association of South Africa, 2018)* *Introduction of MFPP in Eastern Cape 2003 by DRDAR providing 'free'* ***GM seed*** *(MEDPT, 2010, p. 11) to farmers via extension services = TOOL S2* ***Ambivalence:*** *Introduction of a type of 'learning against learning' (Saussy, 1999) by government extension services: partial learning of the 'benefits' of GM seed value chain systems from extension with absence of potential socio-ecological risk vs Traditional collective learning in local seed saving and exchange.* *Training of farmer innovator in agro-ecology by Zingisa Education Project in 2014. Intensification of garden* ***mulching*** *using organic and cardboard box materials = OBJECT W2*

	*Resuscitation of **local seed systems, seed bank through an agro-ecology** project by Zingisa Education Project in 2014 = TOOL S3* *Mediated farmer-to-farmer (meeting of minds) learning of **mulched keyhole and 'circular' RWH&C beds** from a permaculture demonstration activity by a Motivator from a Women's platform for Progress (Omelela) and small farm dams implemented at Lloyd Village; and rudimentary adoption and implementation of both by farmer innovator at homestead and larger garden = OBJECT W3*

The historical analysis was carried out using a historical timeline of local events and practices linked to water and seed activity (from the mirror data in videos and excerpts of transcripts) against a background of national policies influencing these events and practices. Particpants also narrated through stories how they worked with water and seed activity historically and in the current period.

Based on the historicity above and the empirical analyses carried out earlier, the overarching tertiary contradiction (#TCSA1) faced by all subjects is as follows:

> ***A system of government supported agriculture driven by policies biased on dominant conventional technicist methods for commercialisation and with a living history of agriculture as labour and punishment amongst youths and Black folk (commodification value) <u>versus</u> A system of smallholder farming entrenched in local cultural practices of traditional rainwater harvesting and locally adaptive seed within community across many generations and enhanced by agroecological farming systems and RWH&C driven by civic society (co-existence value).***

This contradiction was brought into the networked interaction where the participants tabled, negotiated and agreed on a joint motive of pursuing sustainable agricultural water and locally-adaptive seed as objects of mutual activity. It was a very new object to the local village youths, extension officers new in the IBLN and partly so for the agro-ecology farmers, who were participating in the network for the first time. The Agroecology farmers however had no doubt that they were pursuing their true motive, as indicated by their empathetic desire to include more farmers from a neighbouring village (see excerpt below).

Excerpt 6.40 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)

1) ***Male agro-ecology farmer 1:*** I would love that whatever was discussed as the needs, you could *take it to maybe where we could get help or share it with people that could help us in things like the fencing and the jojo tanks that they were talking about*.
2) ***R1:*** Right, we will definitely take some of the things that have been discussed here for example you said you were interested in trainings. So we are going to take that interest to … Fort Cox College … that "there are more farmers who are interested".
3) ***Male agro-ecology farmer 2:*** I am very much appreciating of all these discussions; they have been so much informative. Because X [FSA10] is already in the learning network and she is the contact for you here, you should tell her far in advance the time of things like this so that even the other villages could be invited … then we can organize more people. … *it could be communicated early so that …* more people can attend.

4) ***R1:*** *By 10 June we will have told people at Fort Cox that interest is growing*. Fort Cox will then discuss with X when the training could be done, in good time ...

In the excerpt above the agro-ecology farmers showed *empathetic agency* as they identified their need with those of other farmers and the agricultural college. He also took forward the solution modelled for water through trainings (dialogue turns #1 and #2)[26]. The researcher-interventionist took forward the message to the IBLN representative at Fort Cox College through a discussion meeting, and also to a meeting with Fort Cox management (led by the Quality Assurance Manager) and IBLN coordinators during an joint project monitoring and evaluation meeting held at the college on 8 June, 2016. Here the Head of Department of Agriculture resolved to work more closely with farmers through a new resident learnership for students to be hosted by such farmers as in Matole Basin for an extended period of time.

The boundary object was not new to the convening farmer innovator who had encountered the expanding object through the IBLN (see previous sub-section) and had invited the other participants to the knotworking BCCLWs in Matole Basin. It was an object that Lovedale college lecturers and students, and the NEDA agricultural specialist, and interns were already following as they were introduced to it earlier in the IBLN. However, because of the expanding nature of the runaway object, all participants had an equal chance of learning and contributing their ideas. This model of capacity building and collective learning of sustainable agricultural water was taken into a follow-up IBLN BCCLW held at Fort Cox College on 7 September 2016 exactly three months after the second BCCLW workshop at Matole Basin (see sections 6.2 and 6.3). This generated agency for collective work between the Matole Basin farmers, Fort Cox College and the IBLN, breeding a number of generative *ilima* activities involving students simultaneously learning from and supporting farmers' work technically, and a new youth group being formed with local mentorship (see below).

6.5.4.3 Integration of youth farmers through empathetic leadership, mentorship and agency of a mature farmer and former professional within IBLN

Having mapped the contradictions to intergenerational work (see Chapter 4) the contradictions were then concretised for deployment to the two BCCLWs held in Matole Basin. Three local youths participated in the first BCCLW on 27 May 2016. The convening farmer innovator (FSA10) had had a first encounter with these three youths from her own village at a farmers' association meeting for their general area held in April 2016 where she noticed the youths' interest and agency. This first

[26] Here it is interesting to note that in the 2017/18 training of trainers (the course-activated learning network mediation strategy) offered by the Amanzi for Food programme over 60 people applied, many of them farmers affiliated to this system of activity, showing the continuity of motive.

BCCLW concretised the interest into relational interactions and co-engaged work; they went on to form a cooperative called ZAMBS that was reported in July 2016 as follows:

> *Excerpt 6.41 (WhatsApp Chat transcript #FSA10W, July 3, 2016)*
> ***R1:*** …So it looks like this coming IBLN meeting (referring to BCCLW of 7 September 2016) will need to take forward the collaborative RWH&C training commitments and plan for common work around food sovereignty ...
> ***FSA10:*** Yes it should. … I also have good news: *the youth that attended from Mqayise* (referring to BCCLW held on 27 May 2016) *joined me and we registered a cooperative* ZAMBS Agricultural Primary co-op, the name is built using our initials. We have started preparing the bigger garden as a start. *Yeepee now I have youth on my side*, its three young ladies, one young male and one mama (me).
> ***R1:*** Congratulations!

In the excerpt above the farmer reported what Haapasaari et al. (2012) described as '*having taken consequential actions*' in forming an agro-ecology cooperative interested in developing agricultural water with the youths after the change laboratory session. Engeström (2011) and Haapasaari et al. (2012) classified this act as a type of *agency expression*. By so doing the mentor and youths changed the youth-absenting farming activity encountered in the entire IBLN workshops and in the two Matole BCCLWs. To understand how this act came about it is necessary to historicise the object and activity formation. The youths' initial interest in farming was manifested by their being at a farmers meeting of their own accord, where they providentially met with the farmer innovator from their village. The farmer innovator described this intergenerational encounter as follows:

> *Excerpt 6.42 (Interview #SAFGIAm2, August 1, 2016, Matole Basin)*
> ***FSA10:*** … they are from this area but they were working in X (name of major city provided), and they have just resigned. They left their jobs coming back home and *I could see the passion; they are very much passionate about agriculture and about learning too*. They went to a meeting for farmers, the ones that we hold every last Wednesday of the month. So we met them there *I could see them interested* and I called them to my house and I told them what we are doing. And we said, OK let's join together and register a cooperative.

The farmer's perspective in the citation above is matched well with the perspectives of the one of the youths she mentored as follows:

> *Excerpt 6.43 (Interview #YFSA2 with a youth, Matole Basin, September 8, 2016)*
>
> 1) ***R1:*** How did you come together?
> 2) ***YFSA2:*** I first met her in Middledrift. *We went to a farmers' meeting*, we went to (department of) agriculture and then we were invited to a farmers' meeting. *That's when we first met her*. ...
> 3) ***FSA10:*** And I was like, I was surprised when I saw them... And then there were questions. And somebody raised her hand. (I said to myself) I know X (name supplied), X is from this village. And then I didn't know there were two (others). *So after the meeting then we talked*.

The meeting of the youths with farmer FSA10 and how they formed a cooperative was confirmed by a second youth interviewed separately, as follows:

Excerpt 6.44 (Interview #YFSA3 with a youth, Matole Basin, September 8, 2016)

1) ***R1:*** The Agricultural Cooperative, how did it come about? How did you start it?
2) ***YFSA3:*** Okay. ZAMBS, we met ngu ma'am X (FSA10) at the meeting, at the department of agriculture. There was a farmers' meeting there.

In between meeting at the farmers' meeting in April and forming a cooperative in June to July 2016, the first BCCLW was conducted. The contradictions involving youth apathy from previous IBLN workshops, some attended by the farmer innovator, were brought to the 27 May 2018 BCCLW, where other youths (students) from Lovedale FET College and youth interns from NEDA were present. A double bind was reached after heated deliberation between the youths, college lecturers, farmers and extension officers, as shown in the excerpt 6.7 where a student criticised ongoing FET agricultural training that lacked practical work. This further highlighted the problem of absence of youth agricultural training in formal systems before late high school level in South Africa. Hence the opportunities for informal youth training and mentorship emerging from the IBLN are significant. The intergenerational encounter described above between the farmer innovator and youths in Matole Basin and its value was confirmed by a second youth mentored by the farmer innovator, who concurred with the process by which they connected as follows:

Excerpt 6.45 (Interview #YFSA2, September 8, 2016)

1) ***YFSA2:*** So we met ma'am X and we talked because *she didn't know us* and we are new here, we come from [city A] and some from [city Y]. *So we spoke to her and we decided to start a cooperative ... because she already had knowledge about agriculture, and* ***we were clueless*** *but we wanted to do agriculture*.
2) ***R1:*** Why were you so keen to do agriculture?
3) ***YFSA2:*** Because we saw that there is a lot of land here and it's not used. *And we strongly believe that we can make money by using the land. Even if we don't want to use it for money, but we can eat out of it.*

At the local village the youths sustained productive interactions with the local smallholder farmer innovator (FSA10) in their village that produced desired implementation results after the BCCLWs. The epistemological subject-object-subject relations, so-called '*coordination'* by Engeström (2008a, p. 50) between the farmer innovator and the youths at the early stage and the expansive transformation to '*reflective communication'* are illustrated as follows (Figure 6.25).

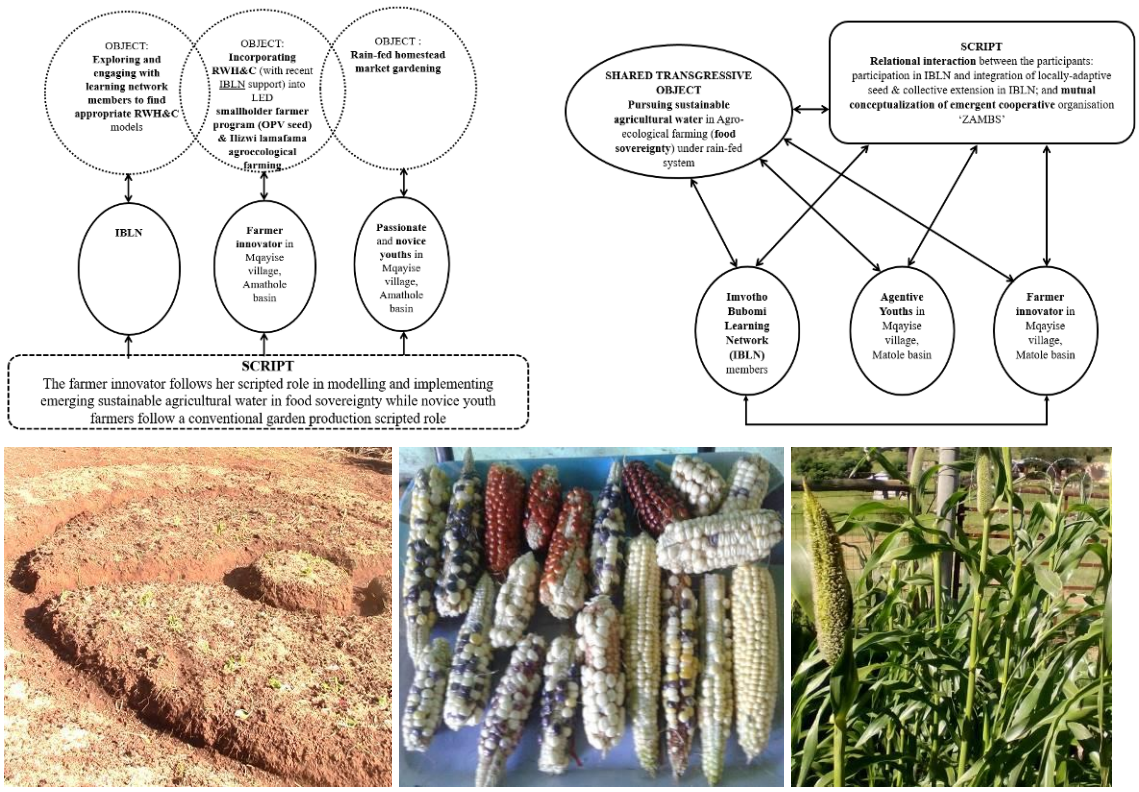


Figure 6.25: *Top: Interactions between youths, a mentor and IBLN members before and after formative intervention (after Engeström, 2008a); bottom: RWH&C beds in ZAMBS garden (left); OPV maize sample harvest by Matole youths (centre); FSA10's millet seed crop (right)*

The diagram on the top left side in Figure 6.25 shows a normal scripted flow of interaction called *coordination* (Engeström, 2008b), whereby the actors are following their scripted roles (see lower rectangle), each concentrating on successful performance of the assigned actions. The diagram on the top right shows expansive transitions after a series of formative intervention actions, that demonstrate a transformed mode of interaction in relation to their shared object. The actors were focused on conceptualising the object, the script and new organisational forms. The latter constitute participation in the wider IBLN through meetings, community radio panels, the IBLN WhatsApp group, forming a local cooperative ZAMBS and seed exchange. Engeström (2008b) called this new mode of interaction, *communication*, which entails collective planning and action, integration, ongoing flow of communication and daily work actions that yielded relational goods such as development of a new production plot (bottom left photo in Figure 6.25), first OPV maize harvest by a youth in Matole Basin from the 2016 season and a millet seed crop (see bottom centre and right photos, shared via IBLN WhatsApp group). Two relational motives drove the interaction between the empathetic smallholder farmer innovator and the passionate youths. This is the joint object of transgressing normalised rain-fed farming with alternative sustainable agricultural water innovations. The development of this

integration and 'communication' (considered "rare" by Engeström, 2008b, p. 51) can be traced in excerpt 6.46 below:

Excerpt 6.46 (Interview #YFSA2, September 8, 2016) [*Spool run = 38min 54sec*]

1) ***YFSA2:*** X (YFSA3)'s grandmother likes to collect things ... a very handy person. She has seeds for maize, butternut and pumpkins. *So we went to her and got those from her* ... And I added that to when we had a workshop here [BCCLW2, May 27, 2016] about the sharing of seeds.
2) ***R1:*** With those ladies that were invited by mum Y? [a seed guardian]
3) ***FSA10:*** Z
4) ***YFSA2:*** Yeah. When they were talking about the sharing of seeds, I think that's a great idea in order for us to do this farming.
5) ***R1***: Did you get any seeds? Because she offered.
6) ***YFSA2:*** I did.
7) ***R1:*** Okay, are you going to plant it?
8) ***YFSA2:*** I already did.
9) ***R1:*** Wow, she has planted. (They erupt in laughter).
10) ***FSA10:*** Yesterday's ones (referring to OPV maize seeds received from R1) ... it was because I didn't see her. I brought some ... but they are so few.
11) ***R1:*** I don't want her to use her seeds. So I am going to give Y some more so that she gives you. (Pouring some more OPV maize seed in a container). ...
12) ***FSA10:*** Thank you Ticha. This is from Mexico.

Dialogue turn #1 shows youths' individual and collective agencies in seeking seeds locally ["we went to her and got those from her"] and collective agency in seed exchange within the IBLN ["added that to when we had a workshop"], and dialogue turns #5 and #6 [R1: "Did you get any seeds ... she offered?", YFSA2: "Yes I did"]. Dialogue turns #10 and #11 show further seed sharing during a visit and at the interview. The youths identified their agency as counter to prevailing dependency and entitlement among villagers and youths in particular;

Excerpt 6.47 (Interview #YFSA2, September 8, 2016)

1. ***YFSA2:*** We had already started the gardening. Then we were discussing the possibilities of having a co-op. At first we called a youth meeting here for the village.
2. ***R1:*** How many came?
3. ***YFSA2:*** A lot in the meeting. As time went by numbers dwindled (laughter). So we had about three meetings before we went to the farmers' meeting.
4. ***R1.*** Okay. Why do you think the numbers went down?
5. ***YFSA2:*** *I think it's because people don't want to do things for themselves.* I don't know, that's just my perception.
6. ***FSA10:*** I think it because *they heard that you are talking about agriculture and gardening and then they knew it's hard work which does not give money easily.*
7. ***YFSA2:*** and so ... what I am quickly learning is that the mentality of a rural person or a person who has stayed long here is that you have to be given things all the time. So working, for them, is another story.
8. ***R1:*** And you think that mentality grows more when you are in the rural area?
9. ***YFSA2:*** Since I stayed in the townships for most of my life, but I think here it's more, if I can put it that way. ... *Entitlement. They [think they are] are entitled to things*.

10. ***FSA10:*** They are dependent. *There is high dependency especially in the rural areas because they live with their grannies that get pension* [state grants] and the grannies will go to lengths to find food for their grandchildren; yet in the townships everybody works, if you are left at home you are not going to eat.
11. ***YFSA2:*** For me it's …. like if you want something, someone has to give it you; you feel like you have to get it.
12. ***FSA10:*** The person is obliged to give you. ...
13. ***R1:*** But how does that entitlement grow?
14. ***YFSA2:*** I think a lot of people when you grow at home, and things just come, you don't know where they come from.
15. ***R1:*** Yeah like the grandmothers who mum X was talking about.
16. ***YFSA2:*** Yeah … So no one tells you where this is coming from and you have to work for it in order for you to get it. So that mentality I think also comes from our parents.
17. ***FSA10:*** Socialisation.

The farmer innovator's ability to notice agency, read emotion (passion) and take the initiative to embrace the young people showing an interest in farming into what she considered a worthwhile and profitable cause of agro-ecological farming shows empathetic leadership. This empathetic leadership was described by one of the youths as follows:

> *Excerpt 6.48 (Interview #YFSA2, September 8, 2016)*
> ***YFSA2:*** ... what you would call inter-generational, like *someone who understands older people and who also understands my age*. It's *easy to have that relationship* like talk with her ... *we don't struggle to joke*. She is that person you *can learn from without being intimidated.*

Such leadership had the potential to contribute to absenting the absence of youth participation so chronic and widespread in this area that many were complaining about but without acting decisively on it (see sections 4.2.1.1, 4.3.1 and 6.3.2). This obvious double bind was brought into the first BCCLW held in Matole Basin on May 2016 in which only two of the local village youths were present, compared to several visiting from NEDA and Lovedale College. The emergence of mentoring leadership by the farmer innovator (a retired professional nurse) springs from the agency of venturing into a territory that is problematic by co-creating a new inter-generational hybrid space by two intentional, agentive and willing parties. In describing her own growth and outreach through boundary-crossing, the farmer said "and now I am teaching the young ones" (FSA10, DIBSAM3, August 1, 2016).

When the Matole youths attended the BCCLW held on 7 September 2016 in their village hall, they were still searching for ways to do productive farming and looking for ways to link with other farmers. Having connected emotionally, cognitively and across the inter-generational barrier, the youths and their mentor consolidated their relations by forming an agricultural cooperative with an obvious agenda of food sovereignty action ("youth on my side", excerpt 6.41) and **mutual understanding** ("understands my age", excerpt 6.48). With this foundation, the intergenerational group established an

agro-ecological garden as a site of testing and implementation of their emerging models of farming. The decision to establish the garden (see excerpt 6.41 and Figure 6.25) took place outside the two BCCLWs, but having been guided by them ("the youth that attended from Mqayise", excerpt 6.41).

9. Possible networked implementation of OPV seed trials and advocacy at provincial extension meeting.

8. **IBLN BCCLW**, September 7, 2016: 'soccer vs rugby' and formation of OPV seed advocacy team (Mediating tools: OPV maize seed; Ilizwi lamafama vs cropping programme; trials)

7. Formation of agro-ecology and RWH&C **co-operative** by farmer innovator and youths (ZAMBS): garden development, August 2016 [Relational goods: new agro-ecological garden development with **RWH&C practices**; OPV maize production by youths; small grain seed production by farmer innovator FSA10; emancipatory knowledge practices]; (Mediating tools: RWH practices; intergenerational energy; *zenzele; ilima*). Transformative learning and agency.

6. **BCCLW2**, 7 June 2016 (local youths participate, and their affinity with farmer innovator increases: '*real dialogue between flesh and blood partners*' as agency; and '*communication'* mode of interaction as boundary-crossing)

5. **BCCLW1** & look & learn visit, 27 May 2016*:* local farmers; Lovedale and Fort Cox Colleges; NEDA; extension services; Zingisa project and neighbouring Amahlati municipality farmers participate (Mediating tools: OPV maize; Ilizwi lamafama; agro-ecological garden). Confrontation with governmentality's marginalisation and symbolic violence. Transgressive learning.

4. Farmer innovator meets youths for the first time at a farmers' association meeting, April 2016: **notices** their **interest and agency**, develops empathy. '*Coordination'* mode of interaction.

3. Farmer innovator inducted into IBLN interacting activity systems: tests farm dam models and mulched circular beds at Lloyd village (30 March 2016), implements models at homestead (Mediating tools: IBLN; WRC RWH&C materials)

2. Meeting of farmer with researcher meditated by NEDA: 13 May 2015

1. Information about sustainable agriculture water learning from IBLN members in the area, April 2015 (Mediating tools: farmers' meeting; community radio programme)

Figure 6.26: *Transformative innovation pathway: historical stepping-up to RWH&C models and intergenerational co-engaged relational agency and learning between youths and a caring mentor*

The dialogues between the youths and the smallholder farmer and what they feel about each other as expressed discursively shows that there is "real dialogue and collaboration between (these) 'flesh and blood' partners", an indicator of what Akkerman and Bakker (2011, p. 18), citing Engeström et al. (1995), described as a transformation. In this case the dialogue is real because it captures emotion and demonstrates relations that absent the absences of action and interaction, themselves causes of

discontinuities. The Matole Basin's Ilizwi lamafama association emerged as a new centre of growth of networked transgressive learning of the importance of OPV seed in adaptation to scarce agricultural water and of food sovereignty as a methodological approach and cultural principle. Together with IBLN partners the Matole farmer innovators successfully confronted marginalisation of their livelihood and symbolic violence against their tools by the mainstream Cropping Programme of the Department of Agriculture that was exclusively promoting GM seed.

6.5.4.4 Continuous joint work at the boundary as 'transformation' in advanced boundary-crossing co-engaged activity

Evidence of continuous joint work at the boundary was found in the work and planned work between Fort Cox College of Agriculture and Forestry, the farmer innovator FSA10 and Ilizwi Lamafama in Matole Basin. Firstly, the Matole Basin farmer inovator and youths in the ZAMBS cooperative have participated actively in Imvotho Bubomi Learning Network meetings chaired by Fort Cox College, and in IBLN BCCLWs that yielded plans for further work along the expansive learning cycle (descriptions of the rest of it lie beyond the scope of this study).[27] The plans to construct deep contours as model for the crop fields and to conduct training, in collaboration with Fort Cox College (see section 6.5.4.2), were left at an advanced stage. The plans to work through the cultural concept of *ilima* (see section 6.5.3) started to be implemented in November 2017 with the construction of RWH&C works in an extended garden in FSA10's homestead (see Figure 6.27), while the plans to rescuscitate growing of small grains as an adaptation measure to climate change were begun in 2016 with pearl millet seed production (see Figure 6.25). Fort Cox College and farmer innovator FSA10 continued to work together in providing experiential lerning for students on-farm whilst they supported farmers technically through building tunnels among others (see Figure 6.27).

[27] The expansive learning cycle and processes have continued into a Phase 2 of the Amanzi for Food programme (2018-2021) via ongoing co-engaged expansive learning and transformative agency activity in the IBLN networked system, the scope of which is too extensive to include in this study report. Suffice to say that at the time of submitting this study co-engaged activity had expanded considerably, especially in the areas of co-operative *illima* practices using RWH&C and OPV seed, extended productive demonstration sites, curriculum innovation at Fort Cox College, youth engagement and farmers joining the IBLN and contributing productive demonstration site activity for mutual co-learning, radio programming contributions from the IBLN, youth groups, and the WhatsApp site (operational since 2015) carrying between 12-20 or more postings for co-learning each day (Lotz-Sisitka, Pesanayi, Sisitka, van Staden, Matiwane & Shawarira, 2018)

Figure 6.27: *Top: Ilima activities at farmer's garden: Fort Cox College lecturer, students, farmers and an NGO Officer making an A-frame (left); preparing new productive demonstration plot (right); bottom: Tunnel garden developed by agriculture students, lecturer and farmer innovator.*

In Figure 6.27 participants can be seen referring to WRC RWH&C materials introduced in 2015 to make an A-frame (in 2018), showing the importance of the mediation of new knowledge resources for activity development via the course activated learning process in the initial stages of the IBLN formation. Relational goods emerged in the process, and are not necessarily things like the tunnel garden. They are also embodied in the individuals-in-relation continuing to rely on and support each other across expanding boundaries and co-existence value. While the farmer benefitted from technical knowledge, labour and joint learning in the installation of the infrastructure, the lecturer and students benefitted from joint learning from materials, farm structures and innovations not necessarily found in practice at their college. The college would conceptualise this community outreach as a new form of 'civic co-engagement'.

6.5.5 Summary of boundary-crossing learning evidences and conclusion to Matole Basin nested case

The processes of implementing the models above shows that the IBLN's training of trainers' course, and use of WRC materials coupled with BCCLWs and the emergence of co-generated productive demonstration plots which modelled RWH&C activity *through co-engaged learning and transformative agency development*, mediated expansive learning of sustainable agricultural water as

shown by further implementations. It also demonstrates the mediation of new connections between people (coordination) as shown by the extended co-engagement between the farmer innovator and Fort Cox College, and with the the permaculture innovator from Khayalethu, and subsequent inter-generational learning processes. Connections were made possible by individual and collective agency, complementarity between farmer aspirations and curriculum innovation needs, market linkages and mentor leadership, all of which was supported by ethics of empathy, respect for historically situated cultures of agriculture, sustainability, and co-engaged learning interactions in the Amanzi for Food programme and its orientation to working with multi-stakeholders. The Matole Basin case demonstrated the transformative boundary-crossing capabilities of the entire IBLN, supportively mediated and co-mediated by IBLN members themselves, via the course-activated learning network using WRC materials (i.e. useful new knowledge that connected with indigenous knowledges), use of social media, and co-development of productive demonstration sites (see Chapter 8 for further reflections). The farmer innovators in Matole Basin were also able to link with and catalyse agroecological farming work with a group of youths.

6.6 SUMMARY OF BOUNDARY-CROSSING EXPANSIVE LEARNING ISSUES, MECHANISMS AND AGENTIVE TRAILS IN THE IBLN

The table in Appendix 6.13 summarises the boundary-crossing and transformative agencies that emerged within and across the case studies in the South African nested case study, incorporating and expanding analyses in Tables 6.3 and 6.8. The analysis is presented in three columns that provide the key boundary-crossing mechanisms experienced, the nature of the boundary issues encountered and the transformative agentive trails followed. The boundary-crossing mechanisms were *'identifying with', transformation, coordination, cooperation and communication* with *'identifying with'* emerging as a new and important mechanism within a learning network. The nature of boundary issues concerned included agricultural extension workers starting to identify with and provide extension advice relevant to farmers' contexts, rather than mere transmission of governmentality. These issues went through a transformative agency trail (Figure 6.28) showing initial r*esistance to change, criticising* farmer practices at variance with the extension script, such as using OPV seed, *through explicating* new possibilities or potentials in the activity based on relating to past positive experience such as using traditional OPV seed, and finally a growing *commitment to action and implementation.*

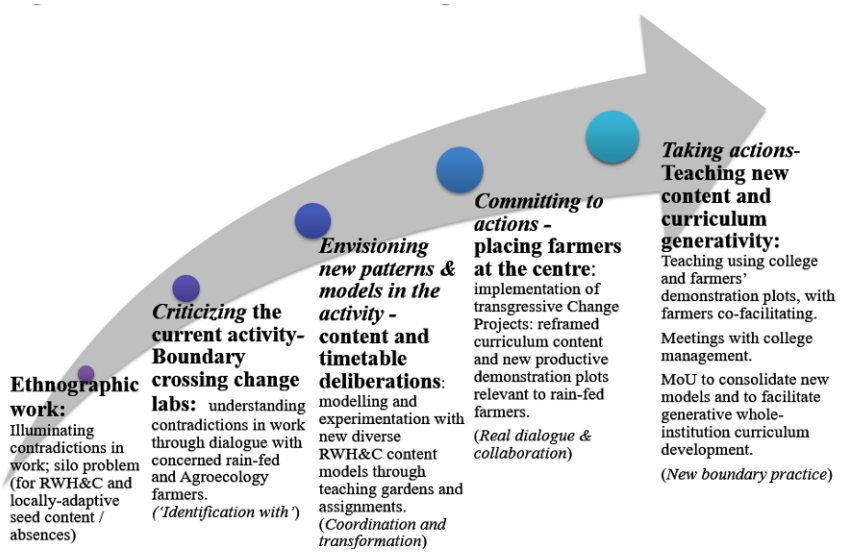


Figure 6.28: *Transformative agency trail followed by extension workers in collective learning in the IBLN*

Agricultural colleges faced issues of ecologies of knowledges challenging their 'monoculture of the mind' trend of transmitting expert knowledge in the academy, some of it irrelevant to rain-fed farmers (see sections 4.2.1.3 and 5.4). As they worked with others in the IBLN they experienced boundary-crossing mechanisms of *communication* and *identifying with* farmers leading to diversification of knowledges to incorporate farmers' contexts in agricultural college curriculum innovation, transforming historically constituted power relations of one-way knowledge transfer to co-learning. In their curriculum innovation pathway (Figure 6.29) agricultural educators helped to reframe power-knowledge relations towards learning together.

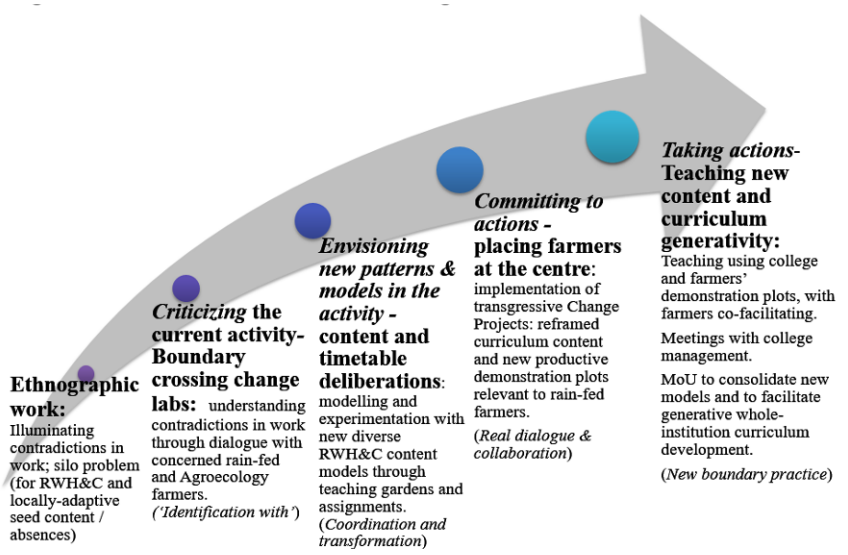


Figure 6.29: *Agricultural college educators' transgressive curriculum innovation pathway in the South African case study*

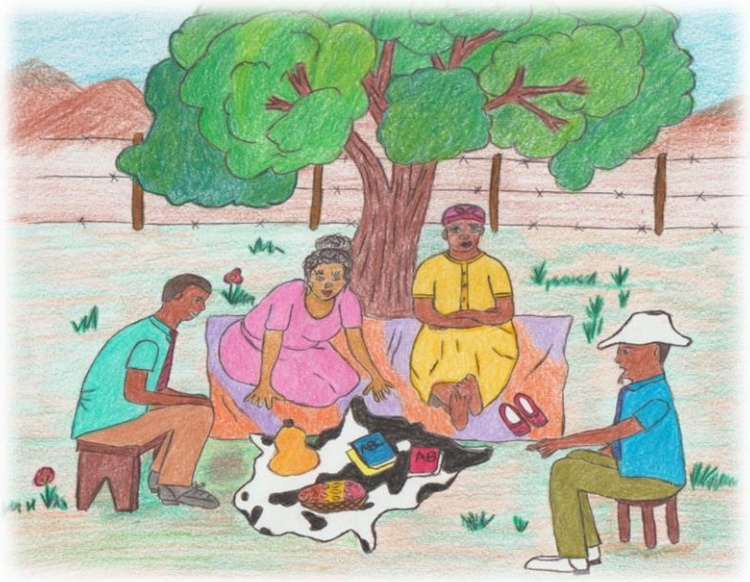
This curriculum innovation pathway was transgressive in that teaching content on RWH&C was improved before official curriculum review was complete as it made sense to lecturers, farmers and

agricultural college management. It was done in line with curriculum regulations and the TACATI process on improving competences (see sections 2.4.4 and 4.2.3). Further analysis of the transformations (as reflected in the analysis above) also shows ethical transformations, underlaboured by empathy and commitment to co-existence values that are deep-seated in the cultures of agriculture in African society (as also reflected upon in Chapter 1). A number of themes emerged from the data namely sustainability, boundary interactions, intermediary action, transgressive actions and generativity (see Appendix 6.5).

6.7 CONCLUSION

This chapter worked on contradictions surfaced in Chapter 4 and emerging boundary-crossing issues in the South African nested case study using a formative intervention approach within a learning network. The chapter foregrounded the needs of farmers by examining the small-scale farmers' activity system in various forms that included cooperative gardens, individual or family homestead gardens and croplands. Expansive learning processes within a learning network formation revealed important boundaries between smallholder farmers' work and that of agricultural colleges and extension services with a focus on agricultural water and locally-adaptive seed. Formative intervention research and mediation processes unlocked ways in which smallholder farmers (including youths) were beginning to be placed at the centre of knowledge generation and flow, with active participation of agricultural colleges and agricultural advisors (extension workers); and for the latter to provide extension within an enabling collective provided by a learning network, underpinned by ethics of empathy and co-existence value (sustainability principles). The diverse members of the then recently formed Imvotho Bubomi Learning Network were able to question their current practices, recognise their need states from relational perspectives (thereby confirming and clarifying contradictions surfaced in Chapter 4).

CHAPTER 7
BOUNDARY-CROSSING EXPANSIVE LEARNING IN THE ZIMBABWEAN CASE STUDY



"You never really know a man until you stand in his shoes and walk around in them" Harper Lee

7.1 INTRODUCTION

This chapter discusses the co-evolution of five key activity systems in the Zimbabwean case study, namely the agricultural college lecturers, extension officers, small-scale farmer innovators, small-scale farmers and agricultural education manager activity systems. In particular, the chapter clarifies the common object of these interacting activity systems defined in sustainable agricultural water provisioning and locally adaptive seed systems from the mirror data documented in Chapter 5 and follows the object through boundary-crossing expansive learning processes. Three boundary-crossing change laboratory workshops were conducted with participants in a learning network formed in Zvishavane on 15 January 2015, 12 February 2015, and 23 April 2015 as discussed in the next section. These were followed up with two BCCLWs at Mlezu and Rio Tinto Agricultural Colleges selected out of many others (see Appendix 7.1 for a list of agricultural colleges) as decribed in chapter 3, and punctuated with meetings held with key informants such as key farmers, agricultural college principals and agricultural education department management to follow up solutions modelled.

7.2 PERCEPTIONS OF SUSTAINABILITY OF SUSTAINABLE AGRICULTURAL WATER AND JOINT PROBLEMS FACED BY THE LEARNING NETWORK

The way sustainability of agricultural water was perceived by agricultural actors in the case study showed diversity and even contradictions at the agricultural learning activity system level. As the activity systems interacted, the perceptions of sustainability were rich with contradictions emanating from mandates of agricultural colleges and university agriculture curricula, innovation in university research, socio-ecological dependence of small-scale famers and transgressive innovations by farmer innovators. The contradictions across the various activity systems as presented in Chapter 5 show that the problem of agricultural water is complex in that there are multiple challenges such as increasingly variable rainfall affecting both rainfed farming and reservoirs for irrigation. Farmers already in marginalised dryland, rainfed areas are facing increasing uncertainity of when to plant as planting seasons vary in starting and ending and rainfall patterns and quantities vary within seasons. The excerpts below show these perceptions from a relational point of view.

7.2.1 Sustainability as <u>environmental integrity</u> of agro-ecological systems

A Zimbabwean farmer innovator (FZ1) described sustainability of agricultural water as a state of adequacy of water from rainfall and therefore dependent on agro-ecological zoning of the area (excerpt 7.1).

> *Excerpt 7.1: (DLNZ1, January 15, 2015)*
> ***FZ1:*** ... not being able to get a job caused me to ask myself how I was to survive. Then I remembered what I had learnt from school ... I learnt that *agro-ecological region 4 where I live does not have adequate rainfall to support farming*.

An agricultural college lecturer (ACLZ2) concurred with the farmer innovator above and indicated that the water scarcity in marginal rain-fed areas (such as agro-ecological regions 4 and 5) was worsened by climate change and variability, a factor also affecting agricultural colleges whose production systems were becoming increasingly rain-fed (excerpt 7.2).

> *Excerpt 7.2: (DFGZ1, March 25, 2015)*
> ***R1:*** How is the college working with people in the community?
> ***Agricultural college lecturer:*** We do interact, I think at almost all the sections they are interacting somewhere somehow. And like we are the trainers of extension officers or workers who are in those communities. We are also interacting at that level. Also, *those people come here for assistance and there is also a facility for farmer training*. .... If you move around *the community, they were also affected like this Mlezu farm in terms of the yields because the rains were very poor, the distribution was very poor*.

An agricultural college student (ACSZ1), who was also a practising extension worker upgrading from a certificate on a block release facility also identified the problem of climate change and variability as a limiting factor for sustainability of agricultural water (excerpt 7.3).

Excerpt 7.3: (DLNZR1, August 6, 2016)
ACSZ1: Even though *the rainfall season is delaying*, we are also experiencing *rainfall within a shorter period* and then it ceases.

Concerns with environmental change, in particular climate change, and its impact on agro-ecological performance in farm production and agricultural education and farmer training expressed in excerpts 7.2 and 7.3 above were echoed by DAEFT management:

Excerpt 7.3B: (Interview #DAEOZ2, May 26, 2015)

1. ***DAEOZ2:*** *Particularly the week I was talking to you about that we discussed at the Principals Council meeting…*, that was week of 11 to 15 May in Victoria Falls. One of the issues was *how can we respond to climate smart agriculture*. Issues that came up were *means of water conservation as a mitigation measure to combat climate change*. Another is the usual one where water is available we need to increase the yield, production, productivity per unit area so that colleges that have got the opportunities advantageous to different fields such as crop production or livestock production can also support those without.
2. ***R1:*** OK so college to college?
3. ***DAEOZ2:*** Yes… which means *northern provinces that are endowed with high rainfall can also increase their food production in terms of grain crops* and *those in the southern provinces where rainfall is a bit limited they also concentrate in small grains, livestock* and increase their livestock units and all those things. …

The DAEFT was clearly in support of curriculum reorientation to address climate change impact, although it was not entirely sure how (e.g. "how can we respond to climate smart agriculture", dialogue turn #1). This shows that emergent solutions were needed rather than prescriptive ones that might generate unwanted unintended consequences (see section 2.2.1).

7.2.2 Sustainability as <u>social and cultural practices</u> of interaction and agricultural curricula

An agricultural college lecturer (ACLZ2) identified the inadequacy of the college curricula in equipping extension graduates with capabilities to function in water-scarce rain-fed systems as an absence of alternatives to conventional irrigation or of relevant complementary systems (see excerpt 7.4).

Excerpt 7.4: (DFGZ1, March 25, 2015)
R1: You mentioned the problem of drought and how crops have failed this season. Do you feel the extension officers are prepared well to deal with these kinds of problems?
ACLZ2: ... Like previously we were advising farmers to irrigate but *we do have challenges with electricity sometimes we won't have enough electricity to pump up the water*. ... So *I don't think they (Extension Officers) are well equipped* to meet these challenges.

In excerpt 7.4 there is also an *economic component* or pillar (see section 7.2.3) that shows the ailing macro-economic environment of the country (see Chapter 2) to support electricity supply to

agricultural college irrigation systems further compromising the quality of teaching of irrigation itself and of agicultural water in general.

7.2.3 Sustainability as economic viability of agricultural practice

The exerpts above show that the agricultural water problems are connected across activiy systems because of how the work of the people in the activity systems are related. Agricultural colleges produce exension workers equipped with commercial technicist irrigation skills and little or no alternative agricultural water knowledge practices (excerpt 7.4) yet the small-scale farmers they serve depend on erratic rainfall (excerpts 7.1, 7.2 and 7.3) as they largely have no access to irrigation schemes. On the other hand, the presence of irrigation systems is not a guarantee of success as seen by maintenance and power challenges faced by the colleges (excerpts 7.2 and 7.4).

7.3 BCCLWs IN A SUSTAINABLE AGRICULTURAL WATER PROVISIONING LEARNING NETWORK

7.3.1 Organisation through a learning network

A learning network forum was planned in December 2014 and formed in Zvishavane in January 2015 drawing people from local small-scale farming, local extension services, the local authority (Runde Rural District Council), agricultural colleges, local community agricultural marketing representatives and youths. The learning network met eight times in various compositions as follows:

Table 7.1: Scope and sequence chart of BCCLWs in the Zimbabwean case study

Date	Activity	Venue and participants
15 January 2015	Network-level boundary-crossing change laboratory workshop	Runde Rural District Council Board room, Zvishavane (farmer innovators, farmers, college principal and lecturers, local agricultural extension workers [AEWs], local ward committee marketing representative, youth, small-to-medium enterprises [SME] coordinator)
12 February 2015	Network-level boundary-crossing change laboratory workshop	Phiri Homestead, Zvishavane (college principal and lecturers, farmer trainers, local farmers, local AEWs)
22 April 2015	Sub-network-level boundary-crossing change laboratory workshop 1 focussing on questioning to modelling solutions at Mlezu College	Mlezu College of Agriculture (farmer innovators, farmers, college principal and lecturers, local AEWs, local ward committee marketing representative, youth, SME coordinator)
23 April 2015	Network-level boundary-crossing change laboratory workshop: modelling and examining new solutions	Phiri Homestead, Zvishavane (farmer innovators, small-scale farmers, local AEWs, college lecturers)

25 June 2015	Sub-network-level boundary-crossing meeting 2 implementation of new solutions at Mlezu College	Mlezu College of Agriculture (college lecturers, farmer innovator, Muonde NGO; NB: College Principal, researcher, local AEWs and local farmers not present)
18-19 February 2016	Sub-network-level boundary-crossing change laboratory workshop 1 focussing on questioning to modelling solutions at Rio Tinto College	Rio Tinto College of Agriculture (college lecturers, farmer innovator from Mazvihwa / learning network, college principal, researcher, local AEWs and local farmers)
11-12 August 2016	Sub-network-level boundary-crossing change laboratory workshop focussing on assessing RWH&C implementation and small-grains	Rio Tinto College of Agriculture (College lecturers, College Principal, researcher, local AEWs, block-release in-service extension students and local farmers)
11 to 12 August 2016	Examining and implementation of rainwater harvesting solutions at Rio Tinto College	Rio Tinto College of Agriculture

The sequence of BCCLWs in Table 7.1 was carefully planned at different levels starting with discussions with small-scale farmer innovators, followed by DAEFT senior managers, college principals, agricultural extension officers and agricultural extension workers, each motivated by diverse factors. Appendix 7.2 provides more details to the data sources for Zimbabwean BCCLWs. The DAEFT and principals' council were keen to learn about how to maintain productivity of college farmers as teaching resources and suppliers of food for students using sustainable agricultural water provisioning innovations that could complement the struggling irrigation systems. Small-scale farmer innovators were motivated by the aspiration to share and spread RWH&C innovations, and the hope of accessing markets for small grains and vegetables via new relations formed in the learning network.

7.3.2 Historicity of agricultural water and locally-adaptive seed systems in Zimbabwean agricultural learning activity systems

The approaches to agricultural water have been diverse across agricultural learning activity systems with agricultural colleges mimicking commercial agricultural production while small-scale farmers were at the mercy of their agro-ecological (re-)locations either in rural, rain-fed marginal areas for the majority, with a handful having access to irrigation and even fewer emerging Black middle-class privileged with access to farmland in African Purchase Areas (see section 2.3.3).

7.3.3 Boundary-crossing change laboratory workshop, session #1 in Zvishavane: 15 January 2015

Two major actions were carried out in the first learning network meeting, namely a boundary-crossing change laboratory workshop and a look and learn field visit to two farmer innovators. The change laboratory workshop was attended by 12 people who included two agricultural college educators, four

farmer innovators, three extension officers and workers, one youth representative also representing the small to medium enterprises network, a local small-scale farming marketing representative and the researcher-interventionist (author) (Figure 7.1).

Figure 7.1: *Participants at the first Zimbabwean learning network boundary-crossing change laboratory workshop (Photo taken 15 January 2015 by author)*

Murowa diamond mine was expected at the boundary-crossing change laboratory but gave an apology as shown in the e-mail communications extracts below:

[redacted] (murowa) Good day TP Thanks for your invitation. We will revert back to you. Regards [redacted] 01/12/15 at 5:17 PM

Tich Pesanayi On Monday, January 12, 2015 5:11 PM, [redacted] wrote: Good day TP Thanks for your invitation. We will revert back to you. Regards 01/12/15 at 5:24 PM

[redacted] (murowa) [redacted] 01/13/15 at 2:00 PM

To Tich Pesanayi

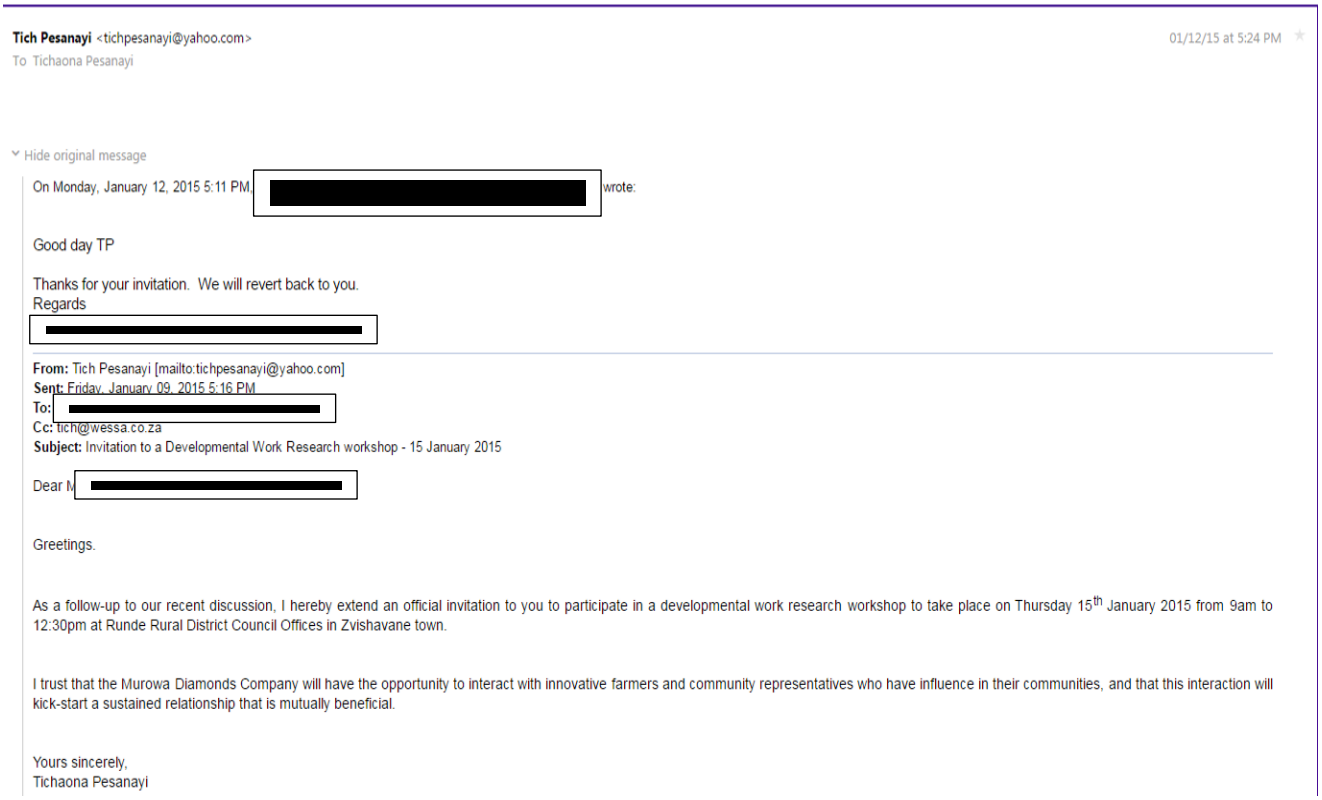
Good day Mr Penayi

Just as a follow up to my earlier communication and update we have a business commitment in the company on Thursday 15th January 2015. As such we will not be able to attend the scheduled workshop in Zvishavane Runde RDC offices.

We however would have wanted to attend and actively contribute in the workshop. Hope that there will be some date again. All the best and wish you a successful workshop.

Regards

[redacted]



Tich Pesanayi <tichpesanayi@yahoo.com> 01/12/15 at 5:24 PM
To Tichaona Pesanayi

Hide original message

On Monday, January 12, 2015 5:11 PM, [redacted] wrote:

Good day TP

Thanks for your invitation. We will revert back to you.
Regards
[redacted]

From: Tich Pesanayi [mailto:tichpesanayi@yahoo.com]
Sent: Friday, January 09, 2015 5:16 PM
To: [redacted]
Cc: tich@wessa.co.za
Subject: Invitation to a Developmental Work Research workshop - 15 January 2015

Dear M[redacted]

Greetings.

As a follow-up to our recent discussion, I hereby extend an official invitation to you to participate in a developmental work research workshop to take place on Thursday 15th January 2015 from 9am to 12:30pm at Runde Rural District Council Offices in Zvishavane town.

I trust that the Murowa Diamonds Company will have the opportunity to interact with innovative farmers and community representatives who have influence in their communities, and that this interaction will kick-start a sustained relationship that is mutually beneficial.

Yours sincerely,
Tichaona Pesanayi

Figure 7.2: *Extracts from e-mail communications with Murowa Diamond Mine (Community Liaison Officer, e-mail communications, January 9-12, 2015)*

The workshop was chaired by the Zvishavane District Environment and Agriculture Special Councillor, who is also a farmer innovator. As per custom, he started the meeting off with a prayer and then asked the researcher-interventionist to facilitate the discussion while he chaired. The discussion started with an ethically informed consent request leading to unanimous agreement to record the meeting on video. Based on interviews previously conducted and the purpose foregrounded in the meeting invitation (see Appendix 7.3) a set of guiding objectives were tabled for discussion with the purpose of confirming and focussing on the common object of activity namely sustainable agricultural water provisioning for adapting to water scarcity. Figure 7.2 shows the way the objectives were shared and how they were modified during the workshop.

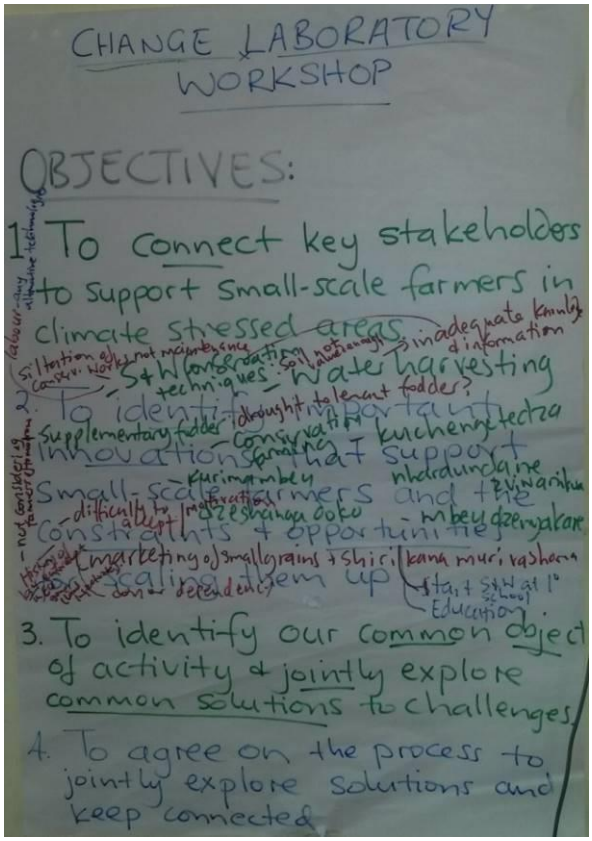

CHANGE LABORATORY
WORKSHOP
OBJECTIVES:
1. To connect key stakeholders to support small-scale farmers in climate stressed areas
2. To identify important innovations that support Small-scale farmers and the constraints & opportunities
3. To identify our common object of activity & jointly explore common solutions to challenges
4. To agree on the process to jointly explore solutions and keep connected

Figure 7.3: *Workshop objectives*

In the discussion of objectives in the first session of a series of boundary-crossing change laboratory workshops I introduced mirror data in the form of problems that were touching and triggering some internal tensions within and across the networked activity systems (see Chapter 5). The mirror data was in the form of narratives and photos of wilting crops as a first series of learning stimuli. According to Engeström (2001), such tensions and dynamics must take place "in their respective institutional contexts, dynamics that can energize a serious learning effort on their part" (p. 140). The connections in the learning network varied from loose (where a few people were meeting for the first time) to strong for example some farmers and extension workers involved in the BCCLWs were both from the same communities in which the colleges were working and serving.

I used the opportunity of discussing objectives to introduce the mirror data on water scarcity that was evident in the interviews and observations (see Chapter 5). The excerpt below indicates how the initial discussion went.

> *Excerpt 7.5 (BCCLW, session #1,* (DLNZ1, January 15, 2015)
>
> ***R1:*** Our objectives are as follows. The first one is to connect key stakeholders *to support small scale farmers in climate-stressed areas.* The climate stressed areas we are talking about in this District … I have been looking at in the research I have been doing in Mapirimira and Murowa (wards). We can say they are climate stressed in the sense that rainfall is low, number one; number two it is very hot. I do not know whether there is a number three where we could say rainfall is getting less? Do you see the difference?

Participants: Yes.
R1: My question on this objective is, are you in agreement with this objective? Is it important to be connected, if so why?
Farmer 1: Yes because *we can share our challenges*.
R1: OK because this workshop is different from other workshops in that it is called a change laboratory workshop. When I met most of you prior to this workshop we were looking into your work to find out what innovations you were encountering and also *what* ***challenges you were facing in your work***. …

In the first boundary-crossing change laboratory workshop session we presented various empirical cases of agricultural water challenges including farmers' (and colleges') struggles with drought under rain-fed conditions (pictures of wilted crops) and curriculum absences of effective sustainable agricultural water provisioning. Somehow the details of the impact of frequent power load shedding on irrigated college farm lands in terms of compromising the teaching of irrigation scheduling and compromising crop production, was not raised directly in the first session of the boundary-crossing change laboratory workshop despite photos and reports that participants were able to access in the workshop archive. Neither was the issue of ageing and poor maintenance of irrigation systems. This is probably because of the association of poor maintenance of government infrastructure with the touchy subject of politics, and people's general politeness. [The archive is thus not "merely a storehouse of documents" (Lalu, 2009, p. 7) but 'an apparatus capable of producing or reproducing forms of subjection' and therefore it requires reflexive interpretation.] The common problem started to shape out a quaternary contradiction as follows:

> ***Farmers continue to grow food in difficult, rain-fed conditions with no sustainable solutions in sight (object of small-scale farmer activity system) while agricultural colleges continue to teach predominantly technicist methods of irrigation to extension officers that are not offering practical solutions to farmers' contexts using rain-fed systems (object of agricultural college lecturers' activity system)***

The participants had various ideas to address the problem such as 'conservation farming, sustainable agriculture, small grains, environmental education curriculum, rainwater harvesting' (DLNZ1, January 15, 2015). However, these had not reached most farmers and agricultural colleges who still experienced crop failure from harsh climates and ageing irrigation systems. The early discussion of deep contour innovations that some farmer innovators in the room were using successfully provided a second level stimulus for problem analysis and collective learning. This discussion pointed towards an attempt to using scaling of innovations as a possible model solution to the problem above. However, this quickly raised internal tensions that unmasked the real causes of water challenges in the agricultural colleges, extension and rain-fed farming systems that showed that more collective expansive learning was needed.

Excerpt 7.6 (BCCLW, session #1, (DLNZ1, January 15, 2015)

Agricultural College Manager 1 (ACMZ1): There is another issue of *digging conservation works. It is a painful undertaking to dig contours. If it were possible for us to get equipment … make the work easier.* If we could access any technologies that would lighten the burden of …conservation works. This would help us very much.

R1: … I think your point also applies to water harvesting (deep contours). Maybe those who do it may come in.

FZ2 (RWH innovator): *It is true what she is saying that it is a painful undertaking*.

FZ4: It is fine to get access to technologies, however it goes back to the point that AGRITEX needs to have its law enforcement powers restored so that farmers operate in properly conserved fields. … *when we go to the rivers we will not find any pools that keep water. … So truly it is painful but should we perish because it is painful*? It is better for us to work bit by bit. *Of course we are not saying everyone should dig the deep contours like we are doing which deepen to reach our waists but at least people should have the regulatory conservation contours,* and if these are restored or maintained then soil conservation will be better than it is now. …

The process of engaged analysis of current innovations and practices started by **questioning** the labour challenges involved in digging soil conservation works and/or their transformation to rainwater harvesting deep contours as application to the current water innovation practice. This was started by an agricultural educator expressing agency in confronting the contradiction between a need to conserve soil and to harvest water through digging contours versus the painful labour input required by proposing simple technological **new tools** of doing otherwise laborious works. This deliberation revealed internal tensions in the activity systems and contradictions between the objects of the agricultural lecturers', the farmer innovators' and the extension officers' activity systems. These internal tensions formed a constellation of contradictions across the interacting activity systems with the outcome of gaps or absences (e.g. of sustainable agriculture water in college curricula), ambivalence (e.g. of extension messages regarding digging conservation works that were draining water out of fields (see Pesanayi 2008; Mukute, 2010), irrelevance (e.g. of college water curricula to extension practice and farmer contexts of frequent drought situations) and poor coordination (see Figure 7.4).

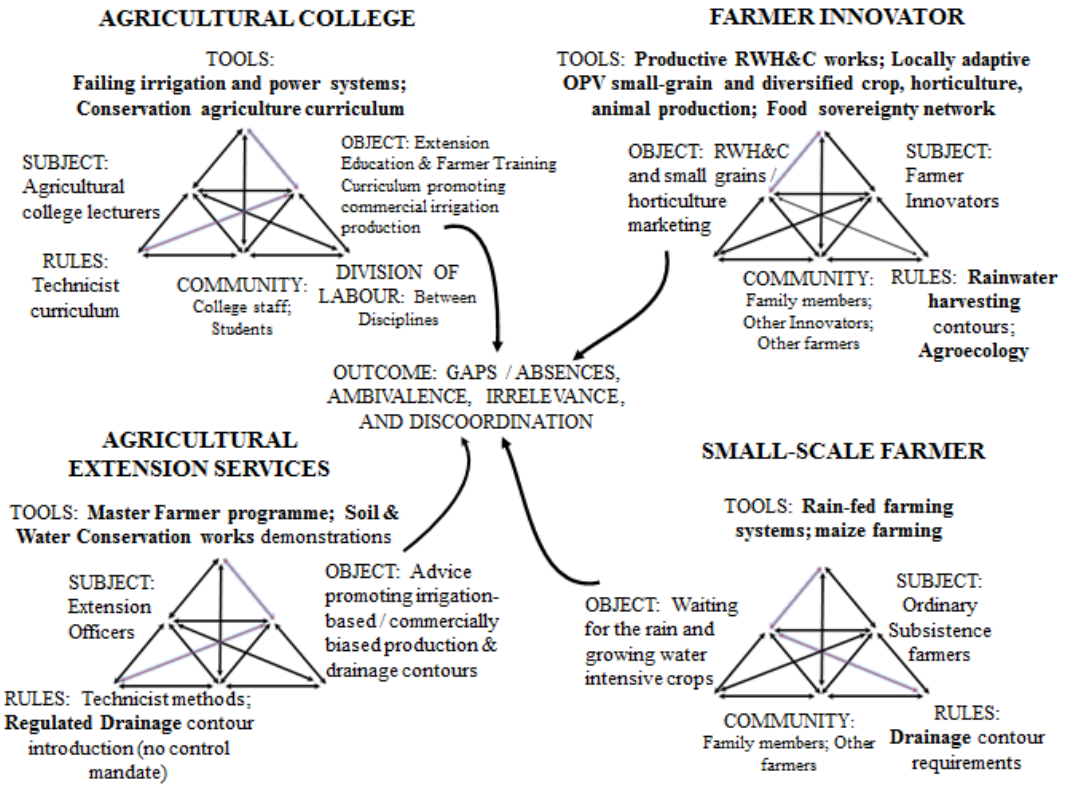


Figure 7.4: *Constellation of secondary contradictions in agricultural water in the Zimbabwean learning network (after Engeström, 2001, p. 145)*

Table 7.2 below summarises the contradictions illustrated in Figure 7.4.

Table 7.2: Summary of contradictions depicted in Figure 7.4

Activity systems	**Contradictions** (secondary)
Agricultural educators	Curriculum script (rule) privileges technicist agricultural water systems (object); Failing irrigation systems (tools) provide poor demonstration to learners / poor curriculum delivery (object)
Farmer innovators	RWH&C works (tools of production) and OPV seed enabling high production / multiplication of small grains and horticultural products but marketing of products poor (object) resulting in grain accumulation and risk of losing perishable fresh produce.
Extension officers	Standard regulation (rule) soil conservation contours (object) are ironically designed to channel much needed water out of fields
Typical small-scale field crop farmers and garden food producers	Waiting for erratic rain (object) increases uncertainty while the rain water that falls is drained out by soil conservation contours (rules); crop production (object) using (mostly staple maize) seed not adaptable to rain-fed farming (tools)

Failing irrigation and power supply systems in agricultural colleges reduced their capacities to demonstrate successful irrigation farming and reduced them in effect to the humbling level of typical rain-fed small-scale farming systems. When the internal tensions discussed above were triggered through engaging with mirror data, it was possible for the various agricultural actors involved in the agricultural water knowledge practice learning network to confront contradictions together.

A historical analysis of rainwater harvesting innovations developed by small-scale farmers revealed that their innovations were developed in specific contexts and through individual inspirations and group interactions. Some innovators were motivated by unfavourable personal encounters with the political economy of the colonial era, divine inspiration and networking with innovators that led them to transgressive actions (Pesanayi, 2016b) as illustrated below,

> *Excerpt 7.7 (Boundary-crossing change laboratory workshop, session #1)*
> ***FZ1 (innovator):*** Prime Minister Ian Smith declared that 'Zephaniah *you will never again find a job*'. That was during the Rhodesian era. Just imagine I was a father of six. … How was I to survive? Then *I constructed a few wells but still they did not see my maize crop to maturity*. Then *I committed myself to Genesis Chapter 2*. If you take verse 15 or 16 you find God telling Adam to say 'Adam here is a garden. Cultivate it and look after it.' (DLNZ1, January 15, 2015)

> *Excerpt 7.8 (Boundary-crossing change laboratory workshop, session #1)*
> ***Farmer innovator:*** *...farmers from Mberengwa, Chivi and Zvishavane, we got together and formed a group* called Upenyu Ivhu (literally Life is in the Soil) Farmer Innovators Group. ... We were able to come together and *formed a network* that worked with other organisations. We worked with Zvishavane Water Project and many other organisations. (DLNZ1, January 15, 2015)

> *Excerpt 7.9 (DLNZ1, January 15, 2015, BCCLW, session #1)*
> ***FZ4:*** In order to farm successfully you need to be very committed because farming is not easy. *You do not need to continue digging all the time. Once you do it and establish your system, it will be a matter of maintenance.*
> ***R1:*** Now I want to get back to your point that you feel the pain once in the initial stages, and combine it with X (extension worker)'s earlier point that it is difficult for a farmer to go through those efforts if there is no carrot ... How do we reconcile that? …
> ***FZ4:*** I think it goes back to AGRITEX. *If AGRITEX could restore and maintain their practice of farmer training schools.* Without bringing farmers together to learn, it is difficult for us to learn well because for me to go and start these things alone, I may think that it is painful. *But when we learn together in groups we will eventually see the value.* … we no longer see the farmer training schools taking place. …
> ***R1:*** Are you talking about Master Farmer Training?
> ***Farmer:*** Yes, *the Master Farmer Training incorporates all these things that we are discussing here*. It teaches the farmer must conserve his / her soil, trees, everything...
> ***R1:*** Thank you.
> ***AEWZ1:*** I think it goes back to the point raised by B (name of agricultural educator) of curriculum development. *If a person develops from a young age with the right knowledge, it will become easier for that person to apply that knowledge later in life* in their practices. It is difficult to teach an old dog new tricks.
> ***R1:*** OK. So curriculum development, the issues keep pointing back to the colleges. People are saying that when you have your principal's forums and meetings with universities you work with, the extension workers see curriculum development as valuable.

The excerpts above show evidence of the influence on agency in water innovations of challenging socially unjust conditions, spatio-temporal experimentation with innovations, perseverance, learning

together among farmers, networking, training and agricultural education (see excerpt 7.9). The activity systems in Figure 7.4 thus came into interaction carrying the above internal contradictions and the subjects agreed to pursue common (boundary) objects of sustainable agricultural water provisioning and locally-adaptive seed systems) although its specifications were not yet defined. The internal contradictions aggravated into the following quaternary contradictions illustrated in Figure 7.5.

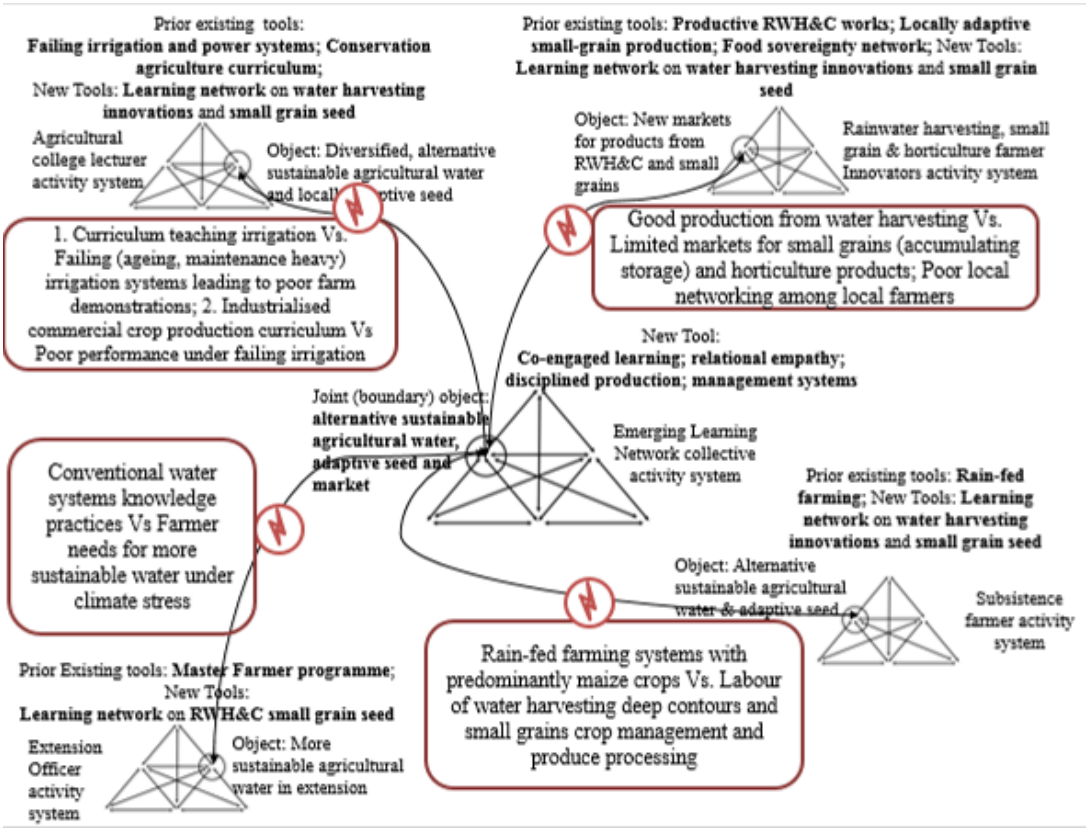


Figure 7.5: *Quaternary contradictions across interacting activity systems in the Zimbabwean learning network*

7.3.3.1 Explanation of quaternary contradictions across the interacting activity systems

Agricultural colleges desired a solution to sustainable agricultural water provisioning that would serve as a practical productive demonstration to extension students, farmer trainees and practicing farmers through its curriculum offerings in the formal and non-formal divisions. However the highly successful model offered by farmer innovators had the challenge of labour intensity that the colleges would have difficulty justifying in farmer training since some practicing farmers were already finding the labour needed prohibitive. The **quaternary contradiction** between the college's aspirations and the small-scale farmer innovator's water object can be represented as follows:

> ***Absence of alternative sustainable agricultural water provisioning in college extension education and farmer training curricula (object of agricultural college activity system) vs***

Prohibitive labour requirements in rainwater harvesting innovators' model among college and farmers (object of small-scale farmer innovator activity system)

The above quaternary contradiction shows a problem in a possible solution to agricultural colleges' water aspirations, and aggravates to absence of such institutional technical and mechanisation support to farmers from agricultural extension officers.

The strenuous labour was also a challenge for other farmers with inadequate labour capability or mechanisation. This contradiction was not only physical and economic, but was also ideological because of its relation to drainage contours and their history of forced labour in the colonial era. The reluctance by farmers to dig contours using backbreaking manual labour does not necessarily imply outright rejection, but a possible act of transformative agency as they sought a better solution (Haapasaari, Engeström & Kerosuo, 2016). Farmer innovators faced a different type of challenge, namely marketing their small grain and horticulture products whose productivity is enhanced by their RWH&C innovations. This illuminated another contradiction faced by agricultural colleges whose curricula promote water-intensive cash crops that are based on technicist irrigation and yet their irrigation systems are failing and therefore their farming systems mimic rain-fed farming systems. Uncontrolled environmental conditions (climate extremes) combined with economic austerity (rules) forced colleges to *identify with* the object and therefore subjects of rainfed farmers. Such an identity shift shows a relational agentive action and appears to have triggered boundary learning as movement in the ZPD. The ZPD for agricultural college lecturers became the joint boundary objects of a yet to be ameliorated sustainable agricultural water provisioning and locally-adaptive seed systems (shown by the emerging learning network object in Figures 7.4 and 7.13).

The question of labour and the pain of digging raised by one of the participants illuminated a real barrier to developing such rainwater harvesting conservation works as deep contours where capable and affordable labour input was unavailable. This meant that in modelling solutions, despite there being some very good innovations that were working elsewhere for some, there were other things to consider, as these innovations could not just be scaled out geographically through replication (Gündel, Hancock & Anderson, 2001) as they were. The discussion on labour challenges generated a double-bind as some farmers who had installed labour-intensive works tried to convince others that it was possible while they found it working but prohibitive ("*so truly it is painful but should we perish*", Farmer FZ4, DLNZ1; "It may be painful that is alright, but we must use a system which helps us to *invest in the hard labour briefly and reap the benefits thereafter*", FZ3, DLNZ1), while other experienced innovators agreed otherwise (*"it is true what she is saying that it is a painful undertaking"*, Farmer FZ2, DLNZ1).

A senior agricultural college manager (ACMZ1) dealt a first blow at the socio-technical design stalemate, showing the *power of individual agency* acting within a networked social learning system, as shown in excerpt 7.10;

> *Excerpt 7.10: (DLNZ1, January 15, 2015)*
> ***ACMZ1:*** *When I was trying to explain about the difficulty of digging contours I was trying get us to come to an agreement ... how to do it better.* There is a group known as 'Farming God's Way' ... in Harare. *... they had good machinery there, some manual and some tractor drawn.* …
> ***R1:*** I have grasped X's point. In the South African case study ... I am working with an agricultural college. They have a demonstration site that was supported by Farming God's Way. I think it is another opportunity to connect with them.

The proposal to design more sustainable agricultural water provisioning ('to do it better') implied that while the current design was working well for a number of individual innovators, it was problematic in the social and organisational spaces where spatio-temporal conditions, physical abilities and economic capacities differed more widely. This raised other factors that were important in the consideration of context, namely such technical issues as scale of operation, soil type, slope and type of catchment. For example, some farmers had modified the deep contour examples available such as successfully harvesting rainwater where there was no rocky catchment (farmer FZ2) and some harvesting runoff from the road (farmer FZ3) and managing the potential water logging through raised beds and use of simple water transfer pipes and valves connecting upper and lower structures (see section 5.3.3.1).

From this double bind situation the participants worked with the researcher-interventionist on mobilising a **second stimulus**, and this was the diversity of successful working models that farmers vouched for example, "*once you do it and establish your system it will be a matter of maintenance"* to consider the modelling of solutions for participants to take away to implement. This had the potential to lead to *"get us to come to an agreement about how to do it better*" (DLNZ1, January 15, 2015). The 'functionally special role' (Vygotsky & Luria (1994, p. 159) of this series of second stimuli was to demonstrate the diverse possibilities of contextually-relevant sustainable agricultural water provisioning options apart from the more promoted conventional irrigation. It started to become clear that a 'germ cell' was emerging, and it was not the deep contours but motivation and personal commitment to **collecting, sinking and conserving water *in situ*** using means that were feasible for agricultural actors' contexts as shown in Table 7.3 below.

Table 7.3: Emergence of a germ cell for sustainable agricultural water provisioning activity

Germ cell property	Explanation

1. Motivation and personal commitment	Motive connects the mind with the hand (agency)
2. Collecting water, **sinking** in root zone and **conserving** water	Historically, this is something that was done through winter ploughing (*kuvundukura*, in Shona) and partially through collection of roof water with portable containers (*kuchingidzira*, in Shona)
3. *In situ*	Within reach, which is reasonably in the crop field or horticulture garden; and then stored where crop roots can reach; Also consideration of the soil type, the slope and susceptibility to direct heat / or crop protection from partial shade / or soil cover.
4. Feasible for agricultural actors' contexts	Labour capabilities of farmers (and agricultural colleges)

A range of agricultural actors showed these characteristics: at least two farmers ("then *I committed myself* to Genesis chapter 2 verse 15 or 16; you find God telling Adam to say 'Adam here is a garden. Cultivate it and look after it'" (see excerpt 7.7)), and an agricultural educator, who expressed agency thus "we therefore *need to know and be flexible enough to accept that these things are there* and to see how we can access and use this type of machinery like jack planters that can make our work easier, because they are there" (DLNZ1). Another farmer innovator noted and proposed, "It is difficult for us to unleash our potential and innovations … because we grew up … constantly told not to do things. … *each person should unleash their potential ... for the benefit of society*" (DLNZ1).

When the properties in Table 7.2 are analysed critically, it can be seen that all of them can be summed up by combining #2 and #3 namely *collecting, sinking and conserving water in situ* because doing this is driven by motive and commitment, and its realisation means it is feasible. Sinking is important to ensure 'effective precipitation', namely the quantity of precipitation such as rainfall that is actually added and stored in the root zone of the soil after evaporation, runoff and deep percolation. All of these water loss processes can be minimised.

From the above deliberations (questioning and analysis) and double stimulation, the proposed new model of mechanised digging of deep contours was considered for the network after undergoing discursive testing. Later I will discuss how this model was reviewed and remodelled with the coming in of another agricultural actor, an NGO, into a subsequent boundary-crossing change laboratory workshop as a 'socio-technical expert' mediating the interaction between people and technology in joint workplaces. What is notable in the above modelling is that the participants mobilised knowledge from a diversity of sources including science (science-based low cost mechanisation), indigenous knowledge practices (farmer-led water and seed innovations) and from the spiritual (inspiration from God; 'Farming God's Way', a faith-based organisation). Using these different sources of knowledge the agricultural actors discussed a number of possibilities in order to come to a common object. There was a diversity of interests that needed to be considered and reconciled in establishing an object that participants could work together ('*come to an agreement'*) on. Most were related to water for food

either directly or through adaptive seed. These included conservation farming, sustainable agriculture, small grains and horticulture for marketing. What became clear was that despite all these farmer practices, there was an absence of local networking and collective learning, as summed up by one of the experienced farmers below.

> *Excerpt 7.11: (DLNZ1, January 15, 2015)*
> ***FZ2:*** I represented the Midlands Province at the World Summit for Sustainable Development (WSSD) in South Africa. We came together as Zimbabwean farmers to form four clusters namely Central Cluster that combines Masvingo and Zvishavane where I am Chairperson. In that *network* we formed a small-scale farmer's council among *farmers doing conservation farming*. … When I stepped into Mr Phiri's shoes I stayed like that but *I found it difficult to bring Zvishavane farmers together*. ... we went to destroy Monsanto Savannah in Mozambique, we also went to Tanzania and saw how they were doing marketing, and also to India to learn how they run markets. So I have travelled most of SADC what has been bothering me was that *I am not doing much in my own home area of Zvishavane*.

An historical absence of relational agency among farmers and with other stakeholders was raised by a farmer innovator in the above excerpt who "*found it difficult to bring Zvishavane farmers together"* in his own home area and felt that this needed to change. This absence was illuminated with the readiness to form a learning network, and with the identification of absent actors who would be needed in producing an effective new model (see excerpt 7.12).

> *Excerpt 7.12 (BCCLW #2 in the Zvishavane learning network)*
> ***AEOZ1:*** … The extension worker only remained with the training function, but when the law enforcement moved to Land Inspectorate it became dysfunctional. …
> ***R1:*** Will it help us to have in our next meeting officers from the Land Inspectorate.
> ***FZ2:*** Absolutely.
> ***R1:*** OK. … How about the EMA (Environmental Management Agency) officers?
> ***FZ2 and AEOZ1:*** Yes.
> ***FZ2:*** And also the District Education Office.

The growth of the list of actors beyond agricultural indicated that there was something missing in order to complete the new model. An analysis of the new model revealed another angle of challenges between structure and agency that followed the above discussion with the excerpt below.

> *Excerpt 7.13: (DLNZ1, January 15, 2015)*
> ***FZ1:*** *Are we seeing the actual causes to these* problems that we are discussing that are *causing AREX and EMA to lose their voices? …* We can surely say these things when these people are present, but from what I see what causes these people not to talk and act on these things that they see but track back is that we need to trace it back to the source. *From my point of view it is politics that has blocked all these officers and leaders. People are afraid* that if they talk about the real problem in trying to solve it they will be accused of betraying the party line, which is not it. … *Let's look after our resources*.

After the above excerpt, there was a brief moment of silence and uneasiness. The excerpt reveals an agentive expression to move from undermined practices to a reclamation of transformative praxis that focussed on what people are able to actually do.

7.3.3.2 Constructing an activity triangle as a second stimulus for boundary learning

At this point I introduced the activity triangle as a second stimulus to clarify how the joint work around the emerging joint object could be seen using an activity system lens, and also to clarify the meaning of 'object' and other activity system elements. This helped to highlight the role of tools, division of labour and rules that may need changing or compliance to. Excerpt 7.9 illustrates preliminary discussion of the activity triangle as a learning tool.

> *Excerpt 7.14: (DLNZ1, January 15, 2015)*
> ***FZ1***: Will the environment I live in survive with the object…I have chosen to follow? … my objective in the area that I live … is alive.
> ***R1:*** What made you to come up with that object?
> ***FZ1:*** That's it; you have asked a good question my child. I was shut down in a can like sardines. The government of the day incarcerated me into detention due to politics. …Then I remembered what I had learnt from school about agro ecological regions. *I learnt that agro-ecological region 4 where I live does not have adequate rainfall to support farming*. … So my objective was this field … I must cultivate it and protect it, but I am in region 4 where there is inadequate rainfall. *This very day I want to invite all of you if you want to come and see for yourself …*
> ***R1:*** Thank you so much. So if we take Mr Phiri's example we could say his object is to have a farming place with adequate water. The outcome he intends to achieve … is that children learn from it and get involved.
> ***FZ1:*** Yes.
> ***R1:*** … So the triangle I have drawn here (referring to an activity triangle) has an element of 'tools'. From Mr Phiri's illustration one of the 'tools' is the idea that if I opened the Bible and studied about Eden, then I must use that idea to help me to develop farming and progress with a good life. … Are we still together?
> ***Participants:*** Yes.

From this excerpt, an object of sustainable agricultural water provisioning ("water harvesting") was identified in relation to the contradiction: Need to produce food ("this field that I have been given *I must cultivate it* and protect it") vs water scarcity ("but I am in region 4 where *there is inadequate rainfall*"). The natural scarcity of rainfall in dryland farming systems formed the core of the first stimulus for co-engaged boundary learning. The activity system above was then pitched in relation to other activity systems ("Agricultural Extension Officer" and "it should help orphans" who form the desired outcome of an envisioned expanding activity system). Figure 7.6 shows the first activity diagram that was drawn to explain activity systems in the workshop and to stimulate deliberation towards focussing on a common object.

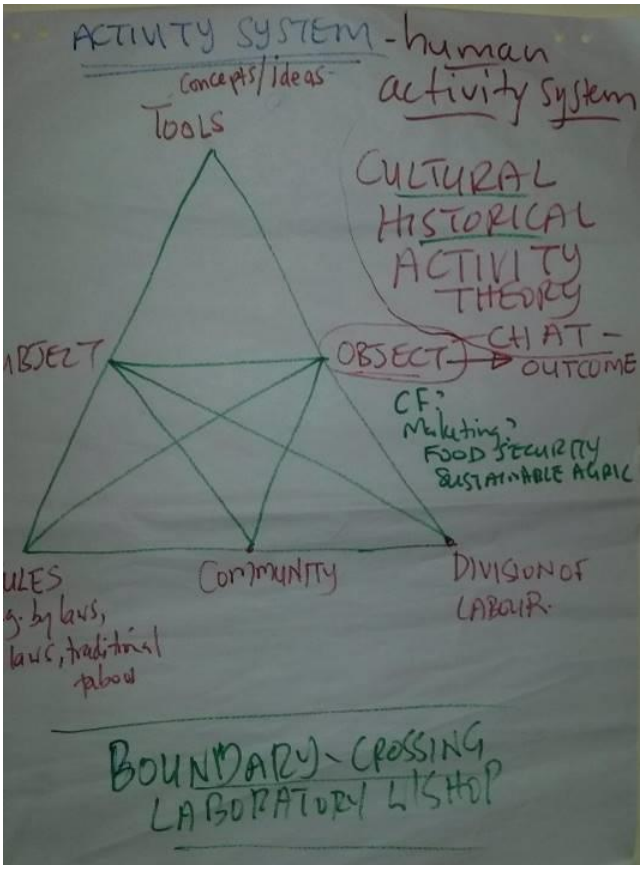


Figure 7.6: *Illustrative activity system diagram used in the first BCCLW as second stimulus*

From the context of double stimulation, this activity system diagram was used to stimulate the analysis of the joint contradictions in the emerging joint object of activity (second stimulus). The emerging boundary object had various dimensions. It had dimensions of conservation agriculture in the context of climate change that extension officers were supporting farmers with and that agricultural colleges were pursuing. It also had dimensions of locally-adaptive seed for food sovereignty and marketing products of food sovereignty and horticulture watered by RWH&C. This characterised it as a complex runaway object.

> *Excerpt 7.15: (DLNZ1, January 15, 2015)*
> ***FZ1:*** I have educated the world on water harvesting. … I just wish that if we could get a full time Agricultural Extension Officer who can manage this place so that the place makes such a great impact that is so well-known that funds generated from it should help orphans.

The workshop participants honoured the invitation extended by the farmer innovator above and encountered water harvesting in action as it happened to rain that afternoon. This experience proved to be another second stimulus for new learning as indicated by one of the participants, "Yes, this is amazing. Really." (Senior Agricultural Educator, DLNZF1a, January 15, 2015).

Figure 7.7: *Top left and right: some workshop participants walking in the rain witnessing water harvesting; bottom left and right: deep contours filling up and full of water respectively (Photos by author, January 15, 2015)*

> *Excerpt 7.16: (DLNZ1, January 15, 2015)*
> ***R1:*** This one really has a lot of water.
> ***FZ1:*** If the water level rises in the contour, the *excess water will be channelled by the pipes to the next contour downstream* by those pipes.

From the above discussion it can be seen that after the first learning network boundary-crossing change laboratory workshop, the following stages of the expansive learning cycle had been achieved (Figure 7.8). This way, participants collectively formed the concepts of 'capturing rainwater for future use' and 'managing captured water to ensure distribution and avoid water logging' (see Chapters 1 and 3).

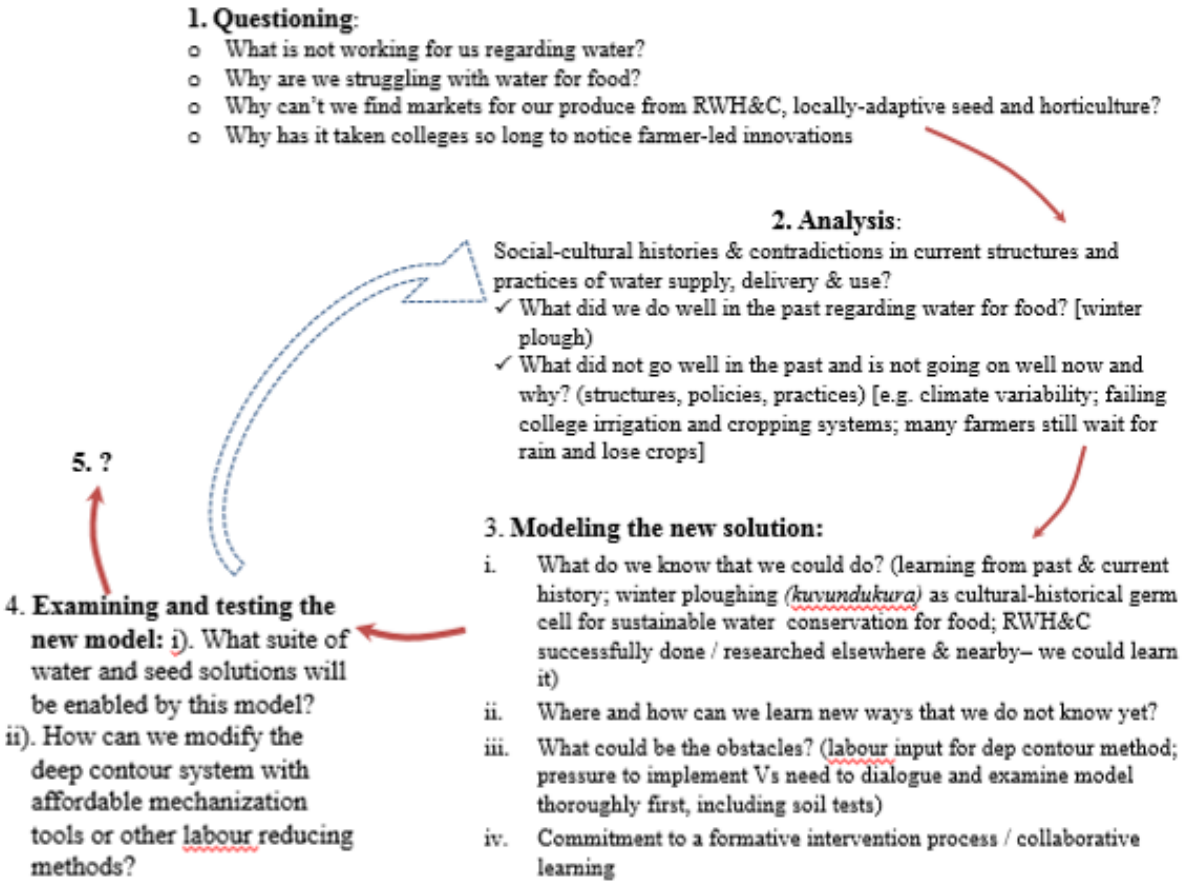


***Figure 7.8**: Expansive learning cycle after the first Zimbabwe case learning network BCCLW*

The expansive cycle above shows that participants managed to go through the first four stages of the ideal-typical expansive cycle, however at the fourth stage, the cycle tracked back to stage 2 for further analysis of the model as there were still gaps in the feasibility of the new model. The questions recorded in each stage represent the issues that workshop participants raised and tried to grapple with during the workshop.

7.3.4 Boundary-crossing change laboratory workshops 2 and 3 in Zvishavane: 12 February 2015 and 23 April 2015

On 12 February 2015, a group of agricultural practitioners including farmer innovators, agricultural lecturers, extension workers met at the Phiri homestead in Zvishavane rural and tested the models developed in the first boundary-crossing change laboratory workshop held a month earlier. The meeting was meant to be held at the Rural District Council Offices but had to shift due to a council meeting that was apparently going to be held there. This meeting confirmed the regular committed members of the learning network and made plans to meet on 23 April 2015 with people capable of making decisions. A group made up of small-scale farmers, agricultural college lecturers, extension officers and youths converged at the Zephaniah Phiri homestead to participate in the third boundary-

crossing workshop for their sustainable agricultural water provisioning network. The aim of this workshop was to model solutions for implementation by their network at various sites. Realising the labour challenge faced by Mlezu College of Agriculture regarding their desire to implement deep contours, an NGO called Muonde pledged to team up with the Mlezu Agricultural College team in terms of technical guidance and labour. This addressed their big challenge of labour before they could worry about acquiring the new mechanisation tools identified in the first workshop. This action (marked point #9 in a red oval) together with others is shown in Figure 7.9 (left) below.

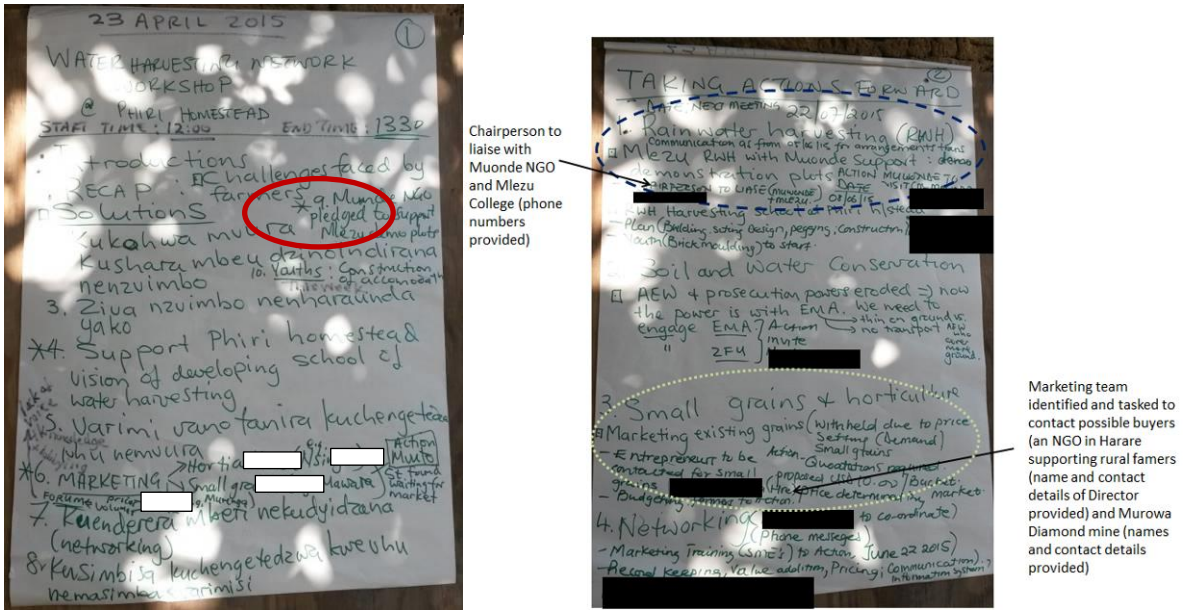


Figure 7.9: *Left: List and prioritisation (with stars) of model solutions in BCCLW 3; right: Model solutions tested for implementation in different sites (April 23, 2015)*

The solutions prioritised in Figure 7.9 (left) include to do the following within a learning network support system; (1) harvest rainwater in ways suited to the context; (2) select seeds adapted to the local climate for planting; (4) support Phiri homestead vision of developing a school of water harvesting; (6) improve marketing of small grains and horticulture products by contacting specific including agricultural colleges and a rural development NGO; and (9) Muonde NGO pledged to support Mlezu Agricultural College to implement a rainwater harvesting productive demonstration site. The model solution was conceptualised in many dimensions and contexts. Various productive demonstration sites for implementation were identified including Mlezu College of Agriculture, Phiri homestead, small grain producers and hortciulture producers. The chart picture in Figure 7.9 (right) summarises the agreed impementation actions, with the Mlezu Agricultural College action point circled in blue (square dashes forming an oval) as the number one priority for joint action. The new model was taken up by Mlezu Agricultural College on the understanding that the NGO Muonde would also ensure that the technical feasibility issues such as slope, catchment and soil type would be investigated. Figure 7.10 shows some of the participants at the third BCCLW of the Zimbabwean agricultural water and adaptive seed learning network.

***Figure 7.10**: Some of the participants at Zimbabwe learnng network BCCLW #3 (Mlezu Agricultural College principal, farmer, farmer innovator, extension officer from Mlezu area, farmer from Mlezu area, lecturer from Mlezu Agricultural College)*

The actions in Figure 7.8 were prioritised as follows (Table 7.4) in terms of where people were committed to work together.

Table 7.4: Action areas for model solutions and their prioritisation

Priority actions (in rank order)	**Actors**
1) Survey, design and implement suitable rainwater harvesting demonstration plot at Mlezu Agricultural College – by 1 June 2015 (INSTITUTION LEVEL)	1.1) Mlezu Agricultural College representative(s) to liaise with college community (lecturers, trainers and extension workers) and researcher-interventionist 1.2) Workshop chairperson to coordinate with the NGO Muonde, Mlezu College and researcher-interventionist 1.3) Muonde NGO to mobilise its field team in Mazvihwa for Mlezu College work
2) Market existing small grains accumulating in farmers' storage granaries (FARMER PRODUCERS LEVEL) i) Farmers to produce quotations ii) Researcher-interventionist to support with any complex communications / linkages needed.	2.1) A team was identified made up of local marketing chairperson, emerging farmer innovator (FZ3) and SME representative 2.2) At least three possible buyers identified to be approached; Murowa Diamond Mine in Mazvihwa (Rio Tinto Pvt Ltd Company), an NGO in Harare promoting small grains among farmers and Mlezu Agricultural College. Researcher-interventionist to support professional production of quotations by farmers.

3) Continue networking meetings for this learning network focussed on specific action themes: (NETWORK LEVEL) i) Marketing training (to be led by SME coordinator) by 22 June 2015 ii) Record keeping, value addition, pricing iii) Communication information system	3.1) A Youth representative was tasked to coordinate communications for meetings
4) Support Phiri legacy rainwater harvesting school at Phiri homestead (FARMER DEMONSTRATION PLOT LEVEL) – medium to long-term i) Conduct some research ii) Develop conceptual and physical design inspired by Phiri family iii) Action 1) above identified as extension of this concept	4.1) Youth and SME representatives volunteered to lead process.
5) Engage with Environmental Management Agency (EMA) and Zimbabwe Farmers Union (ZFU) on soil and water conservation concerns (POLICY LEVEL) – medium to long term	4.2) Communications coordinator to draft a letter of invitation.

The priority action areas in Table 7.4 above were spread across sites that covered all the agricultural actors and layered from key multiplier individual to network and policy levels.

In this study I followed the object's evolution at Mlezu and Rio Tinto Agricultural Colleges (action 1) as is reported in the sections further below, and in the closely linked tool-object identity shift of marketing small grain produce (action 2). Both are shaded in grey in Table 7.4 and marked by blue (top) and olive green oval shapes [the latter has round dots outline, at the bottom] in Plate 7.8 (right). The other dimensions of the model in Figure 7.8 / Table 7.4 were pursuing new markets of small grain and horticulture products, supporting the setting up of a Phiri legacy RWH&C school at the Phiri homestead and continuing the sustainable agricultural water provisioning learning network. A team with a named team leader was set up to approach the Murowa Mine in Mazvihwa regarding possible purchase of small grains from local farmers in the same ward, to call an NGO operating in another province that was promoting small grain farming among small scale farmers, and provide quotations to agricultural colleges interested in buying small grains for seed and for consumption on student menus. Phone numbers were made available.

It can be seen that the boundary-crossing change laboratory workshop participants in the Zimbabwe learning network case created a model with three interrelated solutions. The first entailed the agricultural college taking leadership in the organisation of a rainwater harvesting assessment and implementation session at the college campus. This would be done with the technical support of two rainwater harvesting innovators from Mazvihwa communal lands (FZ2 and FZ4), an NGO Muonde and its farmers' team based and spread across Mazvihwa communal lands some 220km away from the college and the researcher-interventionist. It was resolved that college lecturers and students, farm staff, local farmers and extension officers would be involved. The logistical challenges were noted and a tight coordination protocol agreed upon. The assessment would help to identify a feasible site that would include catchment and slope, proximity to cropping land (to include a small-grain demonstration plot) and soil tests for water holding capacity. Secondly, a reciprocal site would be identified and used to implement a contextually relevant rainwater harvesting solution at one of the local farmers' crop fields in the college's surrounding community. At least one willing farmer had already been identified by a team of college lecturers, extension officers and farmer leaders as will be seen in the Mlezu Agricultural College boundary-crossing discussion below (DLNZM1, April 22, 2016). Thirdly, a task team was established to contact at least three possible markets (Rio Tinto's mine in Murowa Ward (Mazvihwa), agricultural colleges and a development NGO) for at least five tonnes of small grains (DLNZ3, April 23, 2016). that had been accumulating in farmers' storage granaries for over two years.

In February 2016, one of the small grain farmers with a two-tonne grain store reported a positive outcome of implementation of the model from the boundary-crossing change laboratory workshop. Most of his grain had been bought by the local Murowa diamond mine (now under Rio Zimbabwe Pvt Ltd) to provide seed for the local people as a corporate social responsibility to food security in this dry land, and by another buyer from the capital Harare as shown in the two excerpts below.

> *Excerpt 7.17 (Interview #FZ2b, February 19, 2016).*
> ***FZ2:*** *Rio Zim (Pvt) Ltd eventually bought a lot of my grain, one tonne*. ... They bought seed at a very late time, because many people did not go back to plant. People were just given as seed. Once a person received the seed they would simply say God is good, and go to process it for food.
> ***R1:*** … I was asking the Murowa Mine Community Liaison Officer about their source of food for feeding their workers ... pointing him to the local source of small grains ...
> ***FZ2:*** I think they have changed now because they are now saying they even want to buy rapoko from local farmers for their workers' meals.
>
> *Excerpt 7.18 (Interview #FZ2b, February 19, 2016).*
> ***R1:*** That is good. This is really motivating indeed. Isn't it that it was now two years with no one buying your accumulating grain? Three years?
> ***FZ2:*** Absolutely. So *the first to buy was someone from Harare*.
> ***R1:*** OK. Who from Harare?
> ***FZ2:*** Somebody who sells cooked meals. The person did not come ... just sent a truck.

R1: OK. So how much did that person buy?
Small grain and RWH&C farmer innovator: A tonne.

Both excerpts above show it is possible to find and create markets for locally-adaptive seed via networked boundary-crossing social learning actions. The first excerpt reveals a contradiction of individual corporate motive acting without the benefit of networked formative intervention[28]. The saviour approach of the mining company did not achieve its intended objective but this can be corrected through multivoiced dialogue.

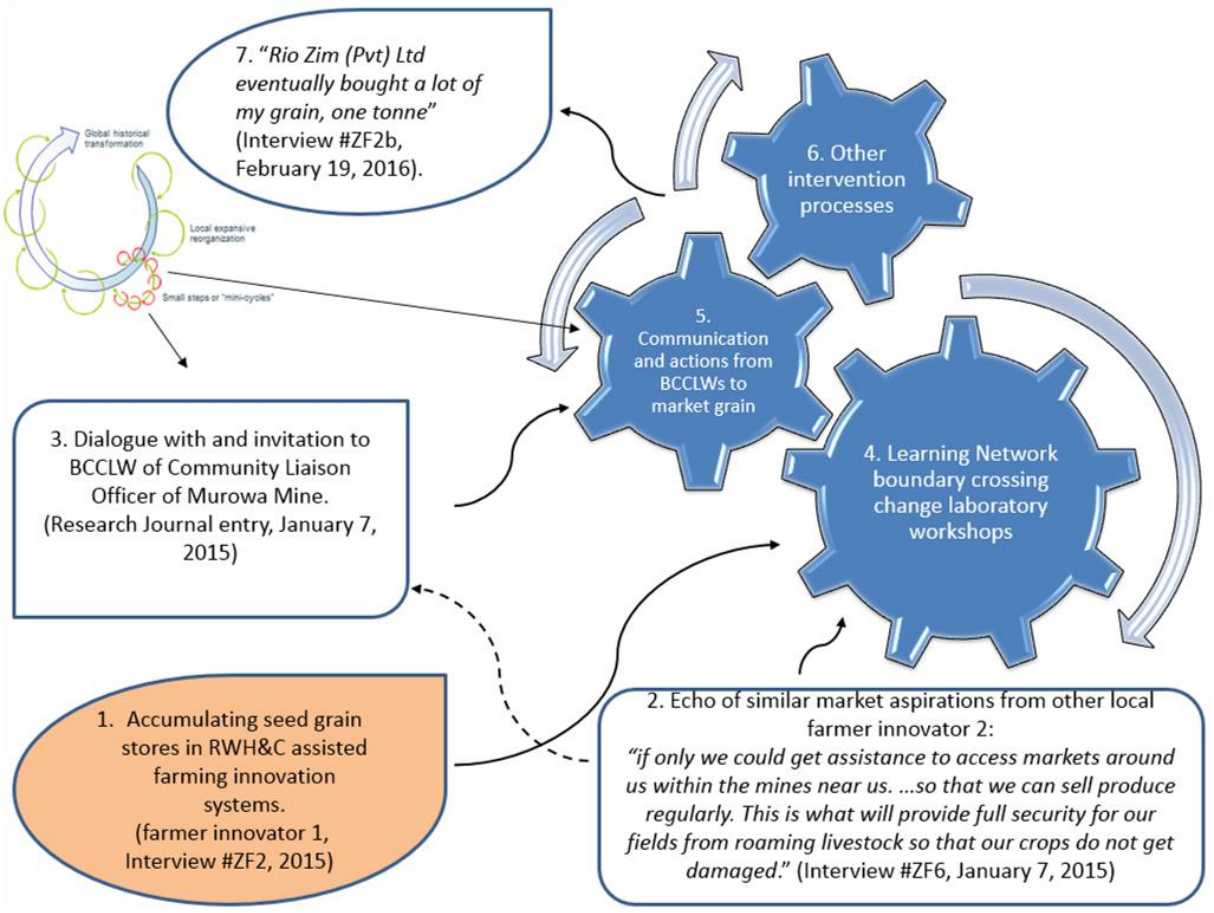


Figure 7.11: *Trail of developmental actions leading to expansion of the object towards market capture for climate-adapted seed grain produce in the Zimbabwean case study*

Figure 7.11 shows the emergence of a realised solution (#7) out of the BCCLWs from the problem (#1), to clarification and magnification of the problem (#2), engagement with a local mine representative for boundary-crossing participation on potential market (#3), deliberation in BCCLWs (#4), 'mini-cycles' (#3 and #5) and other external interventions (#6).

[28] A local mining company did not attend the BCCLW as previously planned to be part of the solution modelling (see Figure 7.2).

The excerpts above show the power of the boundary-crossing change laboratory in generating and examining models for successful implementation. Attribution however is distributed, for example, with the Murowa Diamond Mine a change in management as the company transformed from Rio Tinto to Rio Zimbabwe also came with the agency to buy grain from the small-scale farmers. In the process discussed above, some shifting power relations can be observed. A big diamond company's exercise of power as saviour to farmers struggling with seed and food security was challenged by a small-scale farmer who knew better the technicalities and psychology of small grain farming.

> *Excerpt 7.19 (Interview #FZ2b, February 19, 2016)*
> ***FZ2:*** Instead of them saying Mr X (FZ2) this time we would like to buy seed for other farmers, those people *as soon as they received the seed bought from me they placed it on the grind to make meal*.
> ***R1:*** So they gave out seed before the rains?
> ***FZ2:*** It had rained *but people were facing hunger already*.
> ***R1:*** All right… how much were they giving each person?
> ***FZ2:*** About 6 kg, of which 6 kg of rapoko is far too much for planting. ... *I was even telling them this was a disadvantage*. With 6 kg a person can grind or send to the grinding meal... They were arguing that a person can still remain with 1 kg to plant after consuming 5kg. *I cautioned them that a person will not think that way. The other thing is that the signs in the weather were promising rain, leading people to think that their maize will mature*, saying "even if I eat the rapoko my maize crop will mature".

A key lesson from the above excerpt is that farmers often know themselves and each other better such that if the corporate world would like to assist through corporate social responsibility, it is worth investing in both a co-engaged multi-voiced dialogical process and material than just the latter. It echoes similar sentiments from the South African case study of 'nothing for us without us' (see Chapter 6). Corporate social investment here also means exercising enough humility and risk-sharing as due diligence in transferring leadership of the cropping exercise to the experienced farmers and extension officers trained to do the work. (The same lesson applies to command agriculture.) Further BCCLWs could explore the possible reframing of power relations between the resourced corporate donors, local level farmer expertise, extension workers and agricultural college personnel. My work with the learning network formative interventionists did not go that far in this study. Below I track the learning expansions at Mlezu and Rio Tinto Agricultural Colleges, starting with their exposure to farmer-led innovations as possibilities and stimuli for learning alternatives.

7.3.5 Boundary learning and boundary-crossing accumulating from the learning network

In order to understand the way the collective was active in supporting and scaffolding learning in the learning network, the ZPD as a symbolic space was found to be a useful aid to negotiate and travel 'the way up'. With so many diverse knowledges, all imperfect and some more sustainable than others, the ZPD provides tools to interpret the data for common trends across two dimensions such as a

continuum from silo work to greater collectivity (vertical axis) in the learning of sustainability and diversity of agricultural water (horizontal axis) as shown in Figure 7.12.

7.3.5.1 Boundary learning as collective co-engaged learning through the ZPD

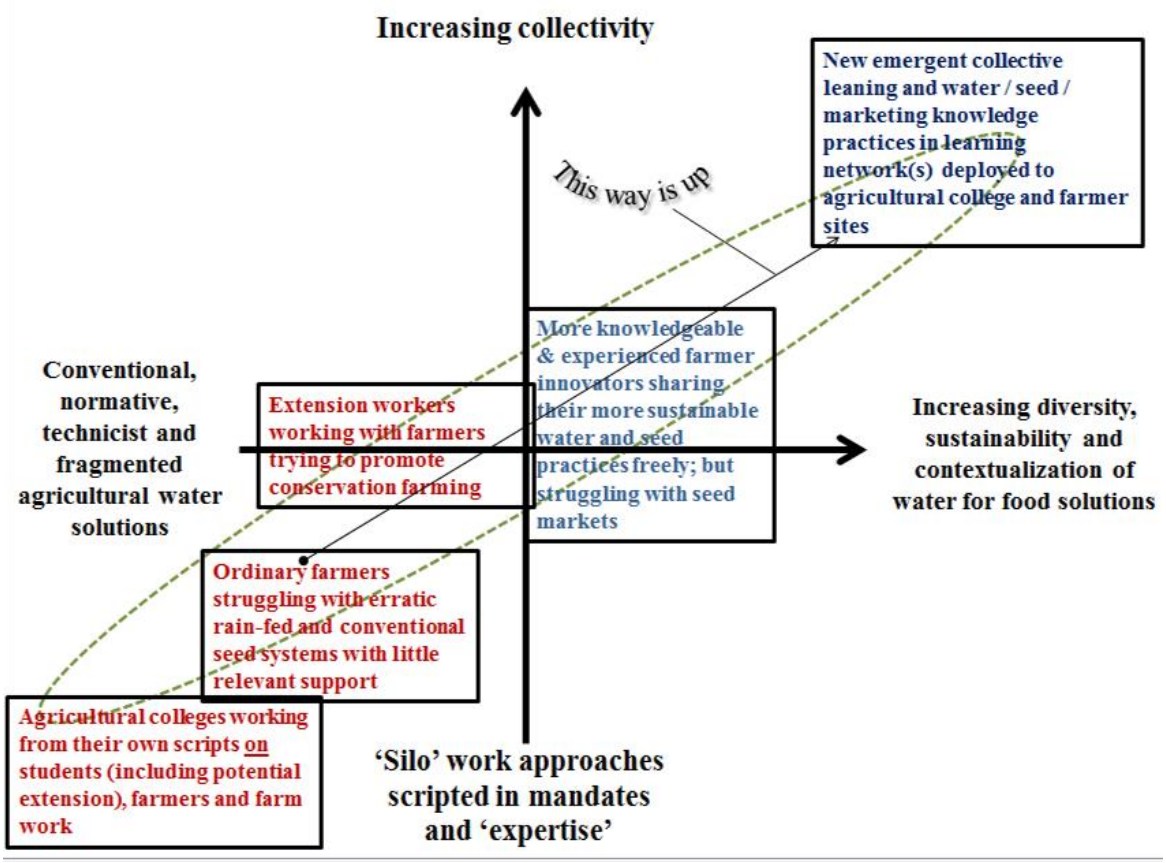


Figure 7.12: *Zone of Proximal Development for the collective of learning network members in the Zimbabwean case study*

From the data, the answer to the often elusive question 'which way is up?' (Engeström, 1990) appears to get an emerging answer judging with the model solution created. Though not a silver bullet, the solution addresses problems faced by members which they failed to address on their own for a long time, but that they started to find solace in through the empathetic relations with others. The movement from the lower left quadrant where all members are is marred with unsustainability defined by members as working alone using one's own institutional script that marked one's identities. The farmer innovators provided great leadership by showing empathy through *identifying with struggling farmers* waiting for the rain. At the same time, agricultural colleges showed empathy *by identifying with the farmer innovators* struggling with unbought grain produce by providing an opportunity for them to provide quotations for selling their grain by following the rules of a competitive and transparent government procurement system. In the process, they were fulfilling a need to move from a state of

growing and consuming grain that was non-adaptive to the erratic climate (and possibly colonising) to more climate-adaptive grain. The 'way up' is not definitive or undisputed. The models implemented need to undergo further reflection and analysis to facilitate continuous improvement. For the college, the suite of solutions for sustainable agricultural water provisioning is not definitive and final, but complements the conventional agricultural water methods that government, the sector and the discipline expects to see. Blending these can be a source of learning for sustainability.

7.3.5.2 Boundary-crossing mechanisms detected

As the formative intervention process was underway in the learning network, the following boundary-crossing mechanisms were detected (see Table 7.5).

Table 7.5: Boundary-crossing mechanisms (*) detected in the Zimbabwean learning network

Code:	Category	Key events or agentive moments
I	**IDENTIFICATION** - **othering** - **legitimating coexistence**	Identifying with: Farmer innovators and Muonde NGO pledged to support Mlezu Agricultural College's RWH&C demonstration plot; empathy regarding mechanisation to replace hard labour; *"… about the difficulty of digging contours I was trying* ***to get us to come to an agreement about how to do it better"*** (ACMZ1, DLNZ1, January 15, 2015) The citation above also shows leadership agency by college management.
R_{pm}	**REFLECTION - perspective making**	Criticising existing model: "If we look at *irrigation systems* … food production is going down due to *insufficient water supply*" (Agricultural College Lecturer, DLNZM1) *"*I gave the lecturers a few sorghum seeds to plant last season *and they did not. Now the maize crop we have is a failure due to the drought. Our water pump is not working"* (ACMZ2) "*Food production is going down* due to *insufficient water supply*" (Agricultural College Lecturer, DLNZM, April 22, 2016)
R_{pt}	**REFLECTION - perspective taking** - taking the perspective of the other	Governance and policy ("***it is politics that has blocked all these officers and leaders***" Farmer FZ1, DLNZ1) Empathy / identifying with the other (*"It is* ***true what she is saying*** *that it is a painful undertaking*", Farmer FZ2, DLNZ1); ""Agricultural College Lecturer, DLNZM1)
T	**TRANSFORMATION**	**Confrontation** with absence / problem towards seriously reconsidering their current practices and the interrelations:

		There was **real dialogue and collaboration** between "flesh-and-blood partners" at either side of the boundary: Dialogues throughout the BCCLWs show evidence of real collaboration at partnership level leading to implementation of model solutions.

*Coding for Boundary learning and crossing based on Akkerman and Bakker (2011) and Engeström et al. (1995) and for Types of Agency expression based on Engeström (2011) and Haapasaari et al., (2012)

7.4 BOUNDARY-CROSSING LEARNING AT MLEZU AGRICULTURAL COLLEGE THROUGH BCCLWs AND INTRAVENTIONS

As discussed earlier, Mlezu Agricultural College became a founding member of the sustainable agricultural water and adaptive seed learning network that connected their community of lecturers, students and surrounding farmers and extension workers in Chiundura (Gweru district side) and Moyo Range (Kwekwe district side) communal lands with other agricultural actors from Zvishavane and Mazvihwa. Two further boundary-crossing change laboratory workshops were planned but for Mlezu College, the execution of the second was modified due to logistical challenges. The boundary-crossing change laboratory workshop held at Mlezu Agricultural College on 22 April 2015 was attended by 10 people as follows: six college staff, two extension workers, one farmer and a researcher-interventionist, R1 (author) (DLNZM1a, April 22, 2016). It was held after two learning network workshops which fed into it and a day before the third learning network workshop which it fed into. The following excerpts and discussion illustrate the double stimulation that was used to mediate boundary-crossing learning. The first stimulus was based on the existing challenges with water security in the context of ailing irrigation applications in the agricultural college system in the wake of rainfall variability, as shown in the excerpts below:

Excerpt 7.20 (Transcript of BCCLW, DLNZM, April 22, 2016)
R1: ... What challenges are you facing with rainfall if any?
Farmer trainer: It is *erratic*.
ACMZ1: It is *not evenly distributed*.

Excerpt 7.21 (Transcript of BCCLW, DLNZM, April 22, 2016)

1. ***R1:*** I ... ask that we *focus on the current irrigation that you are doing here at Mlezu, ... any challenges with irrigation or everything is working ... smoothly*?
2. ***ACMZ1:*** Umm. (Shakes her head indicating that there are problems)
3. ***R1***: Madam Principal is complaining.
4. ***ACMZ1:*** *Yes we have many issues here. ...*
5. [Most participants laugh knowingly].

Excerpts 7.20 and 7.21 show how agricultural colleges were experiencing water scarcity issues similar to those of rainfed farmers thus laying ground for relating the double bind. An agricultural college lecturer representing a lecturers' focus group highlighted the current problem with the college irrigation systems and the need for sustainable agricultural water provisioning options.

> *Excerpt 7.22 (Transcript of BCCLW1, DLNZM, April 22, 2016)*
> ***Agricultural college lecturer:*** If we look at irrigation systems, some reasons for us to learn about water harvesting have to do with what we are seeing that *food production is going down due to insufficient water supply*.

Figure 7.13 below illustrates the problems faced by colleges regarding their reliance on now ageing and maintenance-heavy irrigation systems.

Figure 7.13: *Left: Prematurely wilting maize crop in an agricultural college farm; Right: Ageing, leaking irrigation infrastructure – typical of agricultural college systems in Zimbabwe*

In the BCCLW participants encountered and engaged with mirror data of the agricultural water problems (first stimulus), which built up towards a double-bind: ***dysfunctional irrigation systems versus curriculum demand for successful production despite climate stress*** (dialogue turns 2, 4 and 5, excerpt 7.17; and excerpt 7.18).

Examples of RWH&C innovations (stories, WRC articles and photos) together with 'rainwater harvesting' topics in the Primary School Agriculture syllabus and textbooks were used as a series of second stimuli. According to Vygotsky and Luria (1994),

> We do not limit ourselves to the usual method of offering the subject simple stimuli … to which we can expect a direct response; we simultaneously *offer a second series of stimuli which must play a functionally special role*, serving as a means by which the subject can organize his own behaviour. (p. 159, emphasis mine)

Figure 7.14: *Zimbabwe Primary School Agriculture Textbook with RWH&C topics (Sithole & Jeketera, 2013) that were shared with change laboratory workshop participants as a learning stimulus*

The presence of RWH&C in the primary school curriculum was used to show the agricultural colleges that leadership in RWH&C learning was probably more appropriate in agricultural colleges who were training both farmers and extension workers than in the primary schools. It helped to enhance participation and meaning-making in the learning of rainwater harvesting as alternative sustainable agricultural water as shown in the discussion below:

Excerpt 7.23 (Interview #AEWZ1, April 1, 2013)

> ***Agricultural extension worker, AEWZ1:*** Farmers are responding well to CA (conservation agriculture) because it is restoring their good harvests even when they have not ploughed. … So CA is being received very well by many people in the places where we are because *they are seeing that it is helping them to catch up with time as you can prepare a large tract in only one day instead of systematically ploughing the whole field*. … the little rainwater they have captured leads to earlier maturity of their crops.
> ***R1:*** Did you learn CA from your college training?
> ***AEWZ1:*** Yes, but then we did some workshops after leaving college but CA was mentioned during the college days. …it was still new in the system so it was not dealt with deeply. They just told us about it.

Excerpt 7.24 (Transcript of BCCLW1, DLNZM, April 22, 2016)

> ***Agronomy lecturer, ACLZ4:*** Question 1 asks "as lecturers, do you teach enough about alternative low cost agricultural water to help extension workers and ultimately farmers?" Answer: yes. … The reasons are that we are complying with the curriculum standards, i.e., the syllabus, covering such areas as conservation agriculture. … Then we teach various moisture conservation techniques, including early ploughing for our crops, tied ridging, even mulching. … There are also other crops such as small grains ... of which there is a growing promotion to grow these small grains that require very little water such as sorghum, pearl millet and rapoko. …

The excerpts above show model solutions that were developed in the BCCLW that integrate diverse methods of rainwater harvesting with conservation, mulching and locally-adaptive seed systems.

7.4.1 Boundary-crossing learning look-and-learn visit to Farmer innovator #3's homestead by Mlezu team: 23 April 2015

Participants in the boundary-crossing change laboratory workshops from the Kwekwe area in and around Mlezu College took the opportunity to visit small-scale farmer innovators who were successfully using rainwater harvesting innovations to enhance their production. The visits were inspirational to them as seen by the feedback that they later gave when they returned to their stations. Figures 7.15, 7.16 and 7.17 show some of the scenes from the learning visits.

Figure 7.15: *Left: Team from Mlezu (lecturers, farmer and extension worker); right: Rainwater harvesting tied ridges between raised beds bearing green beans surrounded by a tomato crop and banana planation (Photos by author, April 23, 2015)*

Figure 7.16: *Rainwater harvesting deep contours with water holding demarcations and rainwater harvesting surface tied ridges (Photos by author, April 23, 2015)*

Figure 7.17: *Farmer in rural Zvishavane explaining his water harvesting system to a farmer, agricultural college lecturer and extension officer from Mlezu Agricultural College and Kwekwe rural after BCCLW1 they had all attended (Photo by author, 23 April 2015)*

7.4.2 Implementation of rainwater harvesting at Mlezu Agricultural College

A second boundary-crossing change laboratory workshop planned for the 22 June 2015 could not be conducted due to logistical challenges experienced by the Mlezu field team that had gone to Mazvihwa to pick up a rainwater-harvesting innovator and NGO support team.

Mleazu Rainwater Harvesting demonstration site works and Change-lab workshop2 / p... (11) Peopl

Tich Pesanayi <tichpesanayi@yahoo.com> 06/18/15 at 4:33 PM

[redacted]nail.com

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Thanks for the phone discussion we just had.

I will be on standby for your update regarding the date (Monday and/or Tuesday] or Tuesday and/or Wednesday] I guess).

It appears to me that depending on time people are collected from Mazvihwa/Zvishavane and arrival at Mlezu, the activities may need to spread over a 2 day period (arrival, planning and surveying day 1; then implementation day 2), with people sleeping overnight.

Kind regards
Tichaona Pesanayi

Figure 7:18*: Email communication planning for Mlezu Agricultural College implementation*

The implementation plan discussed in section 7.3.4 was disrupted by delayed transportation of the NGO team from Mazvihwa, postponement of implementation date, illness of principal and exclusion of extension workers. The latter was a departure from what had been agreed earlier and from what the college management had desired. As a result, this last change laboratory could not take place as arranged and three days later lecturers, students and technical partners from the learning network began a process of implementing rainwater-harvesting contours. Unfortunately, the process took place also without the benefit of supervision since the hands-on Principal was unfortunately taken ill and with the researcher-interventionist could not make the new time. The support from an experienced farmer innovator and Muonde NGO that was pledged in a previous learning network BCCLW was honoured. While students and lecturers were involved, unfortunately local farmers, farmer training staff and extension officers were not involved in the practical work again due to the last minute logistical adjustments. Figure 7.19 below shows one of two deep contours implemented at Mlezu Agricultural College farm.

Figure 7.19: *Rainwater harvesting deep contour implemented in the college farm at Mlezu Agricultural College, with herbage accumulation around it (Photo by author, February 19, 2016)*

A post implementation assessment in April 2016 indicated that the area around the contour showed evidence of a higher density of herbage growth compared to adjacent areas nearby indicating that water capture by the contours had made a difference to the water table. The assessment also showed that the soils in the area may have had high porosity especially in the lower contour as shown by lack of water at the time; however it was a drought year and not much rain had fallen. The college staff proposed to

take further action to deal with possible high porosity by adding clay to the surface and by opening up other contours in other sections of the farm where soils were less porous. The college appeared to be going ahead with this intravention process; however, there was agreement among the staff that there would be inclusion of local farmers, extension officers and farmer training staff in the next phase of expansion of the water harvesting works, and thorough soil testing.

7.4.3 Historicity of agricultural water at Mlezu Agricultural College

Agricultural water at Mlezu College of Agriculture was initially planned to abstract irrigation water from Davies Dam which has been the case since the late 1950s. Conservation agriculture was introduced to the colleges system as an environmentally-sound response to the impact of agriculture on ecology and to boost water and soil management.

Table 7.6: Historicity of agricultural water at Mlezu Agricultural College (including general)

Pre-1980	[Irrigation invented in Egypt and Mesopotamia approx. 6000BC; popularised by green revolution 1930s-1960s]; [Conservation agriculture rises in USA in 1930 responding to dust bowls (Farooq & Siddique, 2015)] Mlezu College of Agriculture established in 1958 as a government owned institution Water Supply for College farm: *Davies Dam 680 000 m^3*. Basic climate: • Mean annual rainfall : 670mm/annum • Mean temperature : 18 - 22 C **Object W1: irrigation** (irrigation scheduling and efficiency) Object W2: Beginning of disrepair and struggling irrigation systems in agricultural colleges (2007/2008)
1980 - 2015	Advocacy of conservation agriculture by FAO *Conservation agriculture introduced as a course and implemented in demonstration plots in the college farm in 2011* "We really started teaching conservation agriculture from 2011 / 2012 in order for our students to learn it and take it to the community because we had observed the onset of erratic rainfall and early cut again" (Agricultural College Lecturer, DLNM1, April 22, 2016) **Object W3: irrigation and water conservation in conservation agriculture**
2015 - 2016	*Alternative sustainable agricultural water options and climate adapted OPV seed introduced to College Principals Councils (2010-2015)*
	Mlezu founding member of *sustainable agricultural water and small grains seed learning network* in 2015 – boundary-crossing change laboratory workshops introduced
	Rainwater harvesting deep contours implemented at Mlezu College farm, 2016 **Object W4: irrigation and rainwater harvesting and conservation**

7.4.4 Opportunities for further expansive learning

The formative intervention process involving the researcher interventionist at Mlezu College of Agriculture ended with the assessment of the first stage of implementation of RWH&C works. A lot of scope for further work had opened up including lecturers intending to extend the expansive learning process through their own further studies, including extension officers and workers in the contour development process, and improving on soil testing before implementation. The idea of introducing small grains into the students' diet and farm cropping systems could be considered together with establishing a seed bank of climate adaptive seed both as a genetic resource centre for the community and source of seed for the college's cropping from one season to the next and for exchange with other seed multipliers (e.g. of landraces and heirlooms) to continuously improve genetic diversity.

The boundary-crossing expansive learning processes at Mlezu Agricultural College can be attributed to a number of factors including leadership agency by the management, purpose in the need to find an alternative or supplement to the ailing irrigation infrastructure, and eagerness to learn from farmer innovators. The next section discusses the Rio Tinto College case study.

7.5 BOUNDARY-CROSSING LEARNING AT RIO TINTO AGRICULTURAL COLLEGE: BCCLWs AND INTRAVENTIONS

7.5.1 Boundary-crossing change laboratory workshops at Rio Tinto College of Agriculture

Three boundary-crossing change laboratory workshops were conducted with Rio Tinto (RioZim) College of Agriculture involving the principal, college lecturers, local farmers from the dryland and irrigation schemes, at least three extension workers and a rainwater harvesting innovator from Mazvhiwa representing the wider learning network. The workshops were held on 18-19 February 2016 and 11 and 12 August 2016. Figure 7.7 provides screen shots from a video taken from the first boundary-crossing change laboratory workshop at Rio Tinto Agricultural College that was facilitated by a rainwater harvesting farmer innovator and attended by lecturers, agrcultural extension workers and in-service diploma students.

Figure 7.20: *Left: First BCCLW chaired by College Principal (screenshot @ 10min 55sec); Right: Some of the paricipants (block release students DLNZR1, February 19, 2016)*

The following citation from a video shows how the farmer innovator (FZ2) stimulated discussion around the need to reclaim self-sufficiency and progressive culture in managing agricultural resources. decolonisation and the legacy of family and communal heritage.

> *Excerpt 7.25 (DLNZR1, February 19, 2016; Spool run 13min 02s to 16min 38s)*
> ***FZ2:*** *We must rely on our own things. Our survival, our livelihood, what we have and what surrounds us are what sustain us.* Yes you must go to classes but rely on the things you have, the things surrounding you and pay attention to what you eat. … because we agreed to change everything, even our own culture, and lost even our inheritance. … (addressing a lecturer:) How many cattle did your grandfather have?
> ***Lecturer:*** He had up to sixty.
> ***FZ2:*** And your father?
> ***Lecturer:*** My father had about eighty.
> ***FZ2:*** And your own?
> (Laughter fills the room)
> ***FZ2:*** He was never supposed to buy cattle. Did you ever buy?
> ***Lecturer:*** Yes I did…
> ***FZ2:*** Okay stop there. Your grandfather had fifty cattle. If we subtract say 20, your father's grandfather probably had 70, and his grandfather probably had 90. Cattle reproduce every year, so your father should have had 100 without buying. You shoud leave 1 000 for your children and if we factor grazing you should at least maintain your grandfather's numbers. We lost our culture. But this is what has happened to all of us. When colonisation came it started by changing us to be poor and wretched.

The sharing above brought in an element of the need for paying attention to culture and decolonisation of the mind in the curriculum and extension practices. This latter generated much dialogue regarding the effectiveness of organic farming and the ethics of genetically modified seed versus locally-adaptive seed (see excerpt below) showing the need for deeper engagement with wider generative mechanisms.

> *Excerpt 7.26 (DLNZR1, February 19, 2016)*
> ***Student 3:*** Which are some of the crops that you are growing organically i.e. without using fertilisers? ... How do you see it when we consider issues of labour or the way you work ... to get a good harvest? What challenge can you leave us as your children?
> ***Student 4:*** I would like to ask about GMOs. What is better to die now of hunger or to survive after eating GMOs?

The contributions above are from extension workers-cum-students on in-service training bringing voices directly questioning a suggested model solution from a practising farmer innovator, which in reality is questioning farmer innovator knowledge practice versus normative science on food security. The dialogue was useful in surfacing the contradictions aorund RWH&C and related or competing farming practices (e.g. organic farming versus fertilizers and soil water demand) leading the farmer innovator to propose more dialogue, a look and learn visit to learn about the situation on the ground together and to summarise the issues at stake:

> *Excerpt 7.27 (Video transcript, DLNZR1, February 19, 2016)*
> ***FZ2:*** My wish is to see your place, study it, *perhaps we can work together and agree to change it in a way we agree upon. We can do it together*. There are many farmers, owning farms, whom I have worked with … especially in areas of water harvesting and soil management. I can share with you more knowledge if time allows. Since I have arrived when time has gone, I trust the principal will provide another oportunity for me to return so that we can discuss more fully about a number of *issues including*
> *number one – seed, secondly – water harvesting, three – seed laws*
> .

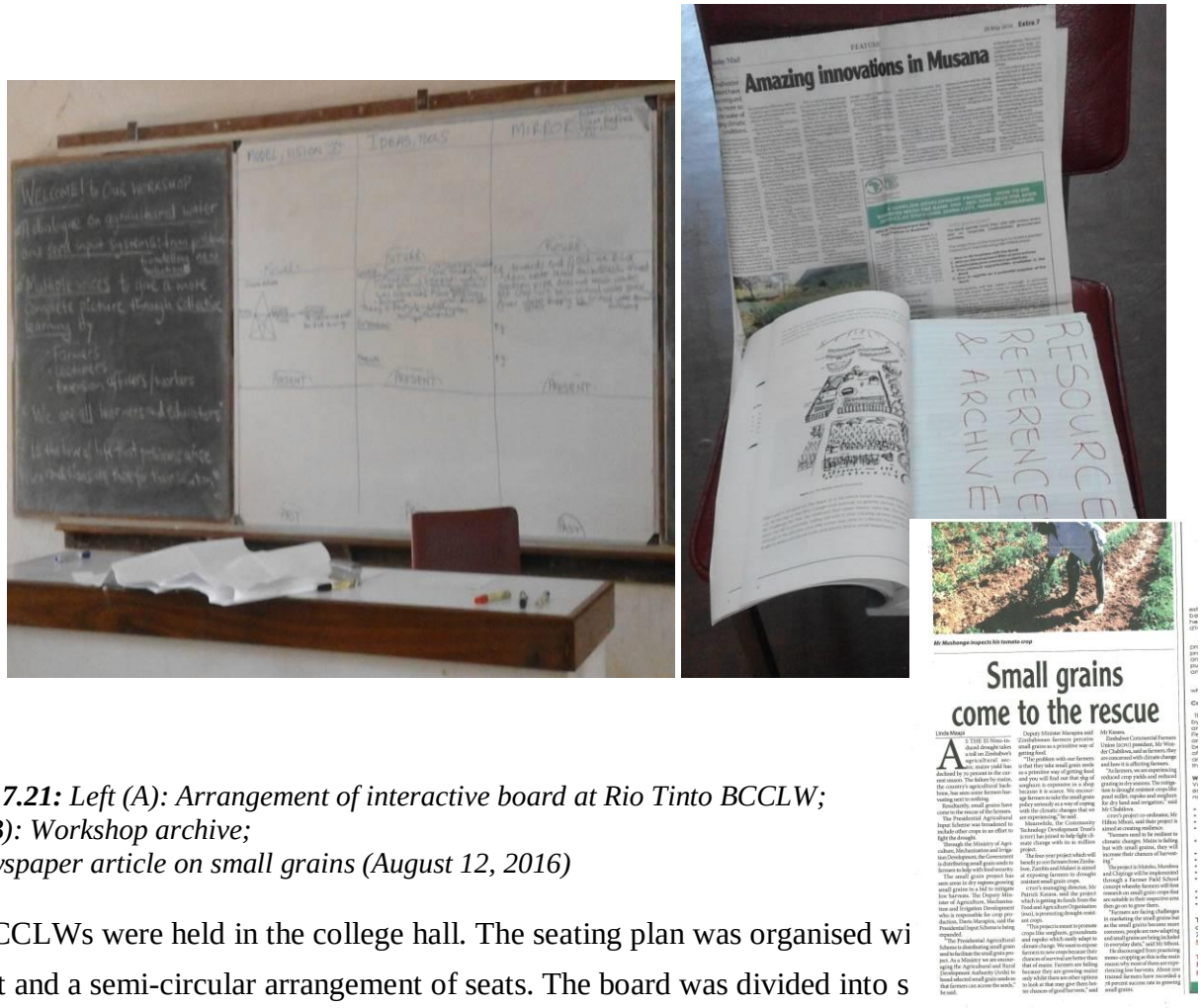

Figure 7.21: *Left (A): Arrangement of interactive board at Rio Tinto BCCLW; right (B): Workshop archive; (C) newspaper article on small grains (August 12, 2016)*

The BCCLWs were held in the college hall. The seating plan was organised wi in front and a semi-circular arrangement of seats. The board was divided into s model/vision, ideas/tools and temporal mirror for past, present and future. The session held with block

release students in February was challenging due to the big numbers of participants in the hall but was enriched with the diversity of inputs from their wide agricultural extension practice contexts. Three BCCLWs were held as shown in Table 7.1 (see section 7.3.1). The workshop archive contained reference materials including Water Research Commission books; recent newspaper cuttings on water, drought, small grains and farming; and agricultural college curricula some of which were used as second stimuli.

7.5.1.1 Historicity of sustainable agricultural water at Rio Tinto College of Agriculture

The history of the agricultural water object at Rio Tinto Agricultural College is generally similar to that at Mlezu Agricultural College shown in Table 7.6. The common issues include challenges of electricity outages to the irrigation system, crop stress and losses from inadequate water supply and experimentation with conservation agriculture. Rio Tinto Agricultural College's agricultural and drinking water is supplied by a pipeline from Ngondoma Dam about two kilometres west by a water pump powered from the national electricity grid. The agricultural water history was discussed and mapped on a board as shown in Figure 7.22 below.

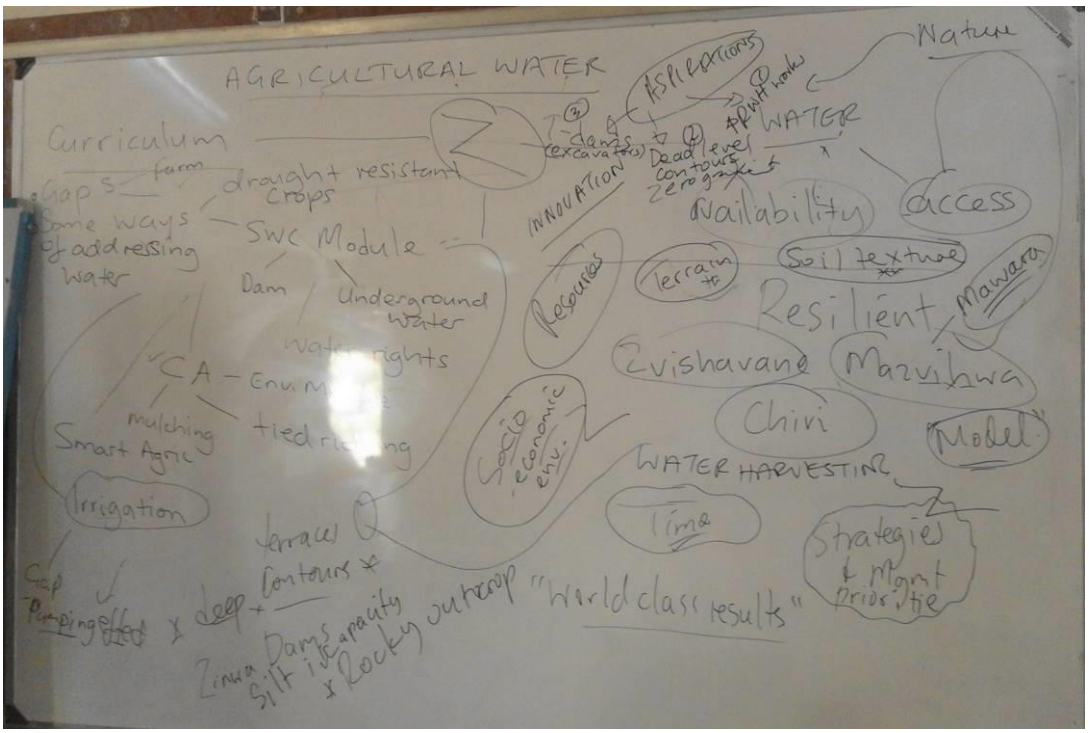

Figure 7.22: *Mapping of agricultural water history and water issues in the curriculum at Rio Tinto Agricultural College boundary-crossing change laboratory workshops*

Agricultural water issues in the historicity in Figure 7.22 include dam water use, dam siltation, water wastage from leaking taps and electricity outages affecting irrigation systems as shown below;

Excerpt 7.28: (DLNZR1, February 19, 2016)

Workshop chairperson (lecturer): Then we see here that there is another problem that was already written beforehand. Let me read it "towards end of October, we find dam water levels have fallen such that … (inaudible)". Wow I think the person who wrote this was really looking at our situation at this college. Please help me in case I may be failing to interpret. Maybe he means that in Ngondoma, I think we are all students here, we all know that *around October time our dam water level falls such that the pump which brings water to this side will not be able to convey water adequately, so as people on this side we suffer, and farmers like Mr X [FZ6] who also depend on this water will also suffer with us*.

Figure 7.23: *Irrigation water tap supplying a vegetable plot and a canal for flood irrigation*

7.5.1.2 Summary of contradictions emerging from the Zhombe learning network around Rio Tinto College of Agriculture

The following contradictions emerged in the Zhombe learning network affecting the agricultural college curriculum small-scale farming systems.

Quaternary contradiction #QCZ1:

College curriculum agricultural water object dominated by conventional irrigation <u>vs</u> Typical small-scale farmer's water object of rain-fed farming under natural water scarcity and climate change.

Quaternary contradiction #QCZ2:

Conventional crops (particularly maize) in college farm (college object) and rain-fed small-scale farming communities (farmers object) succumbing to drought vs Absence of drought-tolerant crops in the college curriculum and farmers' cropping systems (disappearing object of traditional farming and farmer innovators)

Quaternary contradiction #3: A relational problem showing absence of networked learning

> ***College working in an insular and silo approach based on mandate, conventional texts and agricultural science (mediating artefacts of college) vs Absence of co-engagement on farmers' lived experiences and contexts (farmer's object)***

The above contradiction was well articulated by a farmer who lamented the following;

Excerpt 7.29: (DLNZR1, February 19, 2016)

> ***Farmer FZ5:*** The College is not coming to the community to see the problems that we face so that they can teach that to the students such as water problems and seed. (Interview #FZ5, August 11, 2016)

The main quaternary contradictions that emerged from the BCCLWs are as shown above. They are all relational, showing the contradictions between small-scale farmers' work and the work of extension workers and agricultural college lecturers. The BCCLW formative intervention brought these contradictions to the fore for intense deliberations. It became clear from multi-voiced deliberations that there was no joint solution in sight with some lecturers blaming the macro economy. The discussions above highlighted the difficulty of arriving at solutions to alternative sustainable agricultural water as workshop participants moved from blaming the economy to finding comfort in the status quo. For example, the dominant voices among college lecturers felt they were already delivering well on their jobs under the difficult circumstances, while some students felt the situation was one of life and death where any solutions that would maintain survival (e.g. eating and therefore growing GM foods) would be acceptable.

7.5.1.3 Mediating co-engaged learning beyond contradictions towards new models

The mixture of conservative and agentive voices in the dialogues from the BCCLWs showed that there were strong positions held by those who felt nothing much could be changed internally due to the negative influence of an economic meltdown, and those who felt change was possible from within. The latter could easily have felt like theirs were dissenting voices when these were compared with the challenges faced. This impasse was mediated by provision of a second series of stimuli that included WRC materials showcasing rainwater harvesting innovations and newspaper cuttings showcasing locally-adaptive seed innovations by farmers in rain-fed farming contexts (see Figure 23 and appendix 7C). In the third BCCLW on 11 August 2016 participants were divided into two mixed groups to discuss model solutions that could address their reciprocal water problems (see Figure 24). The bottom part of Figure 7.24 shows the collated model solutions and how they were prioritised.

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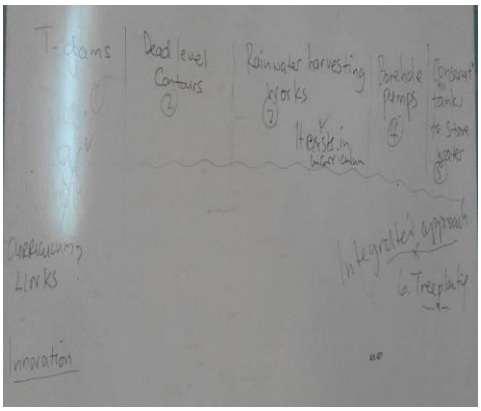

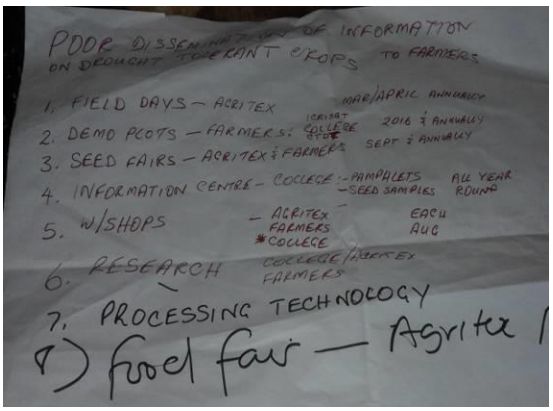

Figure 7.24: *Top: Group work during third BCCLW at Zhombe learning network; Bottom left: Proposed model solutions; bottom right: Prioritised model solutions (typed below)*

<u>Prioritised model actions from Zhombe East / Rio Tinto learning network</u>:

i. Conduct **field days on drought tolerant crops** in March / April annually (starting 2017) in the farming community and at Rio Tinto Agricultural College: Responsible: an AGRITEX nominee and a college nominee;

ii. Implement **productive demonstration plots in the community and at the college** in 2016 and thereafter annually. Responsible: Named farmers and named staff member at college working with ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) and CTDT (Community Technology Development Trust);

iii. Conduct **seed fairs at local community** in September 2016 and annually. Responsible: AGRITEX and named Farmers;

iv. Establish an **information centre at the College** (pamphlets, seed bank [viable samples] etc) all year round: Responsible persons at college and community;

v. Conduct **information dissemination workshops** involving AGRITEX, Farmers and College each August;

vi. Conduct **research and document / publish** (e.g. on food processing technologies; etc.): College, AGRITEX and farmers. Responsible person(s): (names to be advised).

vii. Conduct **Food fairs**. Responsible person(s): AGRITEX (name of officer provided)

viii. Integration of Rio Tinto College / Zhombe network into wider learning network.

Only a few of the prioritised solutions above were implemented during the course of this study but most fell beyond the scope of this study. The discussion below discusses the beginning of implementation of solutions at Rio Tinto Agricultural College.

7.5.2 Implementation of agricultural water solutions and continuous joint work at Rio Tinto College of Agriculture

Rio Tinto College of Agriculture implemented an RWH&C demonstration site between February and July 2016 (see Figure 7.24) following the BCCLWs, in the absence of the researcher. Students and lecturers participated in the internal learning and trial exercise.

Figure 7.25: *Deep contour constructed at Rio Tinto Agricultural College with student involvement – work in progress (Photo by author, August 12, 2016)*

Extension workers were invited but had other commitments during that time. It was agreed that if the RWH&C demonstration plot was successful, extension workers and small-scale farmers would be involved in the next boundary-crossing joint reflection and model development workshop for community demonstration plots in context, using the agricultural college demonstration site as a learning tool. The college management eventually contacted RWH&C innovator FZ2 to assist with modelling further college and community RWH&C solutions, showing continuous joint work taking place after the researcher's departure.

7.5.3 Boundary-crossing learning look-and-learn visits and small grains preliminary 'intraventions'

Rio Tinto College of Agriculture embarked on at least two sustainable agricultural water initiatives on their own following exposure to RWH&C innovations and locally-adaptive (small grain) seed systems at Principals Councils meetings, curriculum reviews and interviews with the researcher-interventionist. One was a series of look and learn visits to farmers innovators' plots in Zvishavane and another was provision of small grain seeds to lecturers by the college principal that the principal expected to translate into some productive rainwater harvesting and conservation and small grain demonstration plots and trials respectively. When this agentive action did not translate into transformative agency downstream it opened space for a different form of intervention that was formative via boundary-crossing change laboratory workshops. The discussion made in Chapter 5 showed that 'look and learn' and 'give and take' did not lead to expected transformative learning and agency when anticipated. The key lesson for boundary learning here is that there was leadership agency (see also section 7.4 above) in exposing staff and students to more sustainable agricultural water and seed alternatives.

7.6 SUMMARY OF BOUNDARY-CROSSING ACTIONS AND MECHANISMS

The Zimbabwean learning network experienced a number of boundary-crossing actions as shown by several boundary-crossing mechanisms at play. In section 7.3.5.2 a discussion was made of boundary-crossing mechanisms in the Zimbabwean learning network before the two colleges were considered. In this section, I summarise boundary-crossing actions and mechanisms emerging from the overall formative intervention processes.

7.6.1 Participants and organisations identified with each other's work contexts and problems with water

Table 7.5 provided examples of how participants identified with each other's contexts of work. Akkerman and Bakker (2011) perceived 'identification' when subjects redefined their complementary nature such as took place in the activity systems in this case study. What emerged was a process of '*identification with*' the other, a significant modification of identification. The shift from inward to outward perspectives was a move from the way agricultural learning activity systems were organised in a knowledge and market economy that valued types of knowledge privileging industrial and technicist farming while marginalising indigenous knowledge and farmer innovations. This master-slave type or power$_2$ relation was affirmed and reproduced when farmers came to colleges for trainings and meetings or when college lecturers and their students conducted community outreach. The agricultural colleges played the expert role while the farmers were mostly learners.

The farmer innovators' and NGOs' identification with colleges' contexts of work was cemented by a follow up of their pledges to support the agricultural colleges which was carried out at Mlezu and Rio Tinto agricultural colleges with their active participation (see sections 7.3.4 and 7.4.2). In the Rio Tinto College / Zhombe East learning network case, a farmer (FZ5, see section 7.5.2.2) clearly identified with the local agricultural college when he observed that the college curriculum would be more relevant if it incorporated farmers' water problems in the teaching of students, some of whom were eventually going to become extension workers. A similar suggestion was made by a farmer at the Zvishavane learning network who identified his innovations with the wider needs of farmers and colleges struggling with water for food (see section 7.3.3.2), thus demonstrating coexistence value.

7.6.2 Coordination between organisations and people

A new level of coordination emerged as boundary-crossing when agricultural colleges, farmer innovators and extension workers developed means and plans to exchange knowledge and cooperate on rainwater harvesting and conservation and locally-adaptive seed (see sections 7.3.4, 7.4 and 7.5), and to incorporate those who had not attended boundary-crossing change laboratory workshops (see sections 7.3.3 and 7.3.4). The coordination between an NGO and an Agricultural College was mediated by dialogical processes in the BCCLWs and enabled by a respected farmer innovator able to travel to the college site. In addition, all parties had committed to "negotiating and combining ingredients from different contexts to achieve hybrid situations" (Engeström, Engeström, & Kärkkäinen, 1995, p. 319).

7.6.3 Reflection through perspective making and perspective taking

There was much critical perspective taking and perspective making as participants in BCCLWs took stock of their own water for food situations in relation to those of others in mutual need or experiencing serious challenges (see sections 7.3.3, 7.4 and 7.5). Much evidence emerged of organisations and people coming to value another's perspective and actually take it up to consider and question their own practice. The excerpt below summarises both perspective taking ("but those people never fall into want of food as they always harvest enough. Even if it rains once") and perspective making ("these very good actions can provide us with water… we are faced with climate change") that transpired in the Zimbabwean learning network.

> *Excerpt 7.29 (DLNM1, April 22, 2016)*
> ***Workshop chairperson:*** *…. We were looking expecting two farmers* but we ended up only having one … perhaps they will arrive and catch up with us. … Maybe to clarify that we are discussing water harvesting possibilities, what we could do to be involved [gesturing with her hands in a circular form to demonstrate water harvesting], so that as farmers this can help us to get better harvests. My name is ... I am hosting you today as the principal at this college. I am very keen on water harvesting because I have actually seen people who are surviving from applying it … I am trying to say that water harvesting is very valuable to us. I went to visit … who is harvesting water. … And as you learn about it *you realise that Chivi is in natural region*

> *five, but those people never fall into want of food as they always harvest enough. Even if it rains once* … These are surprising things, but when they are explaining, you actually see that these are very good actions that can provide us with water… especially when we are faced with climate change as we no longer receive rains when we expect them. … So I am here to learn much from Mr Pesanayi…

7.6.4 Transformation of practices

The process of transformation as described by Akkerman and Bakker (2011) were rarer than the other four mechanisms described above, but elements of transformation clearly emerged from the formative intervention work. The beginning of transformation process appeared to be with the mechanisms of 'identifying with' each other's reciprocal or related problems of water for food production especially between agricultural colleges and water harvesting innovators. For agricultural colleges experiencing acute water problems, the realisation of successful farmer water innovations in rain-fed dryland areas provided 'aha' moments of something that they could learn from and do. What was most significant perhaps was the continuous joint work at the boundary that started off at the general learning network forum and continued with both Mlezu and Rio Tinto Colleges of Agriculture. According to Akkerman and Bakker (2011), such action "is required to preserve the productivity of boundary-crossing" (p. 149). Transformation is further discussed below (section 7.8) under analysis of changed practices. But before engaging in that discussion, a distinct fifth boundary-crossing mechanism appeared to emerge from the Zimbabwean learning network, that of co-engagement of diverse organisations in a learning network across multiple media and learning sites.

7.6.5 Co-engaged interaction in a learning network via multiple media and demonstration sites

This case study revealed an important boundary-crossing mechanism whereby a multiplicity of different organisations and individuals co-engaged with each other through the mediation of multiple media and demonstration sites. Learning networks in this case study provided a unique forum for a fourth generation type of activity interaction whereby multiple needs states were addressed at the same time through reciprocal problem situations and complementary knowledges (see sections 7.3, 7.4 and 7.5). The act of co-engagement rather than engagement emerged as a different way of relating whereby different knowledges, including decolonising knowledge-power$_2$ relations, were brought together not only to create blended knowledges but to seriously consider taking up previously marginalised knowledge practices (small grains and RWH&C) in transgressive ways (knowledge outside of conventional expert domain) connected with multiple benefits from climate change adaptation (cost effective, culturally-appropriate and productive).

7.7 ANALYSIS OF CHANGED PRACTICES AS A JOURNEY THROUGH THE ZPD IN THE ZIMBABWEAN LEARNING NETWORK CASE STUDY

The transformative learning and agency that took place in the Zimbabwean learning network can be illustrated by the movement through the zone of proximal development (see section 3.9.1.3). Changes were observed in the practices shown in Figure 7.26 and are discussed below.

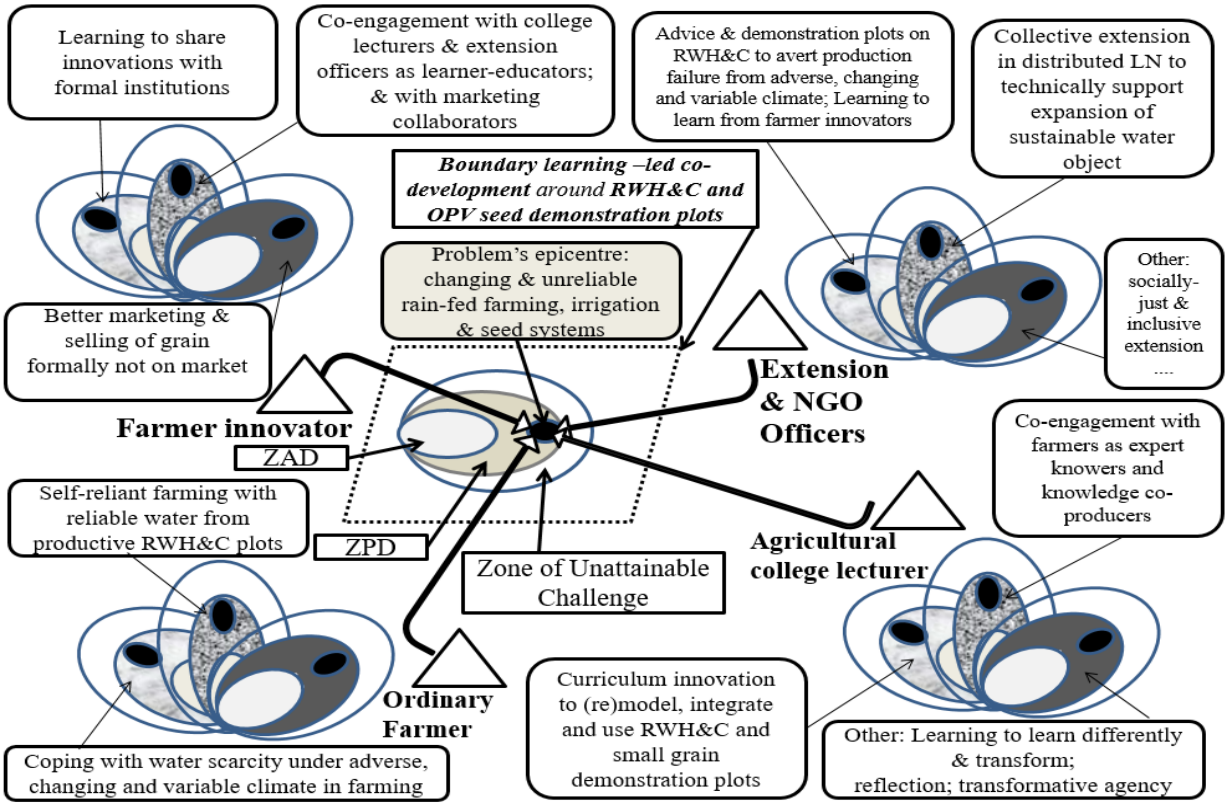

Figure 7.26: *Multi-dimensional ZPD showing developmental changes in practices in the Zimbabwean learning network (adapted from Zaretskii, 2016)*

7.7.1 Changes in relational learning practices and agency

The agricultural colleges developed readiness to accept and use new knowledge emerging from blending knowledge from small-scale farmer RWH&C innovators with formally accepted agricultural science thus exhibiting humility and relational agency. This was shown by their willingness to subordinate their expertise to that of farmer innovators, and negotiating knowledges in order to relate to and align their curriculum with small-scale farmers' rainfed contexts. The successes of rainwater harvesting innovations were thus adapted while the laborious drudgery associated with them was replaced by the machinery that colleges are endowed with or could access via partnerships. However, to cater for small-scale farmers who do not have machinery, the cultural working together was used successfully in the college and taken forward by extension workers. This readiness was not there

initially but developed through the boundary-crossing change laboratory workshops where farmers' adverse rain-fed contexts were shown to count very much especially as they mimicked those in the colleges under dysfunctional irrigation. The willingness to co-engage in a collaborative learning network was the starting point of manifesting the realisation of colleges' need to learn together with others. The co-engagement process itself clarified and enacted the learning with others and realised the mutual walk through the ZPD reflected broadly in Figure 7.12, and in more detail in Figure 7.26 above.

7.7.2 Catalytic reciprocal changes in college curricula and farmers' market opportunities

As this joint walk took place, the need for curriculum change became apparent leading to the development of productive demonstration plots in the colleges. These demonstration plots were productive rainwater harvesting plots (see sections 7.4.2 and 7.5.3), with plans for small grain demonstration trails in place by the time my part of the research ended. At the same time, the college realised the farmers' need for a market for their small grains and invited quotations since they also needed the grain (as seed and source of food) in order to live what they were now willing to preach. Engagement with a local mine yielded results more than six months later when farmers' grain stock piles were bought.

7.7.3 Change in reflexive learning practices

The agricultural college principals developed an understanding of the need to develop a new model for sustainable agricultural water in principals' councils and curriculum review workshops where boundary-crossing workshops were facilitated. These new learnings developed, clarified and amplified the line between their zones of actual and proximal development, thus developing awareness of when and where help was needed, in this case from conventionally unlikely places (in this case small-scale farmers). In addition, there was critical reflexivity in learning that was shaped by what appeared to be consistent improvement of colleges' modes of action regarding transforming and revolutionising their water and seed practices as seen in the examples of actions below. The taking of radical transformative action was noted in the changed practices in the colleges (outlined in section 7.7 above) where colleges started to change the type of demonstration practices used for students learning shown by this statement from a college principal "*The water harvesting contours we installed in this demonstration site have started doing wonders. The herbage around the area is much denser than in other areas. We need to harvest it for livestock feed, and then plant beans. We should extend this to the main college farm cropping area*" (ACMZ1, February 19, 2016). Changes in grain marketing opportunities were also noted among farmer innovators, one of whom said *"I have been able to sell most of my stored millet grain to RioZim Mining Corporation. They distributed it to farmers in our area so more people could*

plant the millet. Unfortunately because of drought almost all have eaten the grain" (FZ2, February 19, 2016).

Despite the above transformative agency actions and realised boundary-crossing actions, some unrealised plans and model solutions remained outstanding after the field studies as discussed in section 7.9.

7.8 SUMMARY OF TRANSFORMATIVE AGENCY EXPRESSIONS AND TRAILS IN THE ZIMBABWEAN LEARNING NETWORK CASE STUDY

The change laboratory processes led to transformations in the college curricula, as well as in farmers' practices as shown by these transformative agency expressions reflecting boundary-crossing, based on Haapasaari et al. (2012);

Resistance to the idea of bringing in small grains and rainwater harvesting at college level where there is perception of a policy support and in a resource-deficient economy was found in discourses of agricultural college lecturers: *"It is very difficult to introduce small grains and water harvesting in the curriculum without policy support from the management (of Agricultural Education Department). All this needs funding. Right now our engine for the water pump is not working so we cannot even use the dam water for irrigation.*" Resistance was also found in college lecturers' practices, as stated by one agricultural college principal who said, *"I gave the lecturers a few sorghum seeds to plant last season and they did not. Now the maize crop we have is a failure due to the drought. Our water pump is not working."* (ACMZ2)

Explicating potential of rainwater harvesting practices became possible through field evidence as noted by this agricultural extension worker, *"Most of the time when you are studying from books it is very different from learning from things that are actually happening on the ground. ... So what I learnt is I found some of the farmers doing water harvesting to extend their growing season."* (AEWZ2, January 7, 2015)

Envisioning new possibilities, *especially the inclusion of* more diverse and sustainable agricultural water practices in agricultural colleges as shown by the discourse of this Senior Agricultural education official (DAEOZ1) in Zimbabwe: *"My change project will be to ... consider implementing water harvesting initiatives like that of Mr Phiri Maseko" and a college principal* (ACMZ1): "*Our college would like to introduce small grains to the students' menu. This way we will practise what we are preaching regarding their importance. If you can ask*

the farmer to give us a quotation for his millet we would be grateful. … We would also like him to come to demonstrate and peg rainwater harvesting deep contours to our team." [Aspirations to **reframe normative curriculum** practice].

Committing to actions: One of the agricultural college principals stated: "*We would like to introduce small grains to the students' diet. We also want to grow the grains in the farm to fight drought and counter the aging irrigation system and power cuts. Can you assist us to get a quotation for seed from the innovator in Mazvihwa [referring to Mr Mawara]*?" (ACMZ1) [Commitment to **reframe power relations** with innovative farmers]. Another agricultural college principal stated, "*Next season we are going to plant a big portion of small grains under water harvesting*" (ACMZ2).

7.9 UNFINISHED BUSINESS, OPPORTUNITIES AND RECOMMENDATION

The boundary-crossing change laboratory workshops for this study ended at both learning network level and at agricultural college level before all intended contradictions had been resolved, but with key plans for implementation of new model solutions in place. Key among the unfinished business were the testing of curriculum innovations on rainwater harvesting and conservation and locally-adaptive seed systems in the agricultural colleges, on the one hand, and consolidation of marketing opportunities and bargaining power for small-grain farmers and horticulture food producers, on the other. The opportunities for these exist through previous curriculum reviews that recognised the need to adopt small grain crops to a larger scale beyond their current treatment as 'minor' crops, the aspirations by principals to integrate small-grains in the students' diets and farmers' aspirations to improve their marketing. In addition, youths in the learning network had resolved to take a farmer innovator's vision to develop his innovation home centre to a national rainwater harvesting innovations school.

I recommend that formative intervention boundary-crossing change laboratory workshops be continued within the wider learning network that incorporated the small-scale farmers, the agricultural college lecturers, the extension workers and the agri-business and marketing promoters as a collective. This is because important model solutions have started to be formed (see section 7.5.2.3) that include new relations across these agricultural learning activity systems and new ways of replacing hard labour with simple affordable machinery for developing water harvesting.

7.10 CONCLUSION

Formative interventions in the Zimbabwean case study found that the agricultural learning activity systems were able to interact out of their normative scripts of 'experts' (agricultural college lecturers and extension) and 'learners' (smallholder farmers) through mediation. These formative intervention efforts included **boundary-crossing change laboratories,** interactive **meetings with senior government officials and college principals and collective learning encounters at productive demonstration sites** in the context of **learning networks.** (This has some parallels to the South African case study processes in Chapter 6). However, with the realisation of the realities of marginalised agro-ecological farming and climate constrained drought contexts that small-scale famers operate in, and the increasing dysfunctionality of technicist irrigation systems compromising agricultural education due to a depressed macro-economy, empathy developed from co-engaged mediated interactions between these agricultural practitioners in change laboratories within the learning network. This empathy led to boundary-crossing along the expansive learning cycle that saw changes in the culture of engagement (from engaging with to co-engaging together) and the establishment and use of productive demonstration sites for teaching led by college lecturers and often in liaison with farmers as co-facilitators. This empathy was expressed as a boundary-crossing mechanism of 'identifying with' the other among other mechanisms. The research outcomes associated with boundary-crossing in this chapter will be synthesised in Chapter 8 together with outcomes from Chapter 6.

CHAPTER 8
SYNTHESIS: STRENGTHENING POSSIBILITIES FOR MEDIATED BOUNDARY-CROSSING LEARNING

"What we need to develop is people, not things, and that people can only develop themselves" Nyerere (1968)

8.1 INTRODUCTION

This chapter synthesizes the research outcomes associated with mediated boundary-crossing expansive learning of sustainability practices in agricultural water and locally-adaptive seed across agricultural learning systems with defined agricultural actors. In both cases under study in this thesis, the latter were made up of agricultural college lecturers, smallholder farmers, agricultural extension workers, NGOs and local authority facilitators (such as LED agency specialists in the South African case study). The agricultural actors and their internal relational actions were conceptualised as activity systems in the CHAT tradition (see sections 1.6, 4.2 and 5.2). Boundary-crossing learning processes were enabled by carefully mediated deliberations between related activity systems in learning networks that emerged in the South African and Zimbabwean case studies (Chapters 6 and 7). **This study found that diverse combinations of change practice courses, change laboratories, productive demonstration sites, exchange visits and media engagements in the context of learning networks strengthened the possibility for boundary-crossing expansive learning and more inclusive knowledge flows across activity systems of agricultural college lecturers, smallholder farmers, agricultural extension workers, NGO and local economic development agency facilitators**. This was made possible

through engaging critically and co-constructively with an emergent common object that was initially abstract in the current context of modern agricultural system development, but present in cultural historical knowledges and practices of smallholder farmers (sustainable agricultural water and locally adaptive seed systems). The 'abstract' nature of these practices became concretised via the above combined mediated processes in learning networks, which included a decolonising bringing of historical cultural knowledges of the practices to the surface. This process also involved placing smallholder farmers and their contextual knowledges at the centre of knowledge as empathetic and relational agencies emerged and grew especially among agricultural college educators as discussed in the next section.

8.2 DIVERSE COMBINATIONS OF FORMATIVE INTERVENTIONS STRENGTHENED THE POSSIBILITY FOR BOUNDARY-CROSSING ACROSS AGRICULTURAL LEARNING ACTIVITY SYSTEMS

It is clear from the analyses in Chapters 6 and 7 that five key formative intervention mediating mechanisms in diverse combinations namely learning network fora, change practice courses and collective learning, boundary-crossing change laboratories, productive demonstration sites and media engagements in the context of learning networks, strengthened the possibility for boundary-crossing expansive learning supported by formative interventionist, generative research in which I was engaged within this process as co-learner and mediator. This section will further analyse the role of these five generative formative intervention mediating mechanisms, how they mediated boundary-crossing expansive learning in different combinations and why they were able to mediate it. People learned together in different ways that suited their learning needs and through media and relational connections to which they had access. Different combinations of formative intervention mediating processes ensured greater reach, deeper engagement, sustained interest and expanded involvement of more numbers of diverse agricultural actors. I discuss these through claims which are supported by the rich, thick descriptions that I have provided across this thesis.

8.2.1 New learning networks formed in both the South African and Zimbabwean case studies provided generative boundary-crossing fora

There was no systematic learning oriented networking when the formative intervention research process started between agricultural actors whose work obviously impacted on each other. In the very early stages of the formative intervention research process, smallholder farmers, agricultural college lecturers and extension workers found it very natural to start interacting and coengaging regularly in

productive ways that became catalytic. The following claims may thus be made on the basis of evidence from Chapters 4 to 7.

Claim 1: ***Learning networks provided fora for deep, regular and extended interaction and mediated collective learning of agricultural water and locally adaptive seed among diverse agricultural actors leading to transformative boundary-crossing.***

New learning networks formed to bring together various agricultural actors from diverse occupations that were able to provide an environment for regular, mediated co-engaged interaction that resulted in new learning of agricultural water and locally adaptive seed solutions. This learning was enabled by recognition of the complementarity of problems faced primarily by rain-fed farmers in production under climate stress conditions, by agricultural colleges in diploma student and farmer training curricula and the development of empathy (sections 6.4. 6.5, 7.4.5 and 7.5). The fact that agricultural colleges also occasionally experienced agricultural water problems in South Africa and regularly did so in Zimbabwe, and that extension workers often found themselves unable to advise dryland farmers in useful ways, strengthened the negotiation and formation of two common boundary objects that enabled expansive learning (see sections 6.2.2 and 7.4.3). These boundary objects were agricultural water provisioning and locally-adaptive seed as ways of making water available for production and for adapting to climate variability and change respectively. The gap between the current knowledge practice states faced by farmers, agricultural college lecturers and extension workers and what they aspired to achieve was explained by the ZPD (see sections 6.3.1 and 7.8).

Smallholder farmers in both the South African and Zimbabwean case studies reflected on extension and political promises that irrigation solutions were their ideal saviour but from their experience turned out to be largely an unattainable one (see under ZPD in Chapters 6 and 7; DLNZM1, DLNZR1, AELZU2; FSA1, FSA11, DIBSAL1, DIBSAL2). The excerpt below from a university agriculture lecturer indicates the elusiveness of irrigation in Zimbabwe:

> *Excerpt 8.1 (Interview #AELZU2, June 26, 2015)*
> ***AELZU2:*** Zimbabwe has got a *limited number of water bodies* which are at the disposal of farmers ... Around 1980s the *government had made plans that they would build one dam per district per year* in order to augment the water supplies in the agricultural sector, right from the small scale to the large scale farmers but *that has been abandoned ... And it has worsened the water situation*. And right now we have got a few irrigation schemes that are running in Zimbabwe … *we are actually relying on rain-fed agriculture [pre]dominantly*. So *national output depends on the season*.

Excerpt 6.17 recognised similar problems that were discussed as boundary issues in section 6.4.1 in the South African case study. Using contradictions from smallholder farmers' dire rain-fed farming contexts as a reference point, the contradictions in the agricultural lecturers' activity system

(concretised as conceptual tools in historically established knowledge embedded in the curriculum versus their agricultural water object) were aggravated to a tertiary contradiction (see section 4.2) and quaternary contradiction in relation to the farmers (see section 6.3.1.1). This triggered reciprocal boundary-crossing learning of more sustainable agricultural water that was understood using the ZPD concept (see sections 6.3.1.2 and 7.4.5). In both the South African and Zimbabwean case studies the reciprocal ZPD was set as follows, with a few notable exceptions:

Table 8.1: Explaining co-engaged learning of sustainable agricultural water through the ZPD

<table>
<tr><th>Subject / activity system</th><th>Zone of Actual Development (ZAD)</th><th>Zone of Proximal Development (ZPD)</th><th>Zone of Unattainable Challenge</th></tr>
<tr><td>Smallholder farmers</td><td>Learning to struggle with rain-fed farming under increasing drought; gelesha / kuvundukura (both country case studies)</td><td rowspan="6">Mutually understood, emergent and contextually-relevant practices and ways of learning sustainable agricultural water
[expanding boundaries of ZPD: e.g. self-reliant farming with more reliable water; Curriculum innovation to integrate and use RWH&C productive demonstration plots; socially-just and inclusive extension within learning network contexts, climate smart agriculture]

No-tillage, conservation farming,
gelesha, roof water harvesting, mulching, deep contours</td><td>Access to conventional irrigation (technical, economic - both country case studies)

Seed and cropping systems controlled by seed cooperations via demand-supply with support of government</td></tr>
<tr><td>Smallholder farmer innovators</td><td>Learning to maintain RWH&C innovations and to share with peers and extension (Zimbabwe case study only); learning to adapt through, advocate for and protect local OPV seed systems (both country case studies)</td><td>Nil</td></tr>
<tr><td>Agricultural College Lecturers</td><td>Learning of conventional irrigation, soil and water conservation and mulching (both country case studies), conservation farming (experimental, Zimbabwe agricultural colleges)</td><td>Nil</td></tr>
<tr><td>Extension Officers</td><td>Learning to support few selected farmers (via Siyazondla garden programme with rooftop RWH and tanks in South African case; and via RWH&C innovations in Zimbabwean case)</td><td>Directly supporting learning of locally adaptive seed systems that are not genetically modified (policy / mandate script - in South African case only)</td></tr>
<tr><td>LED agricultural specialists (in South African case only)</td><td>Learning to support few selected farmers via Smallholder farmer development programme with rooftop RWH and tanks</td><td>Nil</td></tr>
<tr><td>Learning network -mediated WRC RWH&C materials</td><td>Learning together of a wide range of RWH&C practices (via course activation in South</td><td>Nil</td></tr>
</table>

	Africa, and via RWH&C innovations in Zimbabwe)		

Table 8.1 above synthesises discussions in Chapters 6 and 7 and reveals that the different agricultural actors start off at different levels (zones of actual development) that are not necessarily inferior compared to each other but have reciprocal boundary learning potential. This boundary learning potential was underpinned by new knowledge of sustainable agricultural water that all participants could attain as they worked and learnt together (zones of proximal development, ZPD). The ZPD above became the link that cemented the agricultural actors to learn together and sustain the learning network. The movement in the ZPD shown by the arrow in the table indicates that the ZPD was not an empty space but was occupied by what Engeström (2008a) called 'previous categories' (in this case no-tillage, conservation farming, *Gelesha*, roof water harvesting, cultural histories of seed saving) all of which got 'challenged' and transformed to facilitate emergent reciprocal boundary-crossing. This leads to the following claim (#2).

The learning network in the South African case study continued to function well after the formative intervention process, as described in sections 6.4.3.2 and 6.5.4 whereby the WhatsApp group continued to operate under participants' management, learning network meetings continued to take place and innovated into *ilima* activities (from 2016 to date), farmers' demonstration plots continued to be used by lecturers for teaching purposes (see sections 6.4.3.1; 6.5.4.1; 8.2.1); and radio shows have continued to be run by a team composed and led by the research participants to date. The Zimbabwean learning network has not been as vibrant due to lack of a strong meeting forum and WhatsApp group, however on the ground both Mlezu and Rio Tinto Agricultural Colleges have continued to engage with the farmer innovators introduced to them by the researcher for demonstration site model implementation. The DAEFT continues to monitor the sites closely.

Claim 2*: Through mediated co-engaged learning agricultural actors empathised and identified with each other's matters of concern towards agricultural water and locally adaptive seed leading to re-creating value of relational agency with farmers at the centre*

In the process of negotiating a joint enterprise of learning together different agricultural actors from the diverse activity systems started *identifying with* each other's matters of concern with regard to agricultural water and locally-adaptive seed (see sections 6.3.2, 6.4.3, 6.5.4, 7.2.2, 7.4.3 and 7.4.5). This identification with each other's matters of concern was possible due to mediated processes of co-engagement that included use of BCCLWs and productive demonstration sites in both the South African and Zimbabwean case studies, but also the use of a 'WhatsApp' group, radio shows and training of trainers' workshops in the former, and NGO technical support in the latter. The empathy and 'identification with' led to curriculum innovations, development of productive demonstration sites

by changing practice action teams made up of farmers, agricultural educators and extension workers in both South African and Zimbabwean case studies (see sections 6.4 and 7.5). The eDikeni WUA business plan and NEDA strategic plan discussed in section 6.4.1 bear testimony to this *identification with* the other. The resilience of mediated co-engaged learning and development of empathy in the South African case study is demonstrated in the WhatsApp chats that have continued from 2014 to date, with the following recent excerpt giving an example:

Excerpt 8.2 (IBLN WhatsApp chat history B, DIBSAW2, November-December 2017)
(December 6-7, 2017):

1) ***FSA10:*** Good day *team*. I am attending an S.A seed dialogue in JHB tomorrow hosted by African Centre for Biodiversity. There will be seed exchange and sharing. I will be speaking on Friday … more *on what we did in the Eastern Cape* to oppose the two Seed Bills. X, *I am going to share … your father's finger millet*. Would you mind?
2) ***R1:*** Wonderful. No problem mam Y, will send you details.
3) ***FSA10:*** Sure we have our seeds. …*Z with her Gastyeketye*😀[traditional OPV maize]
4) (December 11-16, 2017):
5) ***YFSA4:*** Afternoon *Team* [I am in] Dutywa [these farmers] are fetching water from the river but most of them are farmers, they are doing maize using rain water only.
6) [Posts photo of people drawing drinking water from an open dam used by livestock]
7) ***ZEPOSA*:** Eish bad news. So what are the people doing to mitigate this problem?
8) ***R3:*** It seems like *[as] a team will need to get together with the farmers to look at opportunities and develop a plan to improve the situation*. It won't solve everything but it must help. Who is keen to lead on this? It could become a key IBLN activity.
9) ***YFSA4:*** I think *it needs a team to do something*.
10) ***ACLSA2:*** *A lot can be done* to alleviate the challenge.

There is constant reference to the learning network as a team and team work in excerpt 8.2 (see dialogue turns 1, 5, 8 and 9), and sharing, learning and working together to model new solutions to problems (see dialogue turns 1, 7, 8-10). The multiple voices afforded by the learning network forums in both South African and Zimbabwean case studies enabled the identification with each other and the development of empathy in agricultural water and locally adaptive seed. Also water and seed science knowledge connected with otherwise marginalised and disappearing indigenous knowledge related to sustainable agricultural water and locally-adaptive seed systems. In the South African case study, the Xhosa culture of *gelesha* (soil ripping) was little known among the research participants with only two farmers who were using it claiming knowledge of it, despite it being well documented in WRC materials. The training of trainers' course in the South African learning network mediated the learning of this 'new' indigenous sustainable agricultural water knowledge by agricultural college lecturers that was absent from their curricula and that apparently made scientific sense to them when linked to the science knowledge dominating the curriculum (DIBSA1b, DIBSA2c, DIBSA3e). One lecturer reported linking *gelesha* with an ongoing college curriculum review (DIBSA3e). The power of *gelesha* that appealed to the lecturers was explained by a farmer using it as a "practice utilised so skilfully by

these homestead farmers... breaking the top soil so that rainwater can infiltrate deep easily" (DIBSA3c).

De Sousa Santos, Nunes and Meneses (2008) argued that the canon of knowledge is seriously biased towards Eurocentric distinctions at the expense of other ways of viewing and sharing the world resulting in social injustice. In this study based on the discussion above, there are deeper ways of making distinctions that privilege other knowledges at the expense of indigenous or alternative ways of knowing in agricultural college curricula with specific reference to water for food and seed systems. The training course mediation in the learning network of the South African case study provided relatively new knowledge to all participants in a way levelling the ground for epistemic precedence and access. This means that the RWH&C knowledge provided by WRC materials was not found in any appreciable detail in agricultural college curricula and was virtually absent from normal farmer and extension practice. These materials and the course mediation processes presented and mediated both indigenous and western scientific concepts on RWH&C as important and complementary. The indigenous knowledge practice of *gelesha* that some farmers explained from experience helped to strengthen its value among other farmers and especially among agricultural educators (DIBSA1b, August 12, 2014).

In the Zimbabwean case study, at least three champion RWH&C innovators shared their indigenous knowledge, as a viable, practical and real alternative, much like the farmers in the South African case study. The difference in the Zimbabwean case was that the farmer innovators were able to show and tell about their working practices on site, which had a profound effect on agricultural college lecturers and principals, leading the latter to identify immediately with the farmers' contexts due to their own dysfunctional agricultural water learning systems, and wanting to try out the innovations. The working RWH&C structures and the innovators' explanations provided an effective mediation tool (see sections 7.2, 7.4.3, 7.4.4, 7.4.5 and 7.5).

Nowotny (2003) agreed with the need to mobilise ecologies of knowledge rather than privileging one form such as science(s), which in any case is not uniform, homogeneous or agreeable in its propositions (Radaelli in Howa, 2011) as a way of ensuring boundary-crossing. Howa (2011) argued further for diverse knowledges uptake by policy processes as a 'democratization of expertise' as follows,

> The use of scientific knowledge as a resource for policy makers has a long history … a common and unchallenged concept of scientific knowledge existed in which that knowledge was considered dependable and objective truth. ... scientific "experts" advised policy makers … and subsequently lending policy makers that legitimacy for their expertly-advised policies. Thus, there was no perceived need, no call for, and no participation in this process by citizens, or "lay persons". (ibid., p. 2)

Nowotny (2003) observed that from the mid-20th century the concept of scientific expert changed with the emergence of grassroots movements challenging the status quo. The power of such movements was witnessed in this study through co-engaged interactions in learning networks.

As the activity systems interacted in the learning network, agricultural college lecturers' conceptions of sustainability of agricultural water were challenged by farmers' real contexts of struggle with water scarcity. Agricultural college and university lecturers realised the human element of the impact of drought and dryland farming in rain-fed farming systems as farmers related their crop and livestock losses and their uncertainties in depending on increasingly unpredictable rainfall (DIBSA1b, DIBSA2c; DLNZ1, DLNZ1a). They also realised the material element of the impact of drought when their own irrigation systems failed as explained below. This was a process of learning to learn new emergent categories and to unlearn previous historically established categories that were no longer working. This is also where boundary-crossing took place through learning to transform categories as explained in Chapters 6 and 7. The boundary-crossing learning of sustainable agricultural water and locally adaptive seed systems was a transgressive process challenging normative scripts that for farmers was triggered by periodic drought and prevailing semi-arid conditions affecting their food production. This uptake process can be explained by absence of conceptual and material tools and artefacts and constraining rules in participants' work as revealed by farmers' work, agricultural college curricula and extension advice. When these absences were challenged by drought, natural water scarcity and crop failure in relational spaces provided by the learning networks, they triggered a chain of actions that led to reflexivity and implementation of new sustainable agricultural water practices as shown by a new curriculum and farmer activity. It can be deduced that boundary-crossing expansive learning took place when agricultural educators *understood* the real socio-ecological challenges faced by farmers in water scarce situations, *they empathised with them, reflected on the relevance of their curricula, and started learning curriculum innovation to address the challenges.*

Understanding of the other's context through boundary-crossing interactions was an issue of relationality as agricultural educators identified with each other's matters of concern. Agricultural college lecturers in particular empathised with the learning activity system of agricultural water and seed activity struggles of smallholder farmers in both country cases (DIBSA1b; DLNZR1, DLNZR2). It appears such empathy could not be possible without re-imagining new human activity of capturing, accessing and delivering water to crops, and carefully choosing the type of seed to plant that addressed cultural, economic, environmental and social needs and contexts of farmers. Lecturers in both South African and Zimbabwean case studies described how they experienced rainwater potential by walking purposefully in the rain with an umbrella examining possibilities modelled in change laboratory

workshops and using the experience to implement contextually relevant solutions (DAfFS2, DIBSA1b, DIBSA4a; DLNZ1b).

In the South African case study, the three participating agricultural college lecturers showed remarkable humility as they shifted from a normative attitude of expert to that of co-learners as they encountered farmers that were knowledgeable about and practising successful food sovereignty and were advocating for agro-ecology as 'seed guardians' (DIBSA9a; DIBSAM1). Below is an excerpt from an FET college agricultural lecturer.

> *Excerpt 8.4 (DIBSAM1, BCCLW1 in Matole Basin, May 27, 2016)*
> ***FET college agricultural lecturer:*** If you take some of our textbooks especially plant production, soil science ... you will find that *there are elements of agro-ecology perhaps as modules or incorporated in certain sections in the curriculum*. But what you do not yet find is that *these things are not really flagged out there as let's go agro-ecology...*

In addition the agricultural college lecturers were exposed to and empathised with the *obvious social injustice* that deliberately excluded OPV farmers from extension support for cropping. State-sponsored social injustice such as exclusive grant support of GM seed farming shows that dealing with 'presences' is as important as dealing with absences. The agro-ecological success of these farmers was backed by the success of the local economic development agency's smallholder farmer programme that was using a value chain receiving seed produced from a University of Fort Hare research programme that was seeking such a partner. Through boundary-crossing laboratory workshops the market created by the LED became available for a wider spectrum of smallholder farmers in the learning network, further enhancing the agricultural lecturers' empathy regarding locally adaptive seed systems. As a starting point, the partners agreed to establish a seed bank at the Fort Cox Agricultural College and to do seed trials for open pollinated seed production to inform curriculum innovation. This was a transgressive act for the college because of the dominance of industrial production in the curriculum that was reframed as they identified with the farmers and together confronted the relational evils embodied in both absences and presences. A new $power_1$ relation (agentive power) was thus formed in relation to the historicity of the existent $power_2$ relation, that had the potential to grow through community engagement and expanded curriculum innovation. This was expanded through the proposed introduction of what the Agriculture Head of Department referred to as "work integrated learning" (ACMSA2, personal communication, November, 24, 2016), and appeared as such in curriculum review documents (Fort Cox AFTI, 2017, second page [no page number]).

In the Zimbabwean case, when agricultural educators felt the real socio-ecological challenges of water scarcity from failing irrigation systems, they also reflected on the relevance of their curriculum practices. Combined with the exposure to climate change, OPV seed systems and pressure from the national Department of Agricultural Education and Farmer Training (DAEOZ2) agricultural college

principals sought to align their curricula with extension officers' knowledge practice requirements, farmers' needs and the integrity of their own mediation tools. This contributed to them seeking dialogues with farmers experienced in rainwater harvesting and OPV seed, and they started to change their agricultural water, seed systems and student feeding practices (boarding menu) to reflect the new emergent water and cropping activities jointly modelled with farmers and extension workers. The following excerpt shows transformative agency in the agricultural college system stemming from their higher office that affects both curriculum and lived experience in locally adaptive seed systems.

> *Excerpt 8.5 (DAEOZ2, May 26, 2015)*
> ***DAEOZ2:*** And we recommended that there must be a *revision of our curriculum to put a bit of some emphasis on the potential that small grains have* in agriculture and also to look at beneficiation, processing and also *provision of small grains as a diet in colleges as part of their diet.* … And we agreed that they should come up with a module that incorporates all the recent knowledge which they (Department of Research and Seed Services) have…

In both the South African and Zimbabwean case studies, the experience of farming conditions in agricultural colleges that mimicked those of farmers, combined with extended interactions between college lectures, farmers and extension officers triggered curriculum innovation action in the agricultural colleges.

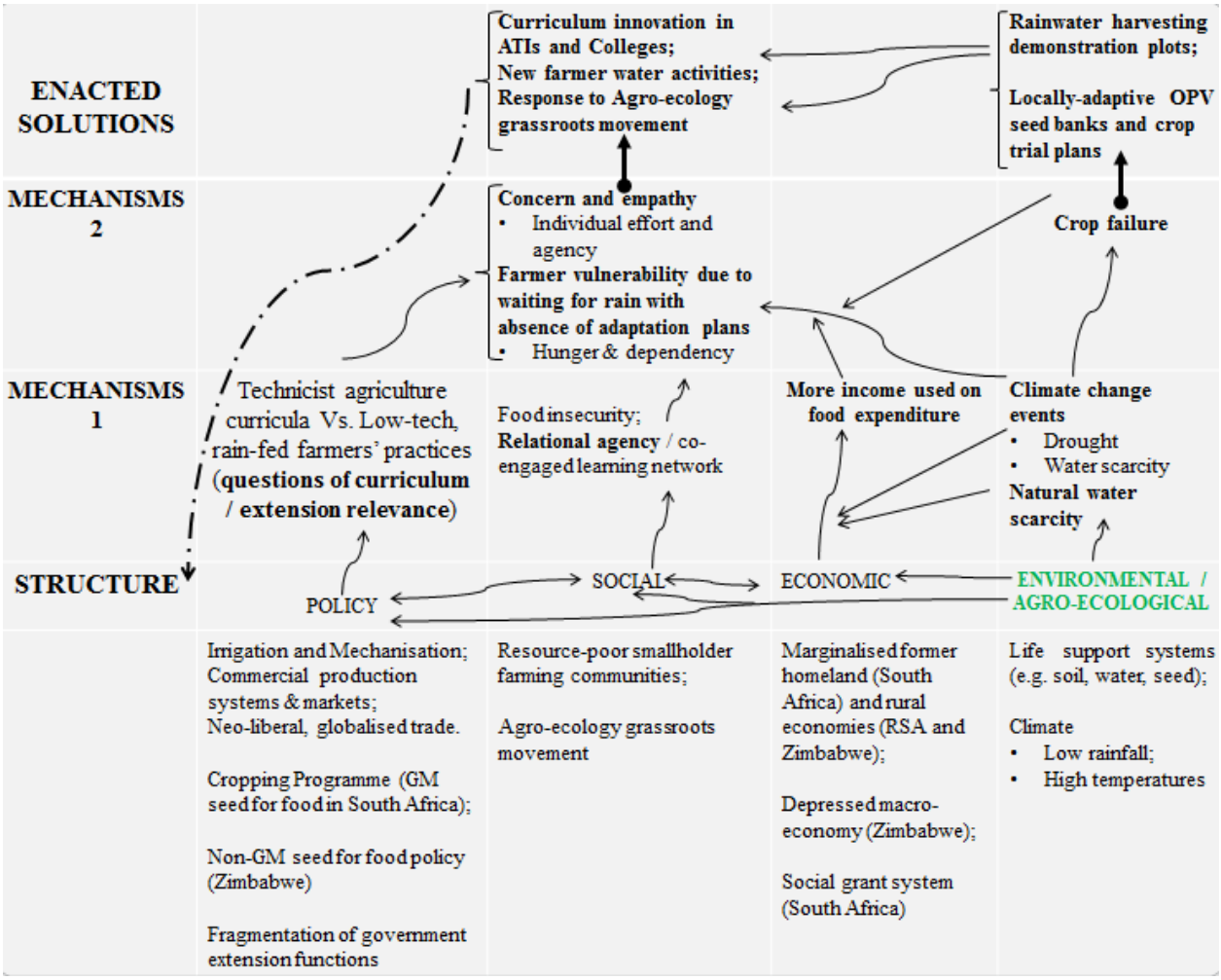

Figure 8.1: *Analysis of generative mechanisms for boundary-crossing expansive learning of sustainable agricultural water*

In Figure 8.1 the solid curved lines pointing upwards or sideways indicate causal mechanisms from one level of causality to another up to an effect or solution to a problem. The knobbed arrows show a process of absenting of absences in the production of solutions. Straight line arrows show synergistic generative mechanisms acting on the former mechanisms. The broken curved line shows feedback mechanisms from modelled solutions to their transformative impact on structures. For example, curriculum innovations in the South African and Zimbabwean case studies started transforming college management and their managing organisations to consider expansion within pilot colleges and across the colleges system. Funding organisations such as the WRC in South Africa have offered extended funding for a national level roll-out of expansive learning of sustainable agricultural water (Phase 2 of the Amanzi for Food programme, 2018-2021 which is now in progress).

In support of forums that build mutual understanding leading to transformation, Blackie (2016) argued for effective networking and collaboration between higher education institutions, farmers and significant others to enable needed innovations for sustainable agricultural development:

> The need for significant numbers of skilled change agents to work with African farmers in transforming the agricultural industries of the continent remains. … *The emphasis must be on doing and accomplishing, not just on training and learning*. …the *careful shepherding*, through *effective networking and collaborations*, of Africa's top talent … is an essential strategy. (pp. 2, 3)

What this important observation misses though is the valuable knowledge that farmers hold and bring to such collaborative networks especially where formal research and education institutions absent such contextually-relevant local knowledges. Blackie (ibid.) alluded to it when he recognised knowledge contributions by diverse agricultural actors:

> on the new approaches in agricultural thinking where universities are leaders in *a new innovation system to which all contribute knowledge* and which relies on the efficient transfer of information throughout the system in a non-hierarchical manner. (p. 3)

Blackie's citation also fails to include the importance of empathy as connecting generative mechanism (shown in Figure 8.1 at the level of 'Mechanisms 2'). The findings from this study reveal that when agricultural lecturers in agricultural training institutions empathise with farmers' contextually relevant problems to which their curricula contribute, boundary-crossing expansive learning takes place that potentially and actually leads to curriculum innovation and new farmer activities in sustainable agricultural water (DIBSA1b, DLNZ1b, DLNZM1; DEDD1). The availability of, and willingness to interact in co-engaged learning networks influenced uptake of emergent sustainable agricultural water and locally adaptive seed systems by farmers and agricultural educators, as shown below:~~,~~

> *Excerpt 8.6 (DIBSA4d, Assignment #3, July 7, 2015)*
> ***ACLSA2:*** In our interactions during the *previous meetings we attended together*, we developed the same understanding on the scarcity of water. We all agreed in our conversations that the knowledge of this nature (RWH&C) must be made available or transferred to the community through experimentation. *Such interactions made us work together towards attaining one goal and it therefore made our work easier*.

The learning networks in both South Africa and Zimbabwe stimulated the entry and participation of young people in co-engaged dialogues in the learning network where initially they were physically absent. In the South African case study, there were three types of youths who first participated: youths involved in their own farming operation, students in internships from Lovedale College and University of Fort Hare working at the local municipality's economic development agency or at Extension Services, and grandchildren under supervision and mentorship of their grandmothers who were members of the learning network. Later a group of youths also joined through invitation by a participating farmer innovator (a former nursing professional) with whom they later formed a cooperative.

Table 8.2: Youth participation in the learning network of the South African case study

Typology of participating youths	Characteristics and context of youths	Participation in learning network
Youth involved in own farming operation	Rare occurrence; contact made during an agricultural show; voluntary participation	Effective and authentic, but limited and short-lived due to busy faming schedule; 3 persons out of 30
Students in internships	Participated through temporary or permanent delegation over a fixed period	A learning exposé for those in temporary delegation; 3 persons out of 30 A life-changing learning experience for those in permanent delegation, but with limited organisational change; 2 persons out of 30
Grandchildren of participating farmers	Participated under supervision and mentorship of their grandmothers	Elements of legitimate peripheral participation; individual agency not determined yet; 2 persons out of 30
Youths in a farming cooperative under 'professional' mentor	Voluntary and self-driven participation	Effective and authentic, persistent development and contribution; 2 persons out of 30

From Table 8.2 it can be seen that the proportion of youth participation was relatively lower. It was influenced by ways of communication with and by the sample group, occurrence of youth in farming and youth attitudes to farming. However there were efforts facilitated by the learning network forum that mediated youth entry and participation and these included self-driven efforts through being present in farming activity known by other network members, delegation by seniors in workplaces, and through guided mentorship by senior family members. Further research on youth engagement over time is therefore needed in such learning networks and in the inter-generational agricultural learning system.

In all cases it can be seen that pioneers of the learning network who continued with the co-engaged learning expansions were serious farmers or professionals all of whom showed human capability for empathy in co-engaged learning interactions, humility and agentive powers of mobilisation ($power_1$). Lee (1960) portrayed a powerful illustration of such empathy for another whereby "you stand in his shoes and walk around in them" (p. 30).

Claim 3: Relational agency is central in co-engaged learning networks and can be generatively supported by a mix of interacting mediation processes building on the mechanism of empathy outlined above

As shown in Chapters 4 to 6 significant expansive learning and changes in practices and activity emerged via the boundary-crossing learning that was supportively mediated via the use of a changing practice course that helped to catalyse reflexion and co-operation in the learning network, boundary-crossing change laboratory workshops that brought multi-actors in the agricultural learning system

together, and communication tools such as WhatsApp and community radio. Chapter 7 demonstrated the same mediated expansive learning, but without the benefit of a course or community radio. Significant in the expansive learning was the co-engaged learning that emerged around the co-development of productive demonstration sites, developing into a recovery of *ilima* agricultural culture (working together) in the South African and Zimbabwean case studies (also called *humwe* in ChiShona, Zimbabwe). The co-development of the productive demonstration sites required relational agency from those in the learning network, which was evidenced in various practices such as the University of Fort Hare bringing technical machines (tractors) to assist the elderly women in Lloyd Village to dig furrows for run-off into the small ponds that were co-constructed by all parties in the IBLN to assist the elderly women; by students in the colleges co-operating with innovative farmers, and by NGOs co-operating with the agricultural colleges in the Zimbabwean case, and by farmers being willing to host college lecturers, extension staff and LED personnel on their plots to demonstrate practices, and to work together to co-construct new productive demonstration sites for collective learning (amongst others – see Chapters 6 and 7 for full details). Such relational agency was developed through mediation and use of double stimulation in the learning network as found also by Sannino & Engeström (2016). **Thus, this study has shown that it is a *mix of mediating processes, such as* changing practice courses, boundary-crossing change laboratories, productive demonstration sites and media engagements in the context of learning networks *constituted across activity systems* that have the potential to expand learning and sustainability practices in agricultural water and locally adaptive seed systems. This finding is significant as it shows that the agricultural learning system itself is complex, and more than one approach to mediating learning and change is necessary for expanding relational agency and power$_1$ (agentive power)[29] of actors along the agricultural value chain.**

The change practice course in the South African case study activated co-engaged learning among people connected together across activity systems in a learning network thus opening up unique and rare opportunities for learning new things together. The course responded to a need expressed by professionals and practitioners who had requested training in rainwater harvesting practices (DIBSA1a and b). It was therefore designed as training of trainers that incorporated rich and diverse voices of people from different educational, agricultural, cultural backgrounds, experiences and worldviews in the same room. Such a way of engaging people in transformative learning and change was not part of the WRC's strategy for disseminating RWH&C information in its published materials and may have caused some initial misunderstanding between the WRC's RDDA approach and the project implementation team's strategy that was later amicably resolved. Howeve,r it addressed both the

[29] Power$_1$ was conceptualized as emancipatory agency in section 3.7.7.1 with the potential to reframe power relations.

WRC's main deliverable of developing an action-oriented strategy for knowledge dissemination and an emergent, trans-disciplinary and cross-sectoral approach to learning boundary-crossing sustainable agricultural water that was not yet there. It was a new way of learning for all the agricultural actors in the four interacting activity systems in this study area. The change practice course using WRC materials (i.e. introducing new knowledge) that was of interest to participants in the learning network, in combination with boundary-crossing change laboratories enabled new ways of interacting where lecturers were not the only knowers of valid agricultural water knowledge but everyone shared their knowledge as they interacted with knowledge in WRC materials and their farming practice interests.

New relations were forged in the course-activated learning network between agricultural college lecturers, farmers, extension officers and local municipality officers that were learning-led, action-oriented for modelling and examining new solutions, joint experimentation and implementation of reciprocal emergent models of contextually relevant agricultural water practices. These relations were catalytic as they brought about new relations thus holding true the idea of the training of trainers approach and the 'course activated learning network'. One lecturer in South African case study described her new relations with farmers and extension officers in an action group as an expansion of learning through connections.

> *Excerpt 8.7 (DIBSA4e, July, 2015)*
> ***ACLSA3:*** *The combination of different stakeholders … has helped to connect our group with the extension officers* in Keiskammahoek. We were therefore sponsored with personnel and resources such as tape measures and the potato seeds. *The interaction* with the extension officers and farmers that *were not part of the network helped to market RWH&C techniques.*

The discourse in excerpt 8.7 above ("*combination of different stakeholders … helped to connect our group with the extension officers"*), section 8.23 ("the network gave me more friends", FSA3), section 6.3 and the discussion in section 6.4.3.1 (e.g. excerpt 6.25) have shown that relationality between research participants expanded between the beginning of formative intervention and when it ended formally in the South African case study. The expansion of the relationality and relational agency can be shown diagrammatically by comparing the learning network map in 2014 and that in 2017 as follows:

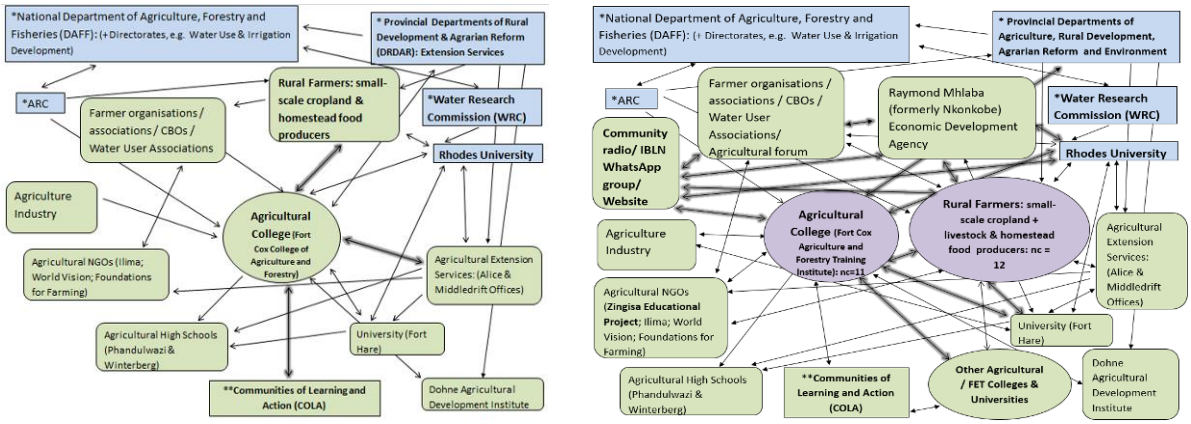

Figure 8.2: *Learning network maps showing expansion of relationality and relational agency from 2014 (left map) to 2017 (right map) due to formative intervention*

The map on the right shows two key differences from the one on the left, firstly the shifted position of the smallholder farmers from the periphery to the centre, and secondly, there are nodal connections between agricultural actors than before. In particular the agricultural college and smallholder farmers became more connected to other activity systems compared to any other showing that there was more relational agency and activity within and around them.

Curriculum innovation in agricultural colleges made possible by autonomy or decisive management agency and collective learning

One of the key boundary-crossing outcomes for agricultural colleges and ATIs was the implementation of curriculum innovation solutions. These served to both ensure curriculum relevance to the college graduates and farmers they become or serve, and to be responsive to own techno-climatic challenges. The following claim explains this finding.

Claim 4: Autonomy and the freedom to make independent decisions in a South African agricultural college and government department support for innovation in Zimbabwean agricultural colleges enabled agricultural colleges to innovate their curricula and pedagogy on agricultural water practices relevant to smallholder farmers' contexts.

As discussed in Chapters 1, 4 and 6, Fort Cox Agriculture and Forestry Training Institute (formerly College) in the South African case study entered into a memorandum of understanding with Rhodes University that entailed a collaborative agricultural water learning action agreement (see section 6.4.4). This dialogical approach led to decision making that enabled transformative pedagogy at lecturer level. This was enabled by the college's autonomy in being able to make decisions to commit to curriculum transformations in partnerships in learning network contexts.

In the Zimbabwean case study, Chapters 5 and 7 showed that there were management expectations and support to agricultural colleges from the parent Department of Agricultural Education and Farmer Training (see sections 7.2.1 and 8.2.1) to embark on measures to adapt to the agro-climatic stress threatening the curriculum. This provided leverage to agricultural college managers striving to motivate their staff (see ACMZ2 in sections 7.3.5.2 and 7.8), and enabled mediated boundary-crossing expansive learning processes (see Chapter 7).

In both cases, lecturers' volitional actions were critical in enabling them to be empathetic and humble enough to accept the role of co-learners with others (see sections 6.4.3 and 7.3.3). Freire (2005b) described this new role as "teacher-student" (p. 80) rather than "teacher-of-the-students" (ibid.) in relation to farmers (from perspective of farmer training in the college) and to their regular students. The farmers and students both emerged as "students-teachers" (ibid.).

8.2.2 Public extension function was improved by co-engaged learning within a learning network as collective extension transcending scripted boundaries

Claim 5: The collective extension function of agricultural advisors and extension officers in sustainable agricultural water and locally-adaptive seed was enabled and enhanced through new co-engagement within learning networks

As shown in Chapters 4 to 7, the learning network provided a forum for extension officers to be more proactive and responsive to the needs of farmers for improved agricultural water and locally-adaptive seed knowledge practices in both cases. Such support was virtually absent from ordinary extension functions in South Africa ("they wouldn't be concerns of the extension directorate", SAEMSA1, February 8, 2016). This helped to address extension limitations (see excerpts 4.7, section 4.2.1.1 and 4.20, excerpt 4.2.2.1) and criticisms from farmers (e.g. "the lack of involvement of the agricultural extension officers. … that Department of Agriculture it's lacking a lot in terms of motivation and technical support to the farmers. … there is no person to guide you", FSA1, September 3, 2014). In addition, extension officers in the South African case study were able to position themselves as collaborators to farmers and agricultural college lecturers in supporting farmers producing food from maize other than mandated by the government's Cropping Programme. Through dialogical deliberations and boundary-crossing expansive learning processes extension officers mobilised the productive demonstration site capabilities of agricultural college lecturers and famer innovators. This enabled the enactment of new extension advice on water for food to farmers facing water problems

and also in particular to Agroecology farmers previously seen as transgressing the flagship Cropping Programme.

The extension officers were also part of planning processes to lobby the Eastern Cape Provincial Department of Agriculture (DRDAR) by providing advice to a lobbying team from the learning network. “If you think of influencing the department, it should go straight to the provincial office, not Regional Director. ... The administrator – the head of the department”, (EOSA1, DIBSA9a, September 7, 2016): “he will be going there as the Imvotho Bubomi Learning Network, ... not carrying the cap of being the NEDA” (ibid.). In addition, the learning network model of co-engagement enabled farmers’ rain-fed contexts to be placed at the centre of knowledge co-generation and application (Kroma, 2003, see section 2.4.5; South Africa. DAFF, 2008a, ASSAf, 2017, see section 2.4.4.2; Blackie, 2016) as indicated by an agricultural college lecturer ACLSA3 “*the combination of different stakeholders ... has helped to connect our group with the extension officers... interaction* with ... farmers that *were not part of the network helped to market RWH&C techniques*” (DIBSA4e). This shows the enabling of knowledge flow between agricultural colleges and extension practitioners. A farmer interpreted this shift as follows, “*If I didn’t have that network then I wouldn’t know that there’s people like X (name of extension officer EOSA1 supplied).* … so the network gave me more friends” (FSA3, December 18, 2014). The learning network forum provided a non-threatening environment for extension officers who indicated a shift from simply adhering to the exclusive rules, like separating rugby from soccer rules (see excerpt 4.16, dialogue turn #6), to being flexible enough to acknowledge the power of traditional OPV seed and accept participation in experiments with locally-adaptive seed (see excerpt 6.9, dialogue turn #11).

In the Zimbabwean case study, it was clear that extension workers in areas where farmer innovators were operating (Mazvihwa and Zvishavane, see section 5.2.2) had the leverage and motivation to promote RWH&C due to its practical success but were limited by poor networking (see section 5.2.2 and excerpt 7.11 in section 7.3.3.1). However this role was enhanced for them and also for other extension workers in areas where agricultural colleges (Mlezu and Rio Tinto, see chapter 7) were co-engaging as a result of learning networks, thus making collective extension possible.

Collectively, the claims 1-5 above show the role of the learning network and associated mediation processes within a formative research intervention process in enabling transformative, transgressive learning in smallholder farming contexts which also reflect African cultures of agriculture (described in Chapter 2), while also adopting innovations from modern knowledge practices (WRC materials, use of machinery etc.) that can amplify and expand these practices in times of climate change and increasing uncertainty.

8.3 SUMMARY OF BOUNDARY-CROSSING EXPANSIVE LEARNING PROCESSES

As reflected in Chapters 6 and 7, boundary-crossing expansive learning took place to varying extents in the South African and Zimbabwean case studies due to varying durations and combinations of formative intervention engagements as also captured above. Key here, is the insight that learning networks in both case studies provided fertile platforms for facilitating co-engagement between agricultural actors from different organisations who normally did not interact as co-learners. The learning network platforms quickly developed into natural organisms whose members had natural affinities that were being suppressed by silo approaches in scripted mandates, oppressive $power_2$ relations and set relational norms.

Boundary-crossing expansive learning took place when silo mentality of mandates were challenged not as invalid, but as drivers of work that needed to be rethought and re-imagined. For example, agricultural college and ATIs mandates to 'reach out' to communities and to 'train farmers' were improved when such engagements were viewed as mutual learning opportunities and not as one-way transmission from knowers (college experts) to learners (farmers). The idea of the ZPD (Vygotsky, 1978) was found useful in conceptualising the learning potential across actors from different agricultural learning activity systems. When applied in formative intervention boundary-crossing mechanisms conceptualised by Akkerman & Bakker (2011), it was used to explain how expansive learning took place (Engeström, 2008a). Figure 8.3 summarises the boundary-crossing expansive leaning processes and mechanisms.

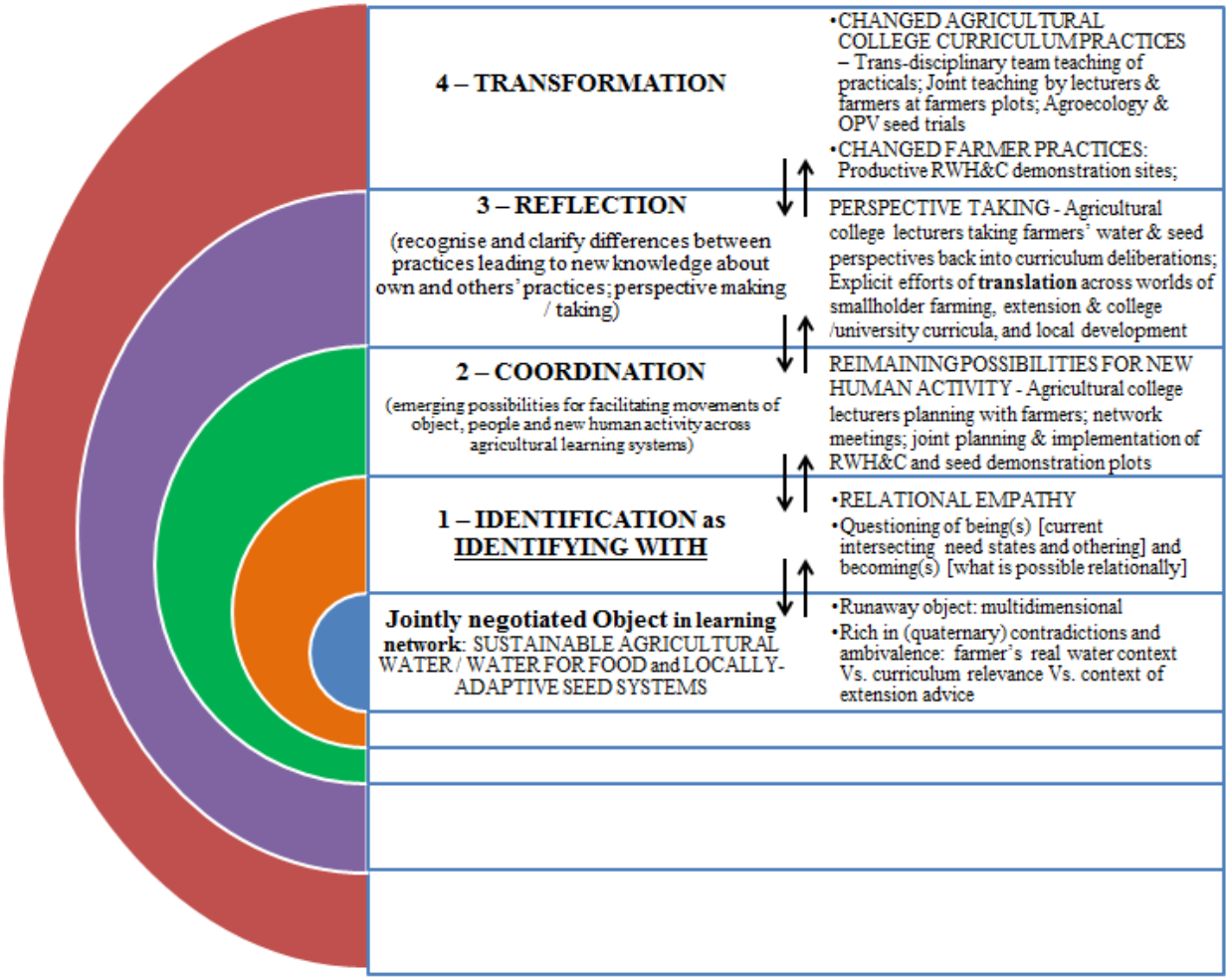

Figure 8.3: *Summary of boundary-crossing expansive learning mechanisms from the study*

Apart from the four boundary-crossing mechanisms described in the literature by Akkerman and Bakker (2011) namely identification, coordination, reflection and transformation, this study found that 'identifying with' (i.e. empathy) each other's contexts was particularly important for boundary-crossing. Figure 8.3 illustrated that the joint object is at the centre of activity and that mechanisms have a knock-on effect on each other shown by the bi-directional arrows. In addition, borrowing from Zaretskii's (2016) idea of multiple steps in development led by learning this study recommends a fifth mechanism of boundary-crossing expansive learning as socio-cultural and cognitive development that results from co-engaged learning.

Figure 8.4 summarises the link between the problem situation and the formative interventions where solutions emerged.

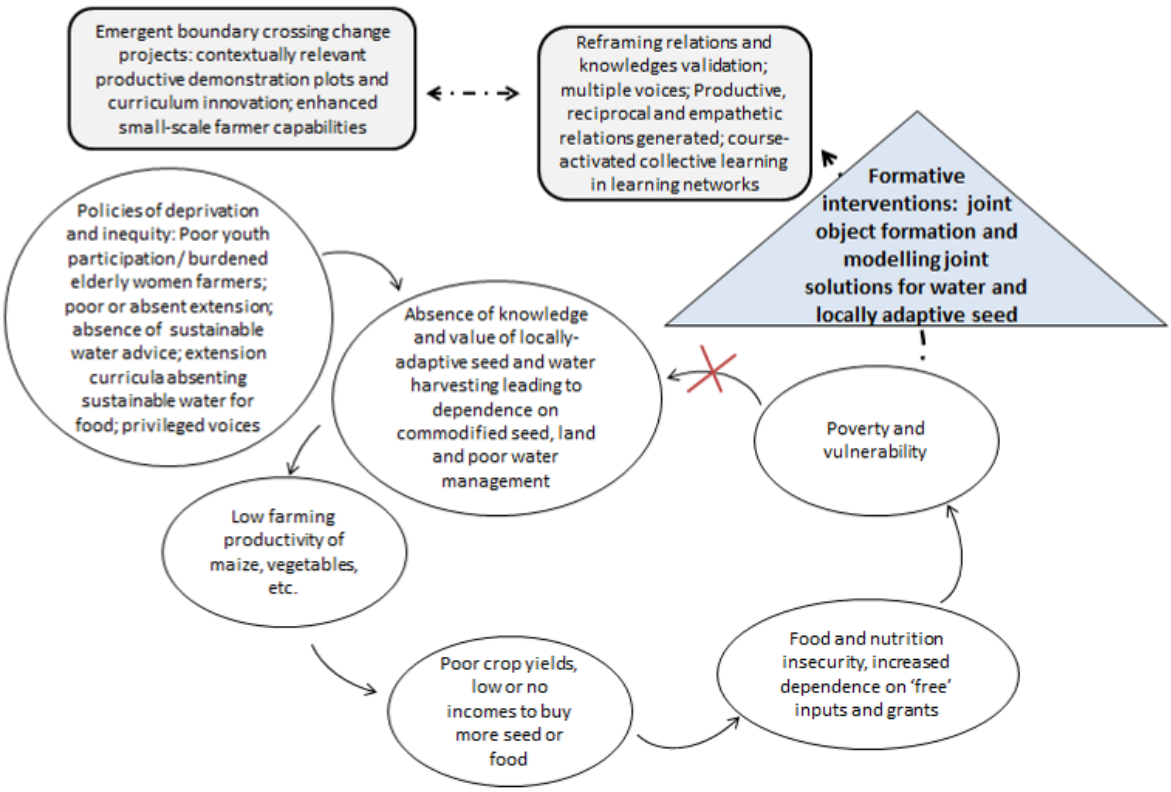

Figure 8.4: *Link between the problem situation and formative boundary-crossing interventions*

The oval shapes represent problem statements feeding into the vicious cycle. The rest of the diagram shows the boundary-crossing formative intervention that started to lift the network out of its joint problematic situation. Below is a summary of recommendations from this study.

8.4 RECOMMENDATIONS

This study makes the following recommendations based on the findings and claims made.

8.4.1 Recommendation 1: That *agricultural actors make concerted efforts to cultivate and nurture learning networks* that enable co-engagement and learning of sustainable agricultural water and locally-adaptive seed

The study recommends that formal agricultural education (schools, ATIs, colleges and universities), community education and training facilitators work closely and differently with local authorities, smallholder farmers and public and private extension services to generate collective and reciprocal benefits (see sections 6.2, 6.3, 7.3, 7.4 and ACLSA3, section 8.2.3). from a training and curriculum planning perspective, Engeström (1994) argued for a formative intervention framework to elicit productive learning in multiple contexts. This would be done to identify, cultivate and support learning

networks working on the objects of sustainable agricultural water and locally adaptive seed, through *a mix of* carefully mediated formative intervention processes that seriously place smallholder farmers operating in rain-fed or dryland farming systems at the centre. Working differently means that such learning networks will benefit from recognising and utilising leadership, not only from the higher education institutions but also from among farmer innovators whose ideas may not be in the majority but have widespread sustainability benefits for local communities and the nation at large (see Pesanayi & Weaver, 2016). It also means dialogue, innovation and using diverse knowledges (Blackie, 2016) instead of only transmitting 'expert' knowledge (see section 8.2.1). Weiler (2009) also argued for valuing diversity in development to circumvent the politics of knowledge.

Recommendation: participatory publication of socio-technical **textbooks or manuals** for the (relational) justification, technological requirements and feasibility, socio-cultural relevance and economic prosperity of developing and **using productive demonstration sites** of sustainable agricultural water and locally-adaptive seed for agricultural colleges and for schools and youths; and a culturally-rich text for early childhood and junior schools. Such textbook development for the formal education system needs to have the partnership of state functionaries responsible for agricultural education and extension, universities that train agricultural educators, extension services and agricultural colleges.

8.4.2 Recommendation 2: That agricultural colleges (or ATIs) and their associates co-learn and empathise with farmer contexts, placing farmers at the centre of knowledge generation and flow to improve curriculum relevance

Rural Development Centres in South African ATIs (transitioning from colleges) and Farmer Training Departments in Zimbabwean Agricultural Colleges have a large potential to influence (accredited) farmer training with respect to enhancing learning of sustainable agricultural water and seed saving and sharing. I therefore recommend that future formative intervention be co-led by ATIs or agricultural colleges and farmer innovators to support boundary-crossing expansive learning of sustainable agricultural water and associated locally adaptive seed systems. Such learning needs to take place in participatory learning networks that include smallholder farmers, extension service organisations, LED agencies, NGOs and relevant departments in university agricultural faculties (e.g. agronomy and agricultural engineering) in a co-engaged learning forum rather than as expert-led intervention as demonstrated by this study. The support of water research and learning organisations such as WRC, agricultural education and extension departments, farmers unions and local authorities is needed to make such sustainability transformations impactful and institutionalised.

Recommendation: It is therefore recommended that policy makers in the agricultural education and extension sub-sectors consider seriously researching and creating real space for the use of knowledge from RWH&C and Agroecology farmer innovators in particular and from the contexts of small-scale farmers in general. In addition, it is recommended that a mechanism be put in place to enable the lessons from research that is done by the national DAFF-funded WRC and within the DAFF itself on RWH&C to move to the provincial levels as a matter of policy. Policies that pursue food security using scientific information alone can have undesirable unintended consequences as is happening with GM maize and the lack of policy on RWH&C via extension services.

8.4.3 Recommendation 3: That agricultural extension workers work with farmers to develop contextually-relevant productive demonstration sites for collective extension and learning within learning network contexts

This study recommends that extension workers work with existing or new learning networks to work with rain-fed farmers through formative intervention to develop practical models of sustainable agricultural water and seed that work for farmers. The learning network forums have proved to be safe working spaces for extension workers and agricultural advisors to collectively support farmers practically on sustainable agricultural water and locally-adaptive seed (see sections 6.3 and 6.5) while at the same time fulfilling their limiting mandates. Limiting mandates were particularly important in the South African case study where top down Cropping Programme was dominant but lacking tools for sustainable water and locally adaptive seed. However, in the Zimbabwean case study where top down extension programmes were limited, with the exception of command agriculture, extension workers were able to align with RWH&C innovators in very productive ways (see section 7.3).

Recommendation: It is recommended that agricultural learning networks continue to work with the concept and co-engaged mediating processes using productive demonstration sites, as these allow for all to learn via the process of co-constructing new human activities that also benefit smallholder farmers.

8.4.4 Recommendation 4: Further research in the South African case study

The three years in which empirical research work was done in the South African case study were relatively few for effective accomplishment of learning-led research and development work in social contexts. Nonetheless, much was accomplished due to the formative interventionist approach that needs to be taken a step further. The learning network that was formed is now being managed well by its members, but it needs further support to consolidate its roots and learning processes. Specifically, the lessons learnt from the agricultural college curriculum work at Fort Cox College of Agriculture

and Forestry (now AFTI) and the former Lowveld College of Agriculture (now University of Mpumalanga) (South Africa. DHET, 2014) need to be carefully documented further for inclusion in curriculum review and development processes and for sharing with other similar agricultural training institutes country-wide. Interest for such learning has been shown by Taung Agricultural College in the Northwest Province, University of Mpumalanga and UNISA's Agriculture campus in Florida area of Gauteng Province, among others. The dual leadership and empathetic community co-engagement role played by Fort Cox Agriculture and Forestry Training Institute in the Imvotho Bubomi Learning Network indicates the potential that agricultural training institutes have in coordinating generative learning networks that also lead to curriculum innovations in the same colleges. In exploring such roles, the need to provide space for growth of and leadership by smallholder farmer innovators is crucial.

The work that agricultural college lecturers have accomplished together with farmers and extension advisors on curriculum innovation needs to be researched deeper for its generativity in expanding the learning to include more local and external players. It is therefore recommended that the process is carefully documented, perhaps with involvement of students and external researchers in order to identify and build on the germ cells for curriculum innovation. Such documentation may include portfolios of evidence that have been started, photo-narratives and videos (see section 6.4). Key sites for such research include Fort Cox AFTI and demonstration sites at Lloyd Village, Keiskammahoek and Matole Basin. (The same applies to Mlezu and Rio Tinto Agricultural Colleges and their surrounding communities in the Zimbabwean case study). Such will enable generativity in other agricultural colleges, agricultural training institutes, universities and farming communities. Some of the modelled solutions to guide this research are found in the MoU monitoring and evaluation plan co-developed to stimulate collective boundary-crossing work (DIBSAF1d).

The South African case study also demonstrated the power of adult farmer innovators, especially retired professionals, mentoring emerging youth farmers. This emerging endeavour has the potential to address the prevailing youth apathy discussed in Chapters 2, 4 and 6 and could provide a model for enhancing youth participation in farming. Such mentoring again appears to be enhanced by a learning network formation and further research on this type of inter-generational learning in learning networks is needed.

The plans made by the leaning network with regard to engaging with agricultural managers (extension and cropping) at District, Provincial and National levels to explore institutionalisation of sustainable agricultural water and locally-adaptive seed systems beyond GM cropping norm needs further exploration to find out the learning generated. This level of research may constitute fourth generation

activity research into the laminated system of agricultural learning systems. I also recommend reflection BCCLWs to assess and expand the power of the learning network with senior managers to enhance institutionalisation of modelled solutions, of which Kerosuo and Toiviainen (2011) found value for "transcending the socio-spatial boundary of the learning network forum" (p. 53). This will entail a detailed network analysis (qualitative and quantitative) to ascertain the growth, impact and sustainability of the leaning networks using data from social media (e.g. WhatsApp), meetings, radio shows, training workshops, *ilima* activities and stories of significant change.

8.4.5 Recommendation 5: Further research in the Zimbabwean case study

The expansive learning cycle in the Zimbabwean case study showed a lot of scope for further boundary-crossing learning within the learning network context that will need further mediation as time, resources and the defined research scope did not allow further intervention involving this researcher. I therefore recommend further formative intervention research to explore the establishment and use of rainwater harvesting demonstration sites and locally-adaptive seed trials involving college lecturers, farmers, extension workers and agriculture college students learning together all the way. Mediated formative intervention research approaches such as those explored in this study (but not necessarily limited to these only) will ensure continued and strengthened multivoicedness and that these endeavours should not be distracted by the good rains received in the 2016/2017 season that are not typical of the prevailing risk experienced in the previous ten years and projected for the future. Boundary-crossing learning that results in curriculum innovation and transformed college dining menus that use these demonstration sites also needs further exploration.

8.4.6 Recommendation 6: Further research in southern Africa and beyond

The development of the southern African sub-region is based on agricultural production and yet it is projected to be the worst affected by climate change as shown by climate change projections (IPCC, 2014; CSIR, 2016). This study recommends further research to consolidate the gains in the case study areas in the light of worsening climate situations projected with business as usual practices. Business as unusual across agricultural learning networks would involve formative intervention research for curriculum transformations in more agricultural colleges to explore interaction and enhanced teaching of practical RWH&C and locally-adaptive seed systems, associated extension policy and praxis, adaptive farming practices and adaptive integrated local economic development that are more aligned with African cultural historical cultures of agriculture and commitments not only to commodification value, but also co-existence value. This study has demonstrated that it is possible to work with these agricultural actor learning network groups together towards such ends. Studies by Knight and Pye (2004), Tongoona and Mudhara (2007), Mukute (2010), and Kerosuo and Toiviainen (2011) also demonstrate the value of exploring the object of learning in networks. A connection between the South

African and Zimbabwean agricultural actors has been initiated at a low level with significant interest shown by actors but needs further exploration regarding its potential for enhancing sharing of experiences and boundary-crossing learning. It is already implied in the WRC RWH&C materials (see section 5.1) and thus can benefit from formative intervention.

Retrieving indigenous concepts, practices, idioms and metaphors relevant to sustainable agri-culture and agricultural water practices that are disappearing such as *gelesha* and *ilima* through dialogues matching youth farmers, experienced elderly farmers and researchers and documenting in academic and non-academic publications accessible to the wider farming community, and using them in short courses is also needed. This study has shown that they have significant generative power that affirms African cultures of agriculture and socio-cultural experiences that have been disrupted but have not completely disappeared in smallholder farming contexts.

I also recommend production of '**How to do it' videos** that cover diverse scales and contexts of productive demonstration plots of sustainable agricultural water and locally adaptive seed applications based on work done in agricultural colleges, and farmers' plots, and with curriculum, learning and marketing links. These will build on the videos already developed featuring the Amanzi for Food programme in the South African case study. For the Zimbabwean case study there are currently no such video materials for learning. Such production and marketing demonstrations will need to model possibilities of transgressing problematic and oppressive models that the United Nations (2017) describes as

> ... we have reached a turning point in agriculture. *Today's dominant agricultural model is highly problematic… effects on climate change, loss of biodiversity and inability to ensure food sovereignty*. These issues are intimately interlinked and must be addressed together… (p. 22).

I further recommend that efforts be made to **incorporate schools** in the existing sustainable agricultural water and locally adaptive seed learning networks in order to expand boundary-crossing learning and curriculum innovation for sustainability in these critical areas of national development.

8.5 PROPOSED TOOLS FOR BOUNDARY-CROSSING EXPANSIVE LEARNING

From this study, boundary-crossing was found to be a rich formative intervention processes requiring mediation using carefully constituted and responsive first and second stimulus tools that facilitate mutual respect, relational agency and deep co-engagement in order for expansive learning to take place and new human activity to emerge. I therefore recommend the following tools for organising learning networks for boundary-crossing, and for facilitating boundary-crossing learning and agency.

8.5.1 Tools for organising learning networks for boundary-crossing learning

Learning networks are worthwhile when they are generative platforms for co-engaged learning of agricultural water and locally-adaptive seed systems. The following characteristics were found critical and the matching actions are recommended;

- **The need** for improving sustainability of agricultural water must be explicit, expressed by the affected and evident on the ground. It is recommended that the contexts of farmers' work and the problems they face be well profiled and historicised so that they become the reference for any formative interventionist work that involves them together with extension workers, lecturers in ATIs and local development authorities. Equal profiling of the latter can enable the relating of water problems across activity systems through quaternary contradictions.
- **An active interest and willingness** to deal with the need state individually and through collaborative multi-actor group work needs to be clarified, with various models of solving the problems being allowed to emerge out of all the voices represented in the above agricultural learning activity systems. Ensuring and managing of multi-voicedness is critical in order to achieve social/relational and individual agency and move from blaming to coordinated action.

8.5.2 Recommended tools for facilitating boundary-crossing learning and agency

Boundary-crossing learning and agency in agricultural water learning involving a diversity of connected actors in a learning network is a complex process due to the many interacting factors. It requires common understanding of rules of engagement and roles in relationship building and maintenance; mediation, monitoring, careful documentation and feedback of joint work; and value creation for the affected.

Establishing common understanding and agreement on the rules of engagement was found to work well using the following tools: *learning network maps, memorandum of understanding (MoU)* with formal organisations such as agricultural colleges or ATIs even with no funds attached, participatory *change practice course-activation* of a learning network where materials and approaches were shared for consideration and local uptake / experimentation (from the WRC materials amongst others), and *research ethics protocols* that clarify how solutions will emerge and be validated. Learning network maps (including activity system representations) indicate current and potential connections, boundaries and their strengths, and boundary-crossing opportunities, and help to clarify the shared object. MoUs clarify agreed obligations that can catalyse implementation of agreed actions within set time frames, thus allowing monitoring, assessment, evaluation and reporting that is not necessarily judgemental but also appreciative.

The **mediation, monitoring, careful documentation and feedback** of deliberations in modelling and examining model solutions and implementing them was found to be important in establishing real boundary-crossing expansive learning. It was found that all agricultural actors achieved a considerable amount in implementing model solutions that they did not document well and therefore went unreported until discovered through extended research work. The development of boundary-crossing learning portfolios of evidence and video-taped lessons was initiated with and led by agricultural college lecturers in the South African case study, in ways that did not introduce 'extra work' by involving the students and as generation of data for continuous learning and future publications. With Fort Cox College an MoU monitoring and evaluation tool was developed that ensured periodic checking of the MoU's performance through joint reflection meetings. A sample of this tool is given in Figure 8.5 below.

MOU Obligation	Activity	Leading institution	2015 Q1	2015 Q2	2015 Q3	2015 Q4	2016 Q1	2016 Q2	2016 Q3	2016 Q4	2017 Q1	2017 Q2	2017 Q3	2017 Q4	Expected outcomes
							FQ4	FQ1	FQ2	FQ3	FQ4	FQ1	FQ2	FQ3	
1. Collaborative learning (RU i; FCC i)	A1. Facilitate agriculture curriculum expansion to include / integrate rainwater harvesting and conservation	Fort Cox College (FCC); Rhodes University (RU)								1		*			Expanded curriculum; Topic specification in course outlines with Amanzi for Food website links; Portfolio of Evidence (evidence into student learning)
	A2. Adapt & adopt exisiting WRC rainwater harvesting materials	FCC				1			1		*				WRC rainwater harvesting materials and Navigation tool in FCC library used by students and lecturers; **Teaching note** on RWH&C (part of tools to implement curriculum) to be **kept in libary every year**; Amanzi for Food website accessed and used for teaching and learning.
5. Joint reflection meetings															
7. Participate actively in the Imvotho Bubomi Learning Network in rainwater harvesting							1	1	1	1	1	*			
10. Curriculum innovation work	A26. Develop Portoflios of evidence for curriculum innovation work done in 2014-2016; continue in 2017	Fort Cox College					1	1	0	*	*	*	*	*	PoEs shared between RU and FCC containing assignments, slides for lesson plan/topics delivered including reference

Figure 8.5: *Sample of MoU monitoring and evaluation tool used jointly by Fort Cox Agricultural College and Rhodes University*

The above sample of a monitoring and evaluation tool shows the MoU obligation, its associated activities, lead organisations and persons, time frames with logged in delivery dates that are assessed when the time arrives with respect to the expected outcome in the last column.

When college management and lecturers, farmers and extension and local economic development agency facilitators saw value in learning together over an extended period, they made boundaries between their activity systems more permeable thus facilitating boundary-crossing. The college management, for example, saw value in collaborative demonstration site development as fulfilling their community engagement mandate tangibly and contributing to the implementation of the new competence-based learning approach facilitating transition of agricultural colleges into ATIs. I

therefore recommend value creation in the modelling of solutions such that farmers can experience improvement in their productivity from improved water security and locally-adaptive seed systems and college lecturers can experience the benefits of curriculum innovations that they are willing to implement in relation to the farmers' needs.

Accessing agricultural water and locally adaptive seed systems knowledge is not always easy because the subjects are not included in mainstream agricultural education, training and extension. I therefore recommend tools to access such knowledge from both human knowers and from journals, books and expert sustainability reports (e.g. the Water Research Commission materials that proved to be catalytic in this study), thus recognising multiple voices and forms of knowledge.

8.6 CONCLUSION

This study has demonstrated the effectiveness of a mix of formative intervention mediating processes in boundary-crossing scenarios in learning network contexts. The synthesis in this chapter showed that diverse combinations of change practice courses, change laboratories, demonstration sites and media engagements in the context of learning networks strengthened the possibility for boundary-crossing expansive learning across activity systems of agricultural college lecturers, smallholder farmers, extension workers and local economic development agency facilitators. Three of the five actions emerged out of the formative intervention processes in both the South African and Zimbabwean case studies while two were not realised in the Zimbabwean case study, namely the change practice course and media engagements, due to different formative intervention conditions, inadequate time and resources. Boundary-crossing was enabled by a variety of actions including understanding and identifying with the context of the other more as a result of change laboratory workshops that ensured confrontation with relational contradictions. The change practice course facilitated in the South African case study deepened co-engaged learning and collective understandings of the agricultural water problems and associated seed systems thus revealing absences in agricultural college curricula, and in extension and farmer practices.

These problems and absences were resolved to varying degrees through expansive social learning interactions that modelled and examined possible solutions, which were implemented with outstanding individual leadership and group efforts, and sensitive mediation and co-engagement by myself as formative interventionist researcher. Productive rainwater harvesting and conservation demonstration plots emerged as sites of realised possibilities for sustainable agricultural water and of mediated action for further boundary-crossing expansive learning that brought the role of locally adaptive seed systems into focus as being part of African smallholder farmers' cultures of agriculture. The expansive learning

cycle was realised more extensively in the South African case study than in the Zimbabwean case study due to more availability of material resources and time. It is therefore recommended that the boundary-crossing potential in the Zimbabwean case study be explored further.

The degree of achievement of objectives can be concluded as follows;

Objective 1.4.1 To find out how agricultural actors learn together

It was found that small-scale farmers, agricultural college educators, extension officers / workers, research technicians and local government agribusiness supporters learn together through collaborating on identifying a common object from their diverse perspectives, and identifying discontinuities in wotk on water and seed activity historically and currently. Through expansive learning processes, particpants crossed boundaries that separated them due to power relations, knowledge barriers and sheer neglect of dryland farming needs in eduation and extension.

Objective 1.4.2 To explore the socio-ecological histories of agricultural water and seed activity

This objective was achieved to a large extent through a process of historicity. It was found that RWH&C and seed saving had histories of success, subjugation and emergence in different times due to politics of knowledge, climate change, cultural practice, advocacy and farmer innovations.

Objective 1.4.3 To understand how learning, curriculum innovation and mediation tools can expand learning of agricultural water and locally adaptive seed

The change laboratory method was successfully used to facilitate expansive learning of RWH&C and seed saving to the extent of influencing curriculum innovation in RWH&C teaching and learning (see sections 4.2.13 and 6.4.1) and agricultural extension innovation through learning networks.

As a general conclusion, boundary-crossing learning potential can be realised when different agricultural learning activity systems are brought into voluntary co-engaged interaction that questions prevailing and historicised structural, cultural and natural norms and constraints. Further mediation was seen to lead to emergent models and new human activity such as enhanced and coordinated practical teaching of rainwater harvesting and conservation and of locally adaptive seed systems to extension students in agricultural colleges at college and farm sites. The teaching was shared by both lecturers and farmer innovators. Crop production from locally adaptive seed started to emerge in agricultural colleges as they learnt together with farmers to transgress strong cultural norms. New collaborative extension practice emerged in a learning network and enabled extension officers in the South African case to advise farmers as part of a wider voice thus reframing extension practice. This achievement would otherwise have been interpreted as violating Cropping Programme policy if done in a normative one on one basis. It is however recommended that further expansive learning combining sustainable agricultural water and locally adaptive seed in both country cases ensure the reciprocal growth of niche markets, market linkages and value-adding agro-processing for such products as

serious climate risk proofing commodities and their promotion as sustainable consumption. Giving attention to the decolonising processes of respecting African smallholder farmers' cultures of agriculture is also a key feature of this kind of research as shown in this study, foregrounding not only commodity value in agriculture, but also co-existence value that also reflects sustainability principles.

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APPENDICES

Appendix 1: Research Access letter 501

Appendix 2.1: Research Access to the Nkonkobe Economic Development Agency (NEDA) and its stakeholders in the Nkonkobe Smallholder Farmer Development Programme 502
Appendix 2.2: Research Access to Agricultural Extension (under Department of Rural Development and Agrarian Reform) in Eastern Cape Province 503
Appendix 2.3: Research Access to Fort Cox College of Agriculture and Forestry 504

Appendix 3.1: Informed Consent – Samples for South African Case study 505
Appendix 3.2A: Research Access to Runde Rural District Council area in Zimbabwe 506
Appendix 3.2B: Research Access to Zimbabwean Agricultural Colleges 508
Appendix 3.3A: List of my Field Engagements in the South African Case Study 509
Appendix 3.3B: List of my Field Engagements in the Zimbabwean Case Study 510
Appendix 3.4A: Extract of Soil and Water Conservation Course from Fort Cox College Prospectus, 2015 511
Appendix 3.4B: Sample of Curriculum Documents from the Zimbabwean Agricultural Education and Farmer Training Activity System (Extract of Agricultural Engineering Syllabus) 512
Appendix 3.5A: Change Laboratory Workshop Training at CRADLE, University of Helsinki ... 523
Appendix 3.5B: Change Laboratory Workshop Training at University of Helsinki: Field Proposals 525
Appendix 3.6A: Initial Categorisation of Data from the South African and Zimbabwean Nested Case Studies 529
Appendix 3.6B: Quantification of Data – Interviews in the South African Case Study 532
Appendix 3.6C: Quantification of Data – Interviews in the Zimbabwean Case Study 534

Appendix 4.1: Extract of Book Chapter by Author analysing Contradictions in Agricultural Water among Smallholder Farmers in South Africa 536
Appendix 4.2: A Detailed Case Description of Fort Cox College 540

Appendix 5: Extract of Book Chapter by Author Analysing Contradictions in Agricultural Water among Smallholder Farmers in Zimbabwe 541

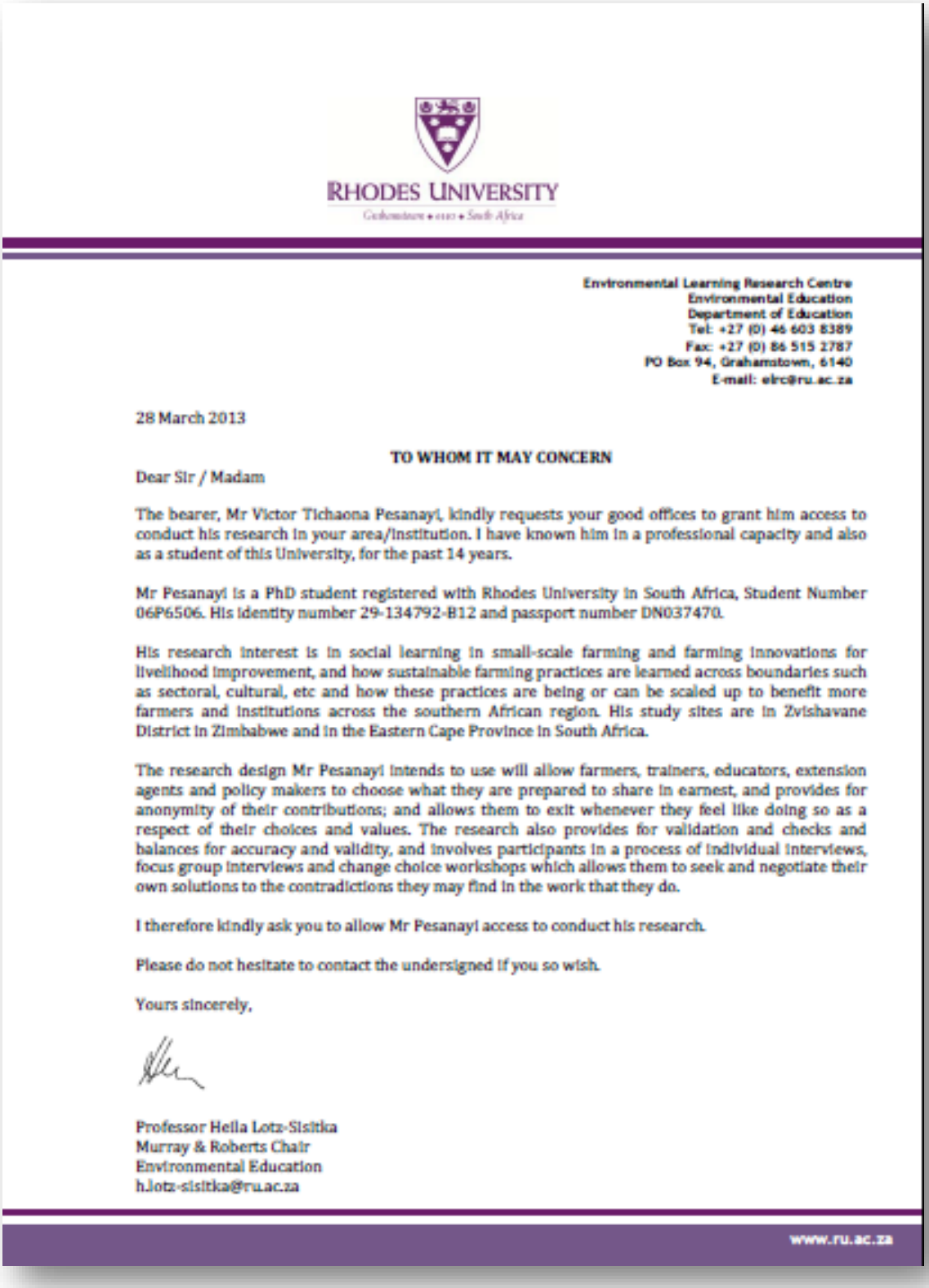
Appendix 6.1: Sample of Amanzi for Food Training of Trainers Course Modules 542
Appendix 6.2: List of Agricultural Colleges and selected FET Colleges in South Africa 543
Appendix 6.3: Sources of Data for Boundary Learning and Boundary-Crossing Issues in the South African Case Study 545
Appendix 6.4: Samples of Learning Network Communications From Various Media 549
Appendix 6.4A: Sample Minutes of Imvotho Bubomi Learning Network Meetings (DIBSAM) 549
Appendix 6.4B: Sample of Imvotho Bubomi Learning Network WhatsApp Chat History (DIBSAW) from 23 November 2016 to 31 March 2017 554
Appendix 6.4C: Samples of Community Radio Show Scripts (DIBSAR) and Studio Presentation Summaries (DIBSARS) 565
Appendix 6.4D: Sample Transcripts of IBLN Boundary Crossing workshops 569
Appendix 6.5: Cluster of Themes emerging from the data 583
Appendix 6.6: Curriculum Analysis Tool used in BCCLWs and applied in Assignment 1 with Analytical Content 584
Appendix 6.7A: Memorandum of Understanding (MoU) entered into between Fort Cox College and Rhodes University on “Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food” (pages 1-3, and 5) 586

Appendix 6.7B: Extract of Monitoring and Evaluation Plan of MoU between Fort Cox College and Rhodes University on “Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food” 588
Appendix 6.8: Transcript of MoU Monitoring and Evaluation Planning Meeting (FCCMESA1) 8 June 2016 590
Appendix 6.9: Nkonkobe Farmer’s Association Agricultural Show Programme, June 10, 2015 . 593
Appendix 6.10: Curriculum Innovation and Development Outcomes in the Fort Cox Agricultural College 597
Appendix 6.11: Matrix for the Empirical Analysis of Boundary-Crossing Expansive Learning.. 607
Appendix 6.12: Summary Of Boundary Crossing Issues, Mechanisms and Agentive Trails in the IBLN (incorporating and expanding Tables 6.3 and 6.8) 608

Appendix 7.1: List of Agricultural Colleges and Selected Vocational Training Colleges in Zimbabwe 610
Appendix 7.2: Data Sources for Boundary-Crossing Expansive Learning Zimbabwean Case Study 612
Appendix 7.3: Sample Transcript of Zimbabwean Learning Network Boundary Crossing Workshops 613
Appendix 7.4: Curriculum Analysis Tool used in BCCLWs and applied in Curriculum Documents with Analytical Content 615
Appendix 7.5: Curriculum Innovation and Development Outcomes in the Mlezu and Rio Tinto Agricultural Colleges 617

Appendix 8.1: Proposed Curriculum Analysis tool for Sustainable Agricultural Water and Locally Adaptive Seed - based on Tested Tools (see Appendix 6.6) 619

Appendix 1: Research Access letter



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28 March 2013

TO WHOM IT MAY CONCERN

Dear Sir / Madam

The bearer, Mr Victor Tichaona Pesanayi, kindly requests your good offices to grant him access to conduct his research in your area/institution. I have known him in a professional capacity and also as a student of this University, for the past 14 years.

Mr Pesanayi is a PhD student registered with Rhodes University in South Africa, Student Number 06P6506. His identity number 29-134792-B12 and passport number DN037470.

His research interest is in social learning in small-scale farming and farming innovations for livelihood improvement, and how sustainable farming practices are learned across boundaries such as sectoral, cultural, etc and how these practices are being or can be scaled up to benefit more farmers and institutions across the southern African region. His study sites are in Zvishavane District in Zimbabwe and in the Eastern Cape Province in South Africa.

The research design Mr Pesanayi intends to use will allow farmers, trainers, educators, extension agents and policy makers to choose what they are prepared to share in earnest, and provides for anonymity of their contributions; and allows them to exit whenever they feel like doing so as a respect of their choices and values. The research also provides for validation and checks and balances for accuracy and validity, and involves participants in a process of individual interviews, focus group interviews and change choice workshops which allows them to seek and negotiate their own solutions to the contradictions they may find in the work that they do.

I therefore kindly ask you to allow Mr Pesanayi access to conduct his research.

Please do not hesitate to contact the undersigned if you so wish.

Yours sincerely,

Professor Heila Lotz-Sisitka
Murray & Roberts Chair
Environmental Education
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Appendix 2.1: Research Access to the Nkonkobe Economic Development Agency (NEDA) and its stakeholders in the Nkonkobe Smallholder Farmer Development Programme

Research Access, Ethics Clearance and consent for Victor Tichaona Pesanayi

This document upon signature is a commitment by the undersigned to participate in a research on agricultural education, small scale farming, water for food, seed and marketing. Where applicable it also covers any mutually-agreed upon research interviews, meetings and workshops.

The document also certifies upon signature that Mr Victor Tichaona Pesanayi, a PhD researcher from Rhodes University (student number 06P6506), has been granted access to conduct developmental work research with you.

I, MANDISI H. MALI, commit myself to participate in this research and to share information willingly and honestly to promote research and knowledge development. I understand that this research will contribute to the agriculture and farming learning network in Nkonkobe and the surrounding communities' understanding and learning of rainwater harvesting and conservation (RWH&C) potential and associated sustainable farming innovations.

I also understand that the researcher shall be recording work sessions on video film, still camera photos and audio. I grant him permission to use this material in feedback reports and in his research and publications in a responsible manner, and also in the Amanzi for Food publications and website. I have been fully informed about the research and have committed myself to the whole process to the best of my ability as indicated by the attached signatures.

I understand that I am free to withdraw from the research at any time as I so wish, and will communicate any such intention in advance.

Signed:

Date: 06 / 11 / 2015

Name: MANDISI MALI

Designation: CEO

Identity Number: 7205305548081

Phone number: 0824842102

Appendix 2.2: Research Access to Agricultural Extension (under Department of Rural Development and Agrarian Reform) in Eastern Cape Province

INFORMED CONSENT FORM

1. My full names are ..... Awonke Sonandi .....,

2. I understand that I am being asked to participate in a research study conducted by Tichaona Pesanayi of Rhodes University in South Africa. This research study will follow a process that has been described to you in the interview you will or have taken part in. The study is looking at us collaborating to create new knowledge and ways of doing things in the sustainability of small-scale farming especially. The study is made of interviews, focus group interviews and discussions, and multi-stakeholder feedback (boundary-crossing laboratory) workshops. I will be sharing back the information from the interview through a feedback session where you can check the interview transcription of our interview and validate that it correctly and accurately represents what we discussed and what you shared. The specific focus of the study is to investigate how people understand and learn sustainability practices in small-scale farming that affect their seed choices, availability and access; water access, availability and innovations; and value or market chains, and how and why this learning is being up-scaled or not used by the farmers, extension and training services, and agriculture education processes. Together we hope to better understand how small-scale farming communities can move from struggling or coping with these many challenges, towards being better able to overcome these problems.

2. I am aware of the benefits of this study, such as providing an opportunity for small-scale farmers, farmer support institutions or organisations to learn together with the researcher and to explore ways for the local farming community to better adapt to or mitigate the multiple challenges they face.

3. I authorise Tichaona Pesanayi to use any photograph I appear in involving extension work processes, either from this interview or otherwise, for the purposes of his research in a responsible manner in line with Rhodes University research ethics.

4. Please select one: I would like my specific input to

   A. Remain anonymous, in which case the researcher will ensure anonymity following research ethics procedures at Rhodes University, _____ or
   B. I do not mind if my identity is explicitly revealed in the study as long as it is in line with the research ethics procedures at Rhodes University. __X__

5. I also understand that my participation in this study is entirely voluntary, that I may withdraw from this study at any time should I wish to do so.

6. The study has been explained to me. I have read and understood the consent form, all my questions have been answered and I agree to participate. I understand that the research process will continuously provide opportunities for research findings to be shared with the farming and extension support community in Alice and its environs.

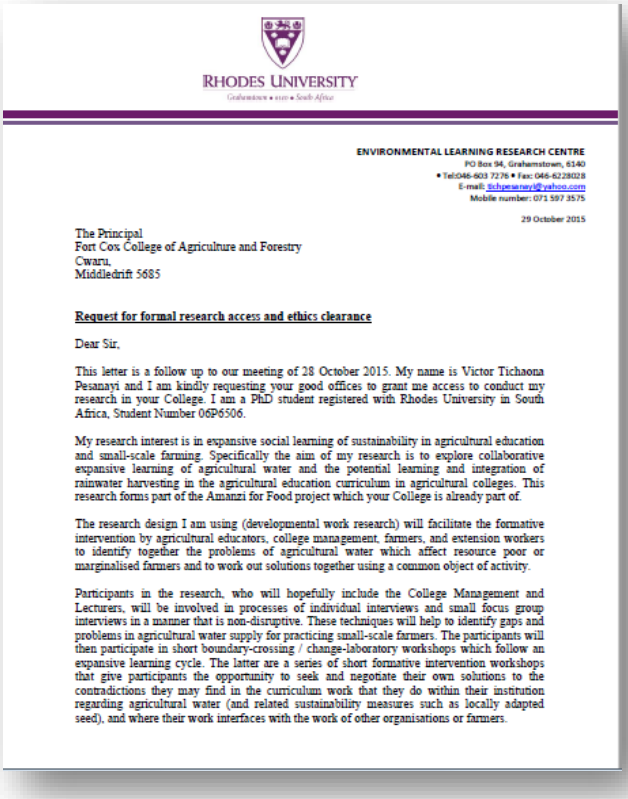
7. If I agree to participate in the study, I will participate in the feedback workshop process which will be arranged for the farming and extension support community of practice. I am free to ask any questions about the study or about my participation in Mr T. Pesanayi's research whose contact details I have received.

Signature of interviewee: .....

Identity number: 670807 5914 087

Date: 08/02/16 Place: K.W.T.

Appendix 2.3: Research Access to Fort Cox College of Agriculture and Forestry



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29 October 2015

The Principal
Fort Cox College of Agriculture and Forestry
Cwaru,
Middledrift 5685

Request for formal research access and ethics clearance

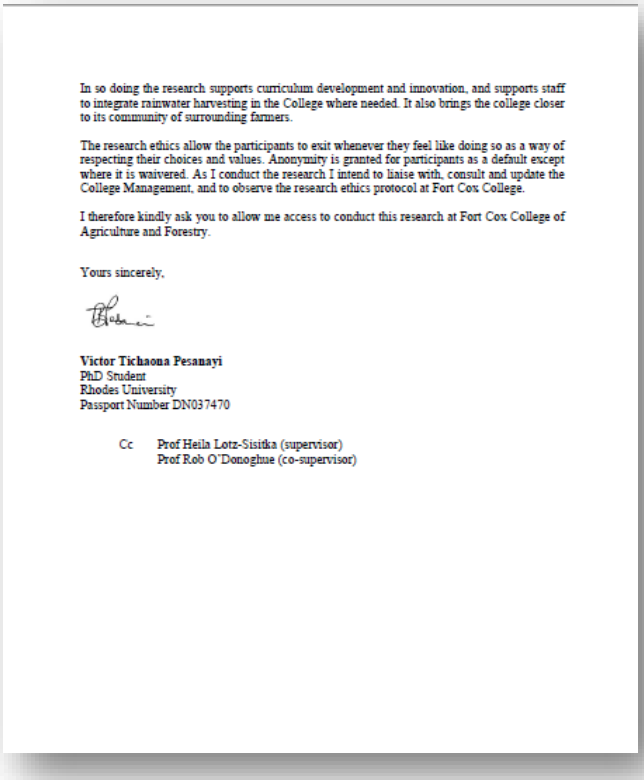
Dear Sir,

This letter is a follow up to our meeting of 28 October 2015. My name is Victor Tichaona Pesanayi and I am kindly requesting your good offices to grant me access to conduct my research in your College. I am a PhD student registered with Rhodes University in South Africa, Student Number 06P6506.

My research interest is in expansive social learning of sustainability in agricultural education and small-scale farming. Specifically the aim of my research is to explore collaborative expansive learning of agricultural water and the potential learning and integration of rainwater harvesting in the agricultural education curriculum in agricultural colleges. This research forms part of the Amanzi for Food project which your College is already part of.

The research design I am using (developmental work research) will facilitate the formative intervention by agricultural educators, college management, farmers, and extension workers to identify together the problems of agricultural water which affect resource poor or marginalised farmers and to work out solutions together using a common object of activity.

Participants in the research, who will hopefully include the College Management and Lecturers, will be involved in processes of individual interviews and small focus group interviews in a manner that is non-disruptive. These techniques will help to identify gaps and problems in agricultural water supply for practicing small-scale farmers. The participants will then participate in short boundary-crossing / change-laboratory workshops which follow an expansive learning cycle. The latter are a series of short formative intervention workshops that give participants the opportunity to seek and negotiate their own solutions to the contradictions they may find in the curriculum work that they do within their institution regarding agricultural water (and related sustainability measures such as locally adapted seed), and where their work interfaces with the work of other organisations or farmers.



In so doing the research supports curriculum development and innovation, and supports staff to integrate rainwater harvesting in the College where needed. It also brings the college closer to its community of surrounding farmers.

The research ethics allow the participants to exit whenever they feel like doing so as a way of respecting their choices and values. Anonymity is granted for participants as a default except where it is waivered. As I conduct the research I intend to liaise with, consult and update the College Management, and to observe the research ethics protocol at Fort Cox College.

I therefore kindly ask you to allow me access to conduct this research at Fort Cox College of Agriculture and Forestry.

Yours sincerely,

Victor Tichaona Pesanayi
PhD Student
Rhodes University
Passport Number DN037470

Cc Prof Heila Lotz-Sisitka (supervisor)
Prof Rob O'Donoghue (co-supervisor)

Appendix 3.1: Informed Consent – Samples for South African Case study

Consent to participate and feature in research, publications and reviews; and waivers

1. This document is an ethics protocol designed to ensure that participants in a PhD research and evaluation processes conducted by Tichaona Pesanayi provide their informed consent to participate.
2. I Stetho Asanda hereby agree to participate in a research carried out by Tichaona Pesanayi on boundary-crossing expansive learning of water for food and local seed-based value chains.
3. The research, publications and / evaluation objectives and processes were explained to me fully.
   - The research design is a developmental work research. It will be a co-engaged process of learning together as a collective meaning that I as a participant will contribute my ideas and voice as a formative interventionist;
   - Knowledge will be co-generated and capacities co-developed to jointly solve sustainability issues and select alternatives in sustainable water for food and seed-based value chains;
   - The research process will provide for expansive learning, reflexivity, innovation and evaluation.
4. I will freely participate in research communications via email, telephone, short messaging service or WhatsApp, as may be appropriate and feasible.
5. I therefore give my informed consent to participate in this research, publications and / evaluation, with the following understanding.

5.1 Rights to privacy and anonymity: The researcher will make efforts to ensure protection of participant's rights to privacy and anonymity and to preserve confidentiality with respect to data.

5.2 The researcher (choose one using a tick): a) may disclose my identity by stating my name responsibly in his thesis or research publications ✓; or

(b) **may not** disclose my identity through publishing my name in his thesis or research publications _____

5.3 The researcher (choose one using a tick): a) may disclose my identity through publishing my photograph responsibly in his thesis or research publications ✓; or

(b) **may not** disclose my identity through publishing my photograph in his thesis _____

6. The researcher will provide opportunities for co-publishing research papers or articles in the public media which I will participate in freely, but with no obligation.
7. The researcher will ensure accuracy of data generated through member checking with me either through checking transcripts or discussion.
8. I understand and that I can freely withdraw my participation from this research at any time I feel like.

Signature of participant: A. Stetho Place: Fort Cox College

Date: 27 October 2015

NB: The rest of the signed consent forms are found in the accompanying DVD.

Appendix 3.2A: Research Access to Runde Rural District Council area in Zimbabwe

RUNDE RURAL DISTRICT COUNCIL

P. O. BOX 240
Tel: (051) 3735

ZVISHAVANE
(C.E.O. Finance)

11 OCTOBER 2013

RE-: LETTER OF CONFIRMATION

THIS LETTER SERVES TO CONFIRM THAT MR VE FOR TICHAONA

PESANAYI ID NO. 29-1 OF SOUTH AFRICA HAS

BEEN GRANTED PER RUNDE RURAL

DISTRICT COUNCIL

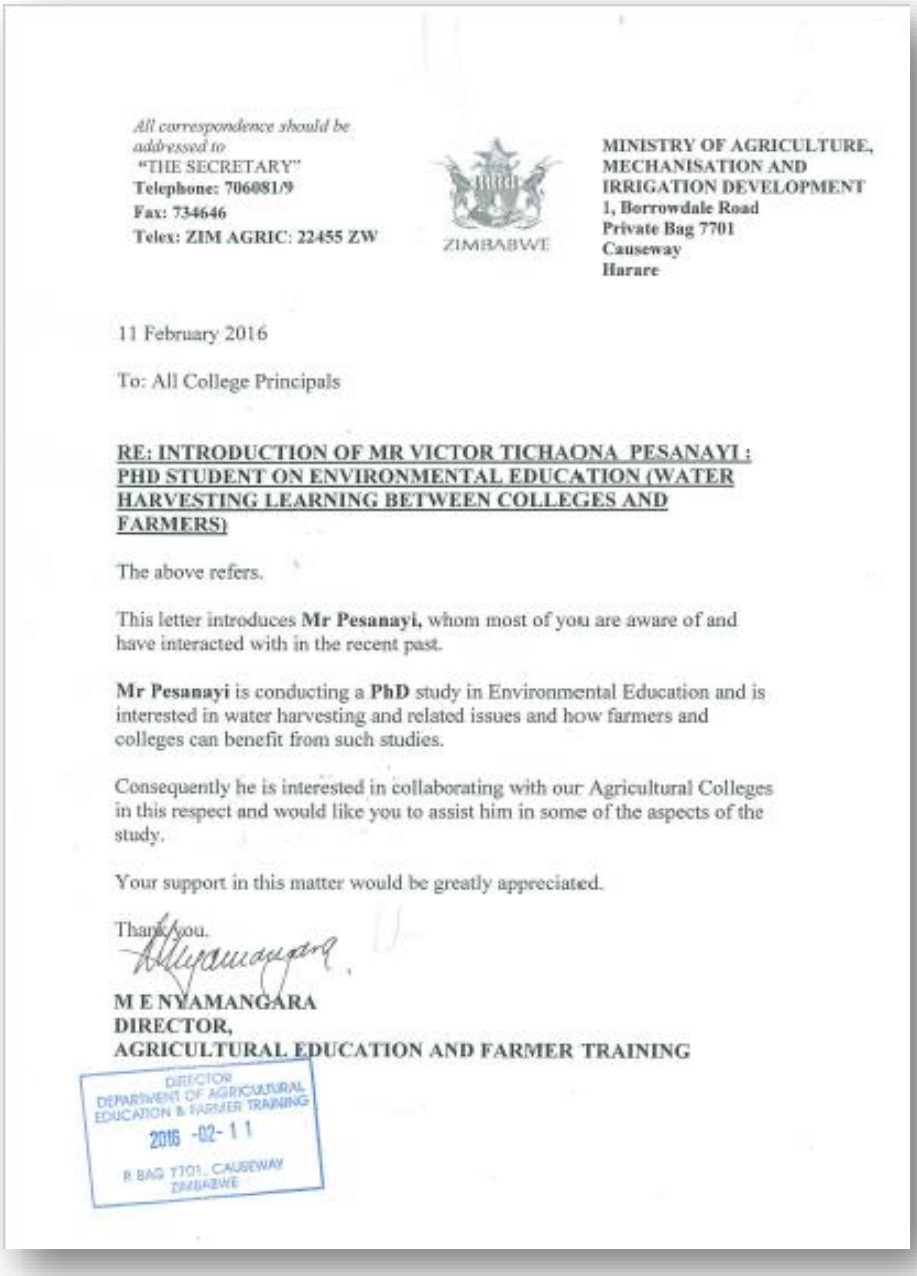
THANK YOU.

YOURS SINCERELY

G. MOYO
CHIEF EXECUTIVE

CHIEF EXECUTIVE OFFICER
RUNDE RURAL DISTRICT COUNCIL
2013 -10- 11
P.O. BOX 240
ZVISHAVANE

Appendix 3.2B: Research Access to Zimbabwean Agricultural Colleges



All correspondence should be addressed to
"THE SECRETARY"
Telephone: 706081/9
Fax: 734646
Telex: ZIM AGRIC: 22455 ZW

ZIMBABWE

MINISTRY OF AGRICULTURE, MECHANISATION AND IRRIGATION DEVELOPMENT
1, Borrowdale Road
Private Bag 7701
Causeway
Harare

11 February 2016

To: All College Principals

RE: INTRODUCTION OF MR VICTOR TICHAONA PESANAYI : PHD STUDENT ON ENVIRONMENTAL EDUCATION (WATER HARVESTING LEARNING BETWEEN COLLEGES AND FARMERS)

The above refers.

This letter introduces **Mr Pesanayi,** whom most of you are aware of and have interacted with in the recent past.

Mr Pesanayi is conducting a **PhD** study in Environmental Education and is interested in water harvesting and related issues and how farmers and colleges can benefit from such studies.

Consequently he is interested in collaborating with our Agricultural Colleges in this respect and would like you to assist him in some of the aspects of the study.

Your support in this matter would be greatly appreciated.

Thank you.

M E NYAMANGARA
DIRECTOR,
AGRICULTURAL EDUCATION AND FARMER TRAINING

DIRECTOR
DEPARTMENT OF AGRICULTURAL EDUCATION & FARMER TRAINING
2016 -02- 11
P BAG 7701, CAUSEWAY
ZIMBABWE

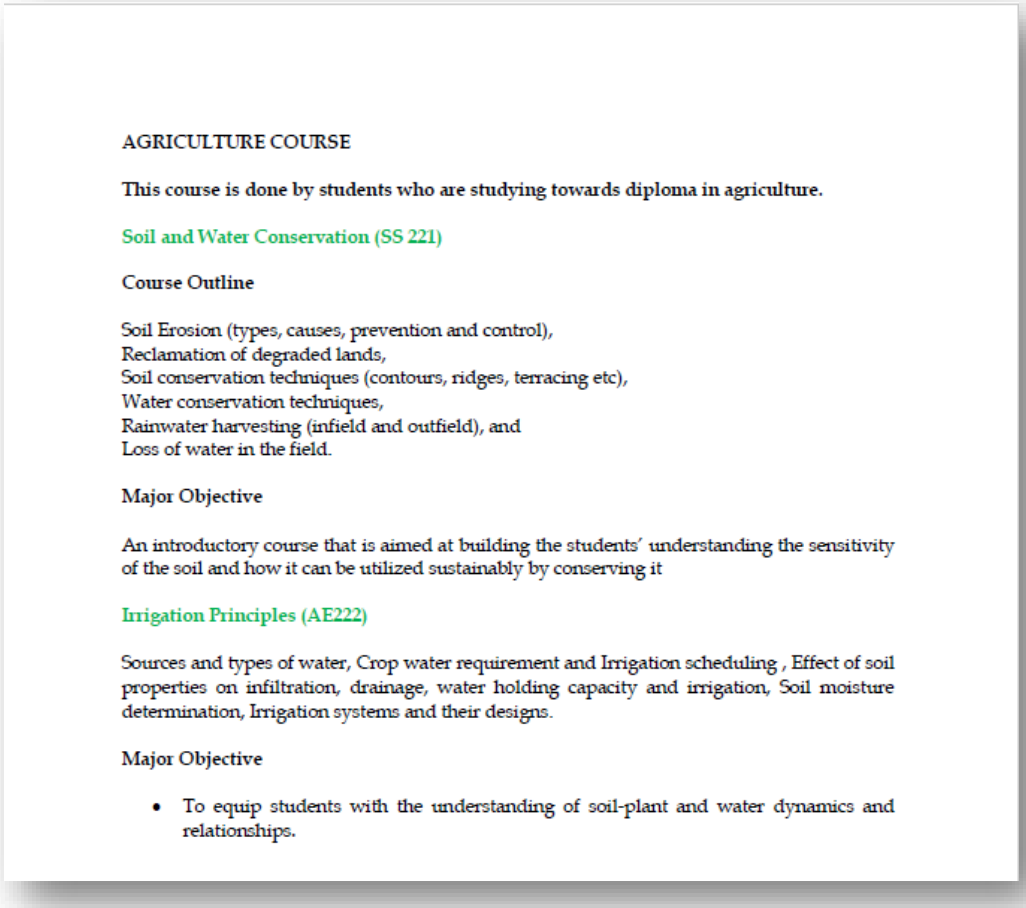
Appendix 3.3A: List of my Field Engagements in the South African Case Study

Date(s)	Activity
March-May 2014	**Scoping** of area to meet people, make appointments and secure research access
June 10, 2014	**Meeting and Focus Group Interview with Fort Cox College middle management and staff** to discuss internal and joint objects of activity. This Focus group was attended by the Head of Department of Agriculture and three agriculture lecturers (agricultural engineering, horticulture and soil science).
August 12, 2014	Boundary Crossing Change laboratory workshop 1 and formation of Imvotho Bubomi Learning Network: object
September 24, 2014	**Curriculum analysis change laboratory workshop** with Fort Cox College and University of Fort Hare research participants
July 2014 - August 2016	**Individual key informant Interviews and observations** with three agricultural college lecturers (ACLSA2 – July 15, 2014, April 13, 2015; ACLSA3 – December 14, 2016), college HoD of Agriculture (July 31, 2015), the chairperson and deputy chairperson (FSA4 – February 6, 2015, FSA6 - May 10, 2015) of Lloyd Village garden, three small-scale farmers in Alice [(Nkonkobe Farmers' Association chairperson and member, FSA1 & FSA2 – September 3, 2014; WUA Secretary, May 14, 2016), Koloni village (FSA3-December 18, 2014) and Matole Basin (FSA10-May 13, 2015, August 1, 2016).
March 19, 2015	Observations of ARC-supported demonstration sites (*amadanyana*) in Khayalethu (FSA9) and Mpundu villages (FSA12)
May 12, 2015	Individual key informant Interview with ARC-supported demonstration site (*amadanyana*) farmer in Mpundu village (FSA12)
August 2014 - March 2015	**Boundary Crossing Change laboratory workshops** in Training of Trainers' Course incorporated in each module / Imvotho Bubomi Learning Network (BCCLWSA1 – August 12, 2014; BCCLWSA2 - September 16, 2014; BCCLWSA3, October 2014; BCCLWSA4 –February 3, 2015; BCCLWSA5 - March 17, 2015)
June 2016	Focus group interview with: Alice Agricultural Extension Officer (Gwali) on June 7, 2016
June 8, 2016; November 24, 2016	**Meetings with Fort Cox College top management** to discuss joint object and to highlight "grey zones" (Engeström, 1987, p. 114), and to review proposed model solutions. These meetings were attended by the Principal and the Total Quality Assurance Manager.
June, August 2016	**Boundary Crossing Change laboratory workshops in Matole Basin** (BCCLWMSA1 – May 27, 2016; BCCLWMSA2 – August 24, 2016)
September 8, 2016	Interviews with Youth farmers in Matole Basin (YFSA2 & YFSA3)

Appendix 3.3B: List of my Field Engagements in the Zimbabwean Case Study

Date(s)	**Activity**
May 26, 2015 (ODAEZ2); February 11, 2016 (ODAEZ1)	Key informant interviews and consultations among senior agricultural education staff in Harare
January 15, 2015 (FZ1); October 2013, February 14, 2015; February 19, 2016 (FZ2); January 9, 2014, February 14, 2015 (FZ3); January 9, 2014, January 7, 2015 (FZ4); August 11, 2016 (FZ5); April 1, 2013 (AEWZ1); January 7, 2015 (AEWZ2); February 13, 2015 (ACLZ1); March 25, 2015 (ACLZ2/ FGI); February 19, 2016 (ACMZ1)	Key informant interviews in Zvishavane, Mazvihwa and Mlezu
June 26, 2015 (ACMZ2); August 11, 2016 (FZ5)	Key informant interviews in Empress, Zhombe and Rio Tinto
January 15, 2015; February 12, 2015; April 23, 2015	Boundary Change laboratory workshops 1 to 4 respectively in Zvishavane
April 22, 2016	Boundary Change laboratory workshops at Mlezu Agricultural College
February 19, 2016; August 8, 11-12, 2016; October 28, 2016	Boundary Change laboratory workshops at Rio Tinto Agricultural College

Appendix 3.4A: Extract of Soil and Water Conservation Course from Fort Cox College Prospectus, 2015



AGRICULTURE COURSE

This course is done by students who are studying towards diploma in agriculture.

Soil and Water Conservation (SS 221)

Course Outline

Soil Erosion (types, causes, prevention and control),
Reclamation of degraded lands,
Soil conservation techniques (contours, ridges, terracing etc),
Water conservation techniques,
Rainwater harvesting (infield and outfield), and
Loss of water in the field.

Major Objective

An introductory course that is aimed at building the students' understanding the sensitivity of the soil and how it can be utilized sustainably by conserving it

Irrigation Principles (AE222)

Sources and types of water, Crop water requirement and Irrigation scheduling , Effect of soil properties on infiltration, drainage, water holding capacity and irrigation, Soil moisture determination, Irrigation systems and their designs.

Major Objective

- To equip students with the understanding of soil-plant and water dynamics and relationships.

Appendix 3.4B: Sample of Curriculum Documents from the Zimbabwean Agricultural Education and Farmer Training Activity System (Extract of Agricultural Engineering Syllabus)

MINISTRY OF AGRICULTURE, MECHANISATION AND IRRIGATION DEVELOPMENT

DEPARTMENT OF AGRICULTURAL EDUCATION AND FARMER TRAINING

NATIONAL DIPLOMA IN AGRICULTURE: CHIBERO, GWEBI, MLEZU, ESIGODINI, RIO TINTO, AND SHAMVA

SYLLABUS FOR AGRICULTURAL ENGINEERING

BACKGROUND TO THE REVIEW

The panel realized that the students we now train have several employment options but not necessarily the usual government employment. Graduates of today now need to see themselves as future employers and such, their training must gear them to be self employed. They need more hands on experience than just large amounts of theory. The trainers must be well prepared to give the hands on training necessary to move agriculture from subsistence to commercial. Two new courses are proposed to replace Civil Engineering and Traction and Transport 2. Traction and transport 1 could be moved to the final year.

FIRST YEAR

1.0 BASIC ENGINEERING

1.1 INTRODUCTION

1.2 SI UNITS

1.3 M0TION OF A POINT

1.4 APPLIED MECHANICS

1.5 EQUILIBRIUM OF FORCES

1.6 MOMENTS OF FORCES

1.7 FRICTION

1.7.1 Laws of friction. Force of friction or frictional resistance. Coefficient of friction

1.8 SIMPLE MACHINES

1.9 STRESS AND STRAIN
1.10 PRESSURE
1.11 THEORY OF GASES
1.12 HEAT TRANSFER

NUMBER OF LECTURES : 50
NUMBER OF HOURS: 33

2.0 ELECTRICAL ENGINEERING
2.1 BASIC ELECTRICITY
2.2 STATIC ELECTRICITY
2.3 THE ELECTRIC CURRENT
2.4 EFFECTS OF ELECTRIC CURRENT
2.5 DIRECT CURRENT AND ALTERNATING CURRENT: MEASURING INSTRUMENTS AND METERS
2.6 ALTERNATING CURRENT
2.7 GENERATORS OF ELECTRICITY
2.8 ELECTRIC MOTORS
2.9 MAINS ELECTRIC (ZESA REQUIREMENTS)
NUMBER OF LECTURES : 30

NUMBER OF HOURS 20
3.0 TRACTION AND TRANSPORT 1

3.1 INTRODUCTION
3.2. ENGINES
3.3 ENGINE COMPONENTS (PETROL AND DIESEL ENGINES)
3.4. COOLING SYSTEM
3.5 LUBRICATION SYSTEM
3.6 FUEL SYSTEM IN PETROL ENGINES
3.7 FUEL INJECTION SYSTEM (PETROL AND DIESEL)
3.8 ELECTRICAL SYSTEM
3.9 INTAKE AND EXHAUST SYSTEM
NUMBER OF LECTURES: 65
NUMBER OF HOURS: 43

SURVEYING

4.0 INTRODUCTION
4.2. AGRICULTURAL SURVEY:
4.3 BACKGROUND MATHEMATICS
4.4. DISTANCE AND AREA MEASUREMENTS
4.6 LEVELLING
4.7 SITE SURVEYING

4.8 GRID SURVEYING
4.9 PROFILE SURVEYING

NUMBER OF LECTURES: 40
NUMBER OF HOURS: 27

5. **FARM STRUCTURES**

Lecture hours

NUMBER OF LECTURES: 42

Expected output:

The student should be able to put up simple to moderately complicated farm structures during and after the course.

Delivery approach

The students must be taught in a practical setting with the theory lectures being given just before each practical. The course must of necessity not be a classroom type of course but one which is done in an open space with building materials available to show and demonstrate their usage. The appropriate tools must also be availed to each College for effective training.

6.0 APPROPRIATE TECHNOLOGY

6.1 Definition, importance and application
6.3 ANIMAL DRAFT POWER

NUMBER OF LECTURES : 25

NUMBER OF HOURS : 17

PROJECT: Building Design and Drawing Project
7.0 VALUE ADDITION TO AGRO-PRODUCTS

INTRODUCTION
It is an accepted fact that selling raw farm products does not offer the best returns. Limited knowledge on possible options is often the setback. There are few skilled people on the ground to process agro-products. Training students at Diploma level in the art and science of value addition will open many avenues for the graduates and farmers to generate increased incomes from their produce.

Objectives

i) Develop in students an appreciation of the systems used in value addition

ii) Offer students other avenues of creating employment and wealth for themselves and their employees.

SECOND YEAR:

At least nine months attachment on a commercial farm ,estate, agricultural government departments(irrigation, LPD, AGRITEX, Research institutes, seed houses, and agro-processing and marketing companies, implement manufacturing companies) as approved by the Principal Councils. The assessment criteria for work related learning must include academic supervisor report, employer assessment report and student attachment report.

SYLLABUS FOR AGRICULTURAL ENGINEERING

FINAL YEAR

1.0 IRRIGATION

1.1 INTRODUCTION

1.1.1 Historical background:

1.1.2 Developmental stages of irrigation in Zimbabwe in relation to Agroecological regions,

1.1.3 Need for irrigation in Zimbabwe.

1.2 SOIL-PLANT-WATER RELATIONSHIPS

1.3 IRRIGATION SCHEDULING

1.3.1 Water requirements during crop growth and development, Water requirements for maize, tobacco, cotton, winter wheat and fruits (deciduous and citrus).

1.3.2 Methods used for water replenishment; pan evaporation, Et/Eo ratio concept and pan man, irrigation scheduling, indicator board and calculations

1.4 WATER MEASUREMENT AND CONTROL

1.4.1 Water measurement: Float method, dye method and current meter.

1.4.2 Devices for measuring and controlling water in channels: Weirs, drops, chutes.

1.5 WATER CONVEYANCE AND CONTROL

1.5.1 Estimation of discharge from canals and formula used.

1.5.2 Surface water distribution system channel and canal underground pipe line distribution system.

1.5.3 Irrigation system conveyance efficiencies (distribution efficiency, water use efficiency, application efficiency and conveyance efficiency)

1.6 IRRIGATION: WELLS AND BOREHOLES

1.6.1 Ground water and aquifers, hydraulic of wells, design of irrigation boreholes.
1.6.2 Boreholes construction procedure

1.7 IRRIGATION METHODS

1.7.1 Irrigation potential of different soils,
1.7.2 Methods: surface irrigation, overhead irrigation, drip irrigation, subsurface irrigation.
1.7.3 Design of flood irrigation systems.
1.7.4 Design of sprinkle irrigation system.
1.7.5 Checking efficiency and fault finding in sprinkler irrigation.
1.7.6 Maintenance of irrigation systems

1.8 PUMPS AND WATER RETICULATION SYSTEMS

1.8.1 Types of irrigation pumps (Centrifugal, submersible, turbine, mono pump, Bush pump, mixed axial)
1.8.2 Electric motor and diesel/petrol engine driven pumps.
1.8.3 Selection of pumps. power requirements and efficiency, frictional losses in pumps and pipelines, pipeline layouts. Design of water reticulation systems.

1.9 LAND DRAINAGE

1.9.1 Drainage of irrigated lands, sources of excess water, drainage problems,
1.9.2 Types of drainage systems(open, closed/tile and mole drains), planning and designing of drainage system.

1.10 SALT PROBLEMS IN IRRIGATED AGRICULTURAL LANDS

1.10.1 Salt balance, quality of irrigation water, plant response to saline and alkali soils.
1.10.2 Reclamation and management of salt affected soils.

1.11 ECONOMICS

Feasibility studies, cost estimates, capital requirements, budget analysis of schemes.

1.12 **NEW DEVELOPMENTS**

NUMBER OF LECTURES : 65

NUMBER OF HOURS : 43

2.0 TRACTION AND TRANSPORT II

2.1 Power take-off
2.2 Axles
2.3 Prop-Shafts
2.4. Suspension and steering systems

2.5 Tyres, tubes, wheel ballasting and weight transfer
2.6 Hitching of implements, selection and safety of tractors
2.7 Brakes
2.8 Hydraulic system of tractor
2.9 Transmission (power trains)
2.10 Administration

NUMBER OF LECTURES : 55

NUMBER OF HOURS : 37

3.0 FARM MACHINERY

3.1 INTRODUCTION
3.2 FIELD PERFORMANCE OF MACHINES
3.3 REVISION ON DEFINITIONS
3.4 IMPLEMENT DRAFT FORCES
3.5 1MPLEMENT POWER REQUIREMENTS

3.6 TILLAGE

3.6.1 Definition - tillage implement, tillage objectives, tillage methods.
3.6.2 Primary and secondary. Multi powered tillage tools.
3.6.3 Minimum tillage systems: objectives, zone or strip
3.6.4 Stubble mulch tillage: objectives - problems and implements used.

3.7 IMPLEMENTS
3.8. PRIMARY TILLAGE IMPLEMENTS:

3.8.1 Ploughs: mouldboard, tractor drawn. Reversible and conventional disc ploughs. Reversible and conventional rippers and chisel ploughs.
3.8.2 Ploughing methods: inland/systematic. squarely ploughing, round and round one way.

3.9 SECONDARY TILLAGE IMPLEMENTS:

3.9.1 Tool bars: types and where used harrows: Disc harrows: single acting, double acting.
Offset, tandem. Tine harrows; passive tools, active tools.
3.9.2 Rollers - packers: chisel rollers and Cambridge rollers, packers.
3.9.3 Ridgers: Disc ridger. mouldboard ridger.
3.9.4 Rotavators: passive tools. active tools.
3.9.5 Cultivating equipment: Different types of tines, rigid, coiled spring. double leaf. Spring loaded and spring tine cultivators. Different types of shares
used. Duck foot, and reversible. Gang tillers.

3.10 FERTILIZING EQUIPMENT:

3.10.1 Fertilizer spreaders: spinning disc, oscillating spout.
3.10.2 Fertilizing patterns, methods.
3.10.3 Fertilizer distributors (full width fertilizer distributor).

3.11. PLANTERS, DRILLS, AND FERTILIZER ATTACHMENTS:

3.11.1 Maize planters: Precision planters.
Horizontal plate metering device. Inclined plate metering devices.
Pneumatic metering systems. Pressurized drum, pressurized disc, vacuum disc. Vertical rotor metering device. Finger pick-up metering device.

3.11.2 Seed drills: studded roller, cup feed metering device (internal and external force feed metering).

3.11.3 Potato Planters, Fertilizer attachments on planters.

3.12 CROP PROTECTION SPRAYERS:

3.12.1 knapsack. ULV. dusting machines. boom sprayers, mist blowers, orchard sprayers, aerial sprayers.

3.13 HAY MAKING IMPLEMENTS:

3.13.1 Mowers, reciprocating, disc rotary mower, gearbox and gladiator rotary mowers. Drum mower, flail.

3.13.2 Hay rakes: acrobatic, tedder, wheel rake

3.13.3 Hay conditioners and crimpers.

3.14. FORAGE HARVESTING IMPLEMENTS:

3.14.1 flywheel type, cylinder type, single chop flail shredder, double chop flail type. self propelled forage harvester

3.15 HARVESTING EQUIPMENT:

3.15.1 Groundnut sheller, maize sheller, combine harvesters: cross flow, axial flow.

3.15.2 Potato harvesters - digger harvester,

3.15.3 Cane, cotton harvester

3.16 MILKING MACHINE AND DAIRY EQUIPMENT:

3.16.1 Milking machines:(types:pipelines, bucket, recorder type)

3.16.2 components: pipelines, vacuum pumps, pulsators, vaccum regulator, vacuum gauge, claw, teat cup ,air admission hole, milk receiving and cooling systems.

3.16.3 Bulk milk equipment tankers. Self cleansing components and automation

3.17 PROCESSING MACHINES:

3.17.1 Hammer mills., augers., elevators., mixing machinery.

3.18 GRAIN AND HAY DRIERS:

Principles of drying: batch driers, continuous driers, cross-flow, tray driers.

3.18.1 Layout and working principles of different types.

3.19 REFRIGERATION

3.19.1 Theory of refrigeration, refrigerators, milk coolers, milk storage tanks, cold rooms refrigerants, maintenance.

3.20 BOILERS

3.20.1 Farm boilers, layouts and fittings, correct operation, requirements of/ or Inspection / legislation, safety.

NUMBER OF LECTURES : 80

NUMBER OF HOURS 54

SOIL AND WATER CONSERVATION

PART I :

4.0 SOIL CONSERVATION

4.1 HISTORICAL BACKGROUND

4.1.1 Conservation practices during the 19th century e.g. use of ridges in vlei.
4.1.2 Conservation practices during early to mid 20th century e.g. introduction of 1951 Native Land Husbandry Act. 1970 Land Tenure Act. Formation of NRB in 1941.Formation of Conex 1947.
4.1.3 Erosion Research (experiments and models)
4.1.4 Current trends in conservation

4.2 ENVIRONMENTAL SCIENCE

4.2.1 Ecology systems analysis. Food web and food chain
4.2.2 Natural Resources: Land, water and climate, renewable and non-renewable natural resources.
4.2.3 Pollution: soil, water, air
4.2.4 Population Dynamics: Malthus principles & equation, biotic potential, environmental resistance, control of population.

4.3 SOIL EROSION

4.3.1 Causes of soil erosion: water, man, wind, snow.
4.3.2 Types of soil erosion: Splash. Sheet, rill, gully, wind, wave-action, stream-bank, slip, subsurface.
4.3.3 Factors affecting soil erosion: climate (rainfall and wind), soil property.
4.3.4 Soil erosion formulae: Universal soil loss equation (USLE), soil loss equation -model for Southern Africa (SLEMSA).challenges of the models

4.4 EROSION CONTROL

4.4.1 Biological control - agronomic control soil management and land use practices.
4.4.2 Mechanical control - storm drains, design, pegging, construction. Contours (standard, non-standard, narrow based, broad based, parallel and non-parallel) design, pegging and construction. Waterways (Artificial and natural) shape and site. Grass strips, terraces, ridges - tie-ridges, pot-holing. Gully erosion and control.

4.4.3 Tillage system: conventional tillage, trash farming, mulch tillage, strip tillage, zero tillage, minimum tillage.

4.4.4 Protection techniques: On grazing lands in communal and commercial areas.

4.5 RESEARCH AND DEVELOPMENTS

4.5.1 Elwell's work on determining grass, mulch and crop cover in relation to soil loss.

4.5.2 Hudsons work: Soil loss slopes/curves.

4.5.3 Recent erosion research studies

NUMBER OF LECTURES : 30

PART II :

5.0 WATER CONSERVATION

5.1 INTRODUCTION

5.1.1 Importance of water, uses: Primary and secondary uses.

5.1.2 Conservation of water in Zimbabwe.

5.1.3 Effective rainfall. Hydrological cycle.

5.2 RUN-OFF

5.2.1 Definition of run-off, factors affecting run-off.

5.2.2 Estimation of run-off from various catchments. Estimating rates of surface run-off (rational method and Cook's method).

5.3 DAMS

5.3.1 Definition of dams, site selection, formulae for estimating capacity, basin and earthwork.

5.3.2 Design and construction of spillwav.

5.3.3 Types of dams: Earth fill dams, Rockfill, Solid ,Masonry and Gravity.

5.3.4 Types of earthen dams: homogeneous, zoned embarkment, diaphram type.

5.3.5 Dam design and construction.

5.3.6 Causes, prevention and control of dam faults.

5.3.7 Materials used, earthworks calculations and costs in earth dams

5.3.8 Maintenance of farm dams.

5.4 LEGISLATION

5.4.2 Water Act of Zimbabwe.

NUMBER OF LECTURES : 10

NUMBER OF HOURS : 7

6.0 RECLAMATION OF DEGRADED LANDSCAPES

COURSE OBJECTIVE

The course will provide an appreciation of the concept of healthy landscapes, and how landscapes health can be assessed. The nature, extent, causes, assessment and impacts of landscape degradation will be discussed. Practical measures that can be taken to reclaim degraded agricultural landscapes will be discussed.

6.1 INTRODUCTION (1 HOUR)

Current state and trends of landscape degradation in Zimbabwe and southern Africa

6.2 LANDSCAPE HEALTH AND INTEGRITY (1.5 HOURS)
6.3 ENVIRONMENTAL EVALUATION (3 HOURS)
6.4 LANDSCAPE DEGRADATION (3 HOURS)
6.5 METHODS OF LANDSCAPE RECLAMATION AND REHABILITATION (3 HOURS)

6.6 CONSERVATION AGRICULTURE (2 HOURS)

6.6.1 Definition of conservation agriculture
6.6.2 Pprinciples of conservation agriculture
6.6.3 Applications of conservation agriculture
6.6.4 Zimbabwe examples
6.6.5 Limitations of conservation agriculture in Zimbabwe

7.0 URBAN AGRICULTURE AND THE ENVIRONMENT (1 HOUR)

7.0 COURSE CONTENT

7.1 Introduction (40 minutes)
7.2 Agro-ecosystems (160 minutes)
7.3 Biodiversity (80 minutes)
7.4 Aquatic ecosystems (120 minutes)
7.5 Agricultural sustainability (120 minutes)

7.5.1 Introduction, definition, importance of sustainable agriculture, poverty and unsustainable agriculture
7.5.2 Sustainability factors: economic, social, environmental
7.5.3 Inter-linkages of sustainability factors
7.5.4 Indicators of agricultural sustainability
7.5.5 Good agricultural practices for sustainable agriculture
7.5.6 Barriers to sustainable agriculture

7.6 Environmental health (80 minutes)

7.6.1 Introduction, human health, 'environmental health
7.6.2 Agriculture related environmental health concerns
7.6.3 Food safety, chemical pollution of air and water, food contamination by manure, ground water contamination

7.6.4 Options for addressing problems

7.7 Waste management and pollution control (120 minutes)
7.8 Geographic Information Systems and remote sensing (80 minutes)
7.9 Climate change and variability (120 minutes)

7.9.1 Introduction to weather and climate, global climate trends, greenhouse gas effects, causes of increased GHG emissions
7.9.2 Climate change scenarios for Zimbabwe
7.9.3 Effects of agriculture on GHG emissions
7.9.4 Increased temperature, droughts floods effects on agriculture
7.9.5 Climate change mitigation
7.9.6 Climate change adaptation

7.10 Environmental Policies, strategies and legislation (120 minutes)
7.11 Topical national and global environmental issues (80 minutes)

7.11.1 Millennium Development Goals concept, ZUNDAF Global climate change
7.11.2 Desertification
7.11.3 Limited freshwater resources Loss of biodiversity
7.11.4 Overpopulation
7.11.5 Human pandemics

PROJECTS:

1. Fabrication Project.
2. Irrigation / Mechanisation (written) Project.

Appendix 3.5A: Change Laboratory Workshop Training at CRADLE, University of Helsinki

Dear Professor Heila Lotz-Sisitka and Ph.D. student Tich Pesanayi

Thank you very much for your application to the international course on the Change Laboratory method for research and development teams. We are happy to accept your application and invite you to take part to the course provided that you can get the explicit consent concerning the Change Laboratory intervention from the organization in which you intend to carryout the intervention.

Before the course starts in March 2, 2015, we kindly ask you and your team to do the following:

First, you will shortly receive the invoice of the participation fee. Please make the payment by February 10th, 2015. This confirms your team's attendance to the course.

Second, as a course participant, you need to have a written consent from your research site for collecting data and carrying out the Change Laboratory intervention in this site. If you have not already secured the intervention site and informed us about it, please do it by February 10th, 2015, at the latest and send it to us (anu.kajamaa@helsinki.fi, jaakko.virkkunen@helsinki.fi).

Third, please write a short (1-2 pages) introduction describing the activity that will be the target of your Change Laboratory intervention. Please send it to us by February 10th, 2015 to be circulated to the other course participants. Include in the introduction the name of the target activity, its location and the putative purpose of the Change Laboratory intervention as well as, if possible, 1-2 photos of the activity.

Fourth, in order to be able to discuss and plan your Change Laboratory intervention during the course, you need to collect preliminary data about the activity that is the target of your intervention. Data collection for the preparation of a Change Laboratory intervention is discussed in the book of Virkkunen & Newnham (2013) *The Change Laboratory* on pages 69-74. We suggest that, before the course, you select 3 to 5 informants who represent different professional groups and can give you information on different aspects of the activity and/or see it from different perspectives and interview them on the following two themes:

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI
KÄYTTÄYTYMISTIETEELLINEN TIEDEKUNTA
BETEENDEVETENSKAPLIGA FAKULTETEN
FACULTY OF BEHAVIOURAL SCIENCES

Contact: Phone (Kajamaa) 0408232368, anu.kajamaa@helsinki.fi

Center for Research on Activity Development and Learning CRADLE
Institute of Behavioural Sciences, P.O. Box 9 (Siltavuorenpenger 3A),
00014 University of Helsinki, www.helsinki.fi /cradle/

1. Major qualitative changes in the history and current phase of the activity (choose a time span that the informant finds meaningful, however, rather long than short).
   A general description can be specified by picking up change events that have affected
   - the object/clientele and purpose of the activity
   - the kind of subjects who carry out the activity
   - the operating principles and tools used in the activity
   - the organizational context of the activity
   - inner division of labor within the work community, and
   - the key rules the actors observe.
2. Problems and recurrent disturbances.
   The informant's view of most important recurrent problems.
   A narrative of a typical/revealing disturbance in dealing with the object of the activity, e.g., in a client case.

Please bring a summary of the main results of your data collection and also the raw data collected with you to the course. If concise documentation of the history of the activity is available and provided to you by your research site, bring also the documents with you.

The course is based on the assumption that the participants have prior knowledge about the Cultural Historical Activity Theory on which the Change Laboratory method is based. This background of the method can be read up on the third chapter of the book of Virkkunen & Newnham (2013) *The Change Laboratory*.

The participants will be given a certificate of their participation to the course. For student participants we will, as representatives of the University of Helsinki, write a certificate of four study credits (4 ects) after the course and the second supervision session concerning the conduction of the actual Change Laboratory intervention.

Please do not hesitate to contact us if you need further information.

Yours truly,

Jaakko Virkkunen Professor Emeritus
Course leader

Anu Kajamaa, PhD, Postdoctoral Researcher
Course coordinator

Center for Research on Activity, Development and Learning (CRADLE),
Institute of Behavioural Sciences
P.O. Box 9, (Siltavuorenpenger 3 A), 00014 University of Helsinki, Finland

Appendix 3.5B: Change Laboratory Workshop Training at University of Helsinki: Field Proposals

AMANZI FOR FOOD – PROPOSED LEARNING NETWORK ENGAGEMENT PROCESS (into which we will build CLWs over the period of time)

Background:

The Amanzi for Food programme is ongoing for the next two years (we have already completed one year of fieldwork). For this programme we are focussing especially on mediating tools, situating their use within a learning network which involves stakeholders from multiple activity systems, all concerned with the common object of rainwater harvesting and conservation practices (RW&C) at the college / farmer support / farmer interface. We have identified mediating tools for a set of 11 RWH&C practices which provides opportunity for expanding the activity of RW&C, depending on the scale of the farming activity, and the focus of the training that intended by colleges.

Tichaona Pesanayi's research is located within this programme (of which only a part is included in his PhD – hence the shorter time frame we submitted), but the processes that we will work with in the Amanzi for Food Programme will be ongoing during 2015, and continue into 2016. We will also have a post-doc on the programme in 2015 and another M.Ed scholar.

Based on the wider framework for the Amanzi for Food project roll out, Tichaona has submitted the following revised time table of the programme's roll out activities, which provides opportunities for ongoing expansion of activity via CLWs over the period.

Our overall research goal is to develop, for the Water Research Commission, an Action Oriented Strategy for the expansion and use of RWH&C knowledge and practice at the college / farmer support / farmer interface. We are hoping that the lessons learned in this process can therefore be more widely shared for agricultural extension trainining in SA and in SADC which is a water scarce country, facing severe threats from climate change in small scale agricultural contexts.

Existing data and proposed timing of learning network engagement and CLWs

We have already a large amount of data from 2014 documentary scoping, sector analysis, and fieldwork which was undertaken to scope engagement with RWH&C amongst the different stakeholder groups, providing good insights into their AS and some of the rules, mediating tools, etc. and I will work with Tichaona to crystallise the emerging findings on theses AS in summative form before the March workshop.

We have already had three learning network meetings with the stakeholder groups in which they have agreed to work together to improve the inclusion of RWH&C in their farming activities, and in education and training activities, and they are already making a start towards working on agreed upon demonstration site developments. In this project our interest is the border crossing between agricultural colleges and training centres, and farmers' learning and knowledge. This represents a broad plan which extends the work beyond the dates that Tich has for his PhD fieldwork, but aligns with the roll out of the Amanzi for Food programme activities.

Session 1: February 2015: Mirror data on RWH&C demonstration sites to agree on join demonstration activity for RWH&C to be examined (already substantive field-based research has been undertaken in 2014 into the existing practices of the following activity system partners relted to RWH&C demonstrations) in the Eastern Cape site where we are working:

(1) AS of agricultural educators involved in curriculum innovation & setting up training demonstration sites/tools in [i] rainwater harvesting, and in supporting a [ii] value chain;
(2) AS of extension service officers and NGOs facilitating rainwater harvesting training and demonstration sites;
(3) AS of farmers practising / experimenting with rainwater harvesting activities and /or productive demonstration sites; farmers producing seed stock and vegetables for a value chain; and farmers [iii] growing open pollinated seed varieties;
(4) AS of local authority economic development agency facilitating rainwater harvesting activities / productive demonstration sites and growing of open pollinated seed varieties,
(5) AS of cooperative [iv] processing vegetable products and marketing soups.

Some field visits will take place between Feb and April for field-based follow up.

Session 2 : April 2015 – approx. 6 weeks later than session 1, but involving documentation and mirror data presentation of emerging contradictions, and associated agentive engagement with development of the agreed upon demonstration/s for RWH&C and how it was implemented by those in the February workshop. Reflection and agreement on how to further develop demonstrations / practice sites for learning that cross the college / farmer support / farmer boundaries. Also focus on use of WRC materials in curriculum change. (CLW 2 hours)

Session 3: June 2015 – Ongoing engagement with agreed upon priorities focussing on the absenting of contradictions and development of new RWH&C activity and related training activities that crosses the college / farmer support / farmer boundary. Reflections on presence or absence of transformative – cross-boundary agency in RWH&C practice and training contexts (farming support and colleges narratives of practice)

Session 4: July/ August 2015: Ongoing engagement with agreed upon priorities focussing on the absenting of contradictions and development of new RWH&C activity and related training activity that crosses the college / farmer support / farmer boundary. Reflections on presence or absence of transformative – cross-boundary agency in RWH&C practice and training contexts (farming support and colleges narratives of practice)

Session 5: September 2015: Ongoing engagement with agreed upon priorities focussing on the absenting of contradictions and development of new RWH&C activity and related training activity that crosses the college / farmer support / farmer boundary. Reflections on presence or absence of transformative – cross-boundary agency in RWH&C practice and training contexts (farming support and colleges narratives of practice)

Session 6: October 2015: reflection and documenting lessons learnt for local cross-boundary agency and possible scaling up in the general area, and process lessons for the national Action

Oriented Strategy for RWH&C learning. Plan for ongoing expansion learning and work in the learning network

Session 7: February 2016: reflection on internal facilitation of expansive learning work and formal closure of externaly facilitated expansive learning in the learning network

site developments. In this project our interest is the border crossing between agricultural colleges and training centres, and farmers' learning and knowledge. This represents a broad plan which extends the work beyond the dates that Tichaona has for his PhD fieldwork, but aligns with the roll out of the Amanzi for Food programme activities.

1. **Session 1: February 2015:** Mirror data on RWH&C demonstration sites to agree on join demonstration activity for RWH&C to be examined (already substantive field-based research has been undertaken in 2014 into the existing practices of the following activity system partners relted to RWH&C demonstrations) in the Eastern Cape site where we are working:

   (1) AS of agricultural educators involved in curriculum innovation & setting up training demonstration sites/tools in [i] rainwater harvesting, and in supporting a [ii] value chain;
   (2) AS of extension service officers and NGOs facilitating rainwater harvesting training and demonstration sites;
   (3) AS of farmers practising / experimenting with rainwater harvesting activities and /or productive demonstration sites; farmers producing seed stock and vegetables for a value chain; and farmers [iii] growing open pollinated seed varieties;
   (4) AS of local authority economic development agency facilitating rainwater harvesting activities / productive demonstration sites and growing of open pollinated seed varieties,
   (5) AS of cooperative [iv] processing vegetable products and marketing soups.

   Some field visits will take place between Feb and April for field-based follow up.

Session 2 : April 2015 – approx. 6 weeks later than session 1, but involving documentation and mirror data presentation of emerging contradictions, and associated agentive engagement with development of the agreed upon demonstration/s for RWH&C and how it was implemented by those in the February workshop. Reflection and agreement on how to further develop demonstrations / practice sites for learning that cross the college / farmer support / farmer boundaries. Also focus on use of WRC materials in curriculum change. (CLW 2 hours)

Session 3: June 2015 – Ongoing engagement with agreed upon priorities focussing on the absenting of contradictions and development of new RWH&C activity and related training activities that crosses the college / farmer support / farmer boundary. Reflections on presence or absence of transformative – cross-boundary agency in RWH&C practice and training contexts (farming support and colleges narratives of practice)

Session 4: July/ August 2015: Ongoing engagement with agreed upon priorities focussing on the absenting of contradictions and development of new RWH&C activity and related training activity that crosses the college / farmer support / farmer boundary. Reflections on presence or absence of transformative – cross-boundary agency in RWH&C practice and training contexts (farming support and colleges narratives of practice)

Session 5: September 2015: Ongoing engagement with agreed upon priorities focussing on the absenting of contradictions and development of new RWH&C activity and related training

activity that crosses the college / farmer support / farmer boundary. Reflections on presence or absence of transformative – cross-boundary agency in RWH&C practice and training contexts (farming support and colleges narratives of practice)

Session 6: October 2015: reflection and documenting lessons learnt for local cross-boundary agency and possible scaling up (generativity) in the general area, and process lessons for the national Action Oriented Strategy for RWH&C learning. Plan for ongoing expansion learning and work in the learning network

Session 7: February 2016: reflection on internal facilitation of expansive learning work and formal closure of externally facilitated expansive learning in the learning network

Appendix 3.6A: Initial Categorisation of Data from the South African and Zimbabwean Nested Case Studies

Category (South African nested case study)	Category (Zimbabwean nested case study)	Theoretical frame of networked systemic elemental categories (CHAT)
Smallholder / small-scale farmers and 'subsistence and household food producers' in Nkonkobe are heterogeneous groups with diverse levels of relational capabilities influenced by historical marginalisation and contemporary depravation. The role over time of segregatory State laws and policies, and contemporary of democratic State policies on **access to communal farming resources and traditional common and collective activities** with family as basic unit, on the **value and valuing of farming as a cultural and commercial activity**, and on **the survival of its artefacts**. The **curricula of historically black agricultural education and training institutions** have been influenced by deliberate hegemonic policies of offering compromised and poor quality education and training to black students that created a type of subaltern destined for white farm labour. In the post-apartheid paradigm a different form of hegemony has been replaced by its ante-type through an impositional superiority of science knowledge subjugating other knowledges such as farmer's local, traditional and indigenous knowledge. This new hegemony is religiously mediated by the (colonised) academy and its partner the extension services.	Smallholder / small-scale farmers and 'subsistence and household food producers' in the Midlands Provice are heterogeneous groups with diverse levels of relational capabilities influenced by historical marginalisation and contemporary depravation. Two groups of farmers can be distinguished according to capability, the typical small-scale farmers and farmer innovators employing RWH&C and/or traditional locally adaptive seed. State policies on supporting marketing or trade in OPV / traditional grain have been generally poor. Traditional governance structures support **access to communal farming resources and traditional common and collective activities** with family as basic unit, on the **value and valuing of farming and co-existence as a cultural activity**, and on **the survival of its artefacts**. The **curricula of state agricultural education and training institutions** have been influenced by the commercial farming systems and knowledge that value commodification over many years and continues to be mediated by the (colonised) academy and its partner the extension services at the expense of other knowledges.	Historicity
Smallholder rural farmers and their farmer and water user associations, **Agricultural Educators** in Agricultural colleges and universities, who are trained scientists; Public **Extension Officers** and **Local Economic Development Agency Facilitators** are the key agricultural actors directly influencing the sustainability learning and practices of agricultural water and local seed-input value chain systems in Nkonkobe Local Municipality. Farmers face problems of lack of **poor youth participation** and lack of inter-generational knowledge transfer and labour sharing (division of labour).	**Typical Smallholder/small-scale rural farmers** and the local networks and the Zimbabwe Farmers Union, **Small-scale farmer innovators**, **Agricultural Educators** in Agricultural colleges and universities, who are trained scientists; Public **Extension Officers, Extension Workers** and **NGO Field Officers** are the key agricultural actors directly influencing the sustainability learning and practices of agricultural water and local seed-input value chain systems in rural Zimbabwean farming contexts. Farmers face problems of lack of **poor product marketing** especially of tradition grain products.	Subject

• Most farmers in the Nkonkobe local municipality case study have **aspirations to improve their agricultural water** which is rain-fed and therefore subject to climate variability and change, and their seed with respect to climate change adaptability. They however lack appropriate resources, knowledge and skills. • Agricultural college students' practical work lacks alternative sustainable agricultural water and locally-adaptive seed training relevant for farming in water-stressed rain-fed conditions.	• Most farmers in the Zimbabwean case study have **aspirations to improve their agricultural water which** is rain-fed and therefore subject to climate variability and change, and their seed with respect to climate change adaptability. They however lack appropriate resources, knowledge and skills. • Agricultural college students' practical work lacks alternative sustainable agricultural water and locally-adaptive seed training relevant for farming in water-stressed rain-fed conditions.	Object
The agriculture educators are guided by a production-focussed **curriculum** and **courses** which culminate in an examination for students who exit with a Diploma qualification in Agriculture (Agribusiness, Animal Production or Crop Production). Curriculum generally biased on commercial agriculture (**commodification value**). A college agriculture **timetable** allows for both theoretical and practical teaching; however, the latter is not adequate for common cohort lecturers' practical aspirations and breeds conflicts. Resource constrained farmers receive **free seed-based inputs** from agricultural extension services in which they have no freedom to choose seed diversity; while other farmers feel dis-serviced through lack of choice in seed varieties offered and associated inputs; and experience threats to their **seed sovereignty** posed by inputs they deem to carry genetically-modified 'contaminants'. **Mechanical tillage using tractors** has dominated farming to the exclusion of animal traction.	The agriculture educators are guided by a production-focussed **curriculum** and **syllabi** which culminate in an examination for students who exit with a Diploma qualification in Agriculture (Agribusiness, Animal Production or Crop Production). Curriculum generally biased on commercial agriculture (**commodification value**). A college agriculture **timetable** allows for both theoretical and practical teaching. Farmers obtain **seed from the market (seed houses)** and from **seed saving and exchange.** NGOs and some government programmes facilitate procuring of **OPV seed** from Research Stations that support adaptability to climate variability and change. **Animal traction and minimum tillage** common.	Mediation instruments / artefacts / tools
Agricultural extension services are guided by the minimum "**Norms and Standards** for Extension and Advisory Services in Agriculture" (RSA. Department of Agriculture, 2005) which have a transformative and improved productivity agenda; and also operate under instructions from higher extension offices which may be in conflict with the above norms and standards. **Cropping programmes** tend to be top-down and lack authentic farmer participation especially in seed choices. **Demonstration plots** are used in extension practice.	Agricultural extension services are an extension of central government policy, and have been influenced by changes in the Ministry of Agriculture, sometimes with confusion as to the role of extension workers with regard to conservation works, thus affecting farmer support. **Demonstration plots** are the standard practice for extension. Agricultural colleges also operate under the policies of the Ministry of Agriculture. Principals Councils have been innovative in bringing in high stakeholder participation in **curriculum**	Rules

Agricultural colleges have their **own norms and standards** that govern their curriculum objectives regarding water and inputs, and graduate profiles and competences. **Curriculum reviews** are held regularly with stakeholder participation, however the commercial farming sector is dominant.	**reviews** that govern their curriculum objectives regarding water and inputs, and graduate profiles and competences. ***Ilima*** is a common practice among farmers to boost labour.	
Agricultural actors (smallholder farmers, college/university lecturers, extension officers, LED officers) have each other as sources of knowledge and collective labour (*ilima* in isiXhosa) in the spirit of Ubuntu. Their connectivity varies from collegiality to educator vs. learners but has potential for growth through co-engagement.	Agricultural actors (smallholder farmers, college/university lecturers, extension officers, NGO officers) have each other as sources of knowledge and collective labour (*ilima* in Ndebele) in the spirit of Ubuntu. Their connectivity varies from collegiality to educator vs. learners but has potential for growth through co-engagement.	Community
Responsibilities within and between collectives is compromised by power relations, especially between extension services and smallholder farmers and between college lecturers / trainers and these farmers, but has potential to grow conceptually into collaboration through joint learning. Colleges have a farmer training programme for small-scale farmers.	Responsibilities within and between collectives is compromised by power relations, especially between extension services and smallholder farmers and between college lecturers / trainers and these farmers, but has potential to grow conceptually into collaboration through joint learning. Colleges have a farmer training programme for small-scale farmers.	Division of labour

Appendix 3.6B: Quantification of Data – Interviews in the South African Case Study

Type of data	Number of interviewees	Duration	Hours / pages of transcription	Core participants	Activity focus
Interviews	**9** Agricultural educators and trainers	5 interviews:			
		FGI@FCC, **42 min**	4.9hr	ACLSA1 to 5; ACMSA1 and 2	Agricultural water
		ACLSA2B, 15/07/2014; **9min 50sec**	1.15hr	ACLSA2	Agricultural water
		ACLSA3A, 25/08/2015, **35min**	4.08hr, 13 pp. typed, Times New Roman, size 12, single spacing	ACLSA3; with approx. 20 students	Agricultural water, implementation of RWH&C in curriculum / class lesson
		ACLSA3B, 29/11/2016-04/12/2017	21 pages, Times New Roman, size 12, single spacing	ACLSA3	Agricultural water, reflections via WhatsApp chat
		ACLSA4, 04/04/2016, **47min 55sec**	5.59hr	ACLSA4	Agricultural water
	8 Students / youths	5 interviews:			
		ACSSA1 and 2, 27/10/2015 – approx. **30min**	3.50hr	ACSSA1 and 2 (Paired interview Fort Cox students)	Agricultural water
		YFSA1-**28min 38sec**; 06/02/2015	3.34hr	YFSA1	Agricultural water
		YFSA2, 08/09/2016 – **1hr 00min 29sec**	7.06hr	YFSA2	Seed and agricultural water
		YFSA3, 08/09/2016 – **23min 45sec**	2.77hr	YFSA3	Seed and agricultural water
		YFLVSAFGI (focus group), 28/10/2015-**21min 51 sec**	2.55hr	YFLVSA1-3	
	16 Farmers	9 Interviews:			
		FSA1 & FSA2 (paired interview),	7.10hr	FSA1 & FSA2	Agricultural water

		03/09/2014 – **1hr 51min**			
		FSA3, 01/02/2015 – **21min 16sec**	2.48hr	FSA3	Agricultural water
		FSA4, 06/02/2015 – **58min 28sec**	6.82hr	FSA4	Agricultural water
		FSA5, 14/05/2016 - **6min 15sec**	0.73hr	FSA5	Agricultural water
		FSA6, 14/05/2016 - **6min 15sec**	0.47hr	FSA6	Agricultural water
		FSA10, 13/05/2015 – approx. **10min 16sec**	1.20hr	FSA10	Seed and agricultural water
		FSA12, 12/05/2015 – **25min 23sec**	2.96hr	FSA12	Agricultural water
		FSA16, 20/05/2015 - **11 min 22 sec**	1.33hr	FSA16	Agricultural water
		FSA20, 10/05/2015 **34min 17sec**	4.00hr	FSA20	Agricultural water
	7 Government extension personnel	4 interviews:			
		EOSAFG, 15/07/2014 – **40min**;	4.67hr	EOSA1 to 3	Agricultural water
		EDSA1, 08/02/2016 - **11min 57sec**	1.39hr	EDSA1	Agricultural water
		EMSA2, 03/03/2016 – 21min 26sec + 9min 27sec = **30min 53sec**	3.60hr	EMSA2	Agricultural water
		EOSA4, 07/06/2016 – **14min 25sec**	1.68hr	EOSA4	Agricultural water and seed
	2 Local Economic Development Agency officers	2 Interviews:			
		NEDSA1, 06/11/2015; **15min**	1.75hr	NEDSA1	Seed and agricultural water
		NEDSA2, 29/01/2015; **12min 11sec**	1.42hr	NEDSA2	Seed and agricultural water

Appendix 3.6C: Quantification of Data – Interviews in the Zimbabwean Case Study

Type of data	Number of interviewees	Duration	Hours / pages of transcription	Core participants	Activity focus
Interviews	**8** Agricultural educators and farmer trainers	7 interviews:			
		ODAEZ2, 26/05/2015, **28min 38sec**	3.34hr	ODAEZ2	Agricultural water and seed
		ACLZ1, 19/01/2015, **4min 02sec**	0.47hr	ACLZ1	Agricultural water
		FGI ACLZ1 & ACLZ2, 1hr **25min 24sec**	9.96hr	ACLZ1 & ACLZ2	Agricultural water and seed
		ACLZ3, 13/02/2015, **25min**	2.92hr	ACLZ3	Agricultural water
		ACLZ5	4.5 pages WhatsApp chat (typed, Times New Roman, font size 12, single spacing)	ACLZ5	Agricultural water
		ACMZ2, June 2015	5.5 pages (typed, Times New Roman, font size 12, single spacing)	ACMZ2	Agricultural water and seed
	5 Farmers	6 Interviews:			
		FZ1, 02/04/2013, **47 min 08 sec**	5.50hr	FZ1	Agricultural water
		FZ2 (A), 08/01/2014, **2min 55sec**	0.34hr	FZ2	Agricultural water and seed
		FZ2 (B), 19/02/2016, **1h19min39sec**	9.29hr	FZ2	Agricultural water

		FZ3, 09/01/2014; **17min 06sec**	2.0hr	FZ3	Agricultural water
		FZ4, 07/01/2015, **29min 58sec**	3.50hr	FZ4	Agricultural water
		FZ5, 11/08/2016, **27min 06 sec**	3.16hr	FZ5	Agricultural water and seed
	4 Government extension personnel	3 interviews:			
		AEWZ1, 09/01/2014, **1h01min09sec**	7.13hr	AEWZ1	Agricultural water
		AEWZ2, 07/01/2015, **22min 42sec**	2.65hr	AEWZ2	Agricultural water and seed
		Paired interview AEO1 & AEO2, April, 2013, **50min 14sec**	5.86hr	AEO1 & AEO2	Agricultural water and seed
	1 Local Authority Environmental and Agricultural Officer	1 Interviews:			
		LAEOZ1, **20min**	2.33hr	LAEOZ1	Agricultural water

Appendix 4.1: Extract of Book Chapter by Author analysing Contradictions in Agricultural Water among Smallholder Farmers in South Africa

13 Exploring contradictions and absences in mobilizing 'learning as process' for sustainable agricultural practices

Tichaona Pesanayi

Introduction

Over 60 per cent of the staple the world eats is derived from rain-fed agriculture, a practice that covers 95 per cent of the agricultural area in Sub-Saharan Africa (FAOSTAT, 2005; Wani *et al.*, 2009). Nevertheless investment in its water potential has not been prioritized. Small-scale farming, while of varying importance in South Africa and Zimbabwe (the two countries referred to in this chapter), plays a critical role in mostly rural household food security and incomes in both countries. The quest for a more sustainable solution to agricultural water and appropriate seed systems is a key endeavour for small-scale farmers, but there is an interplay between different, ambivalent and sometimes contradictory information, knowledge and economic systems. Using agri-*cultural* water practices immersed in history and contemporary practices, this chapter explores the surfacing of contradictions and absences, framing possibilities for learning as process in collaborative developmental work in small-scale agriculture. In so doing, it opens up possibilities for formative intervention research and expansive learning to improve water supply, delivery and use challenges. The chapter shows how the emergence of contradictions and absences are related to generative mechanisms that have long-term effects on an object of activity, and how an understanding of these can be important for considering learning as a passage through the dialectic (Bhaskar, 1997; Nunez, 2013, 2014), strengthening especially the questioning phase in the expansive learning methodology used in cultural historical activity theory (Engeström, 1987).

Critical realism, agriculture and educational mediations

The current micro economies of both South Africa and Zimbabwe are characterized by large numbers of people living off the informal sector. Many of them live off the land but in a rapidly changing and variable climate which requires (re-)learning of new or forgotten skills at national and regional levels, and unlearning of cultural practices that deprive

Proof

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families of livelihood capabilities centred around water scarcity and increasing drought (SADC, 2012a, 2012b). According to reporting by the Intergovernmental Panel on Climate Change (IPCC), there is very high confidence that agricultural production and food security in Africa will be compromised (IPCC, 2012). South Africa is classified as a water-stressed and water insecure country, and relies on water imports from neighbouring Lesotho to ameliorate its freshwater requirements (Mashinini, 2010; Malzbender and Earle, undated). Climate change is threatening to worsen this water stress impacting on the agricultural sector from projected increases in temperatures and drought and variable rainfall within seasons (DEA, 2013). Ziervogel *et al.* (2014, p. 611) state: 'Using … community-based adaptation planning, adaptation has become an iterative co-learning process, rooted in farmers' existing knowledge of what works in practice. Such "rooted" adaptation strategies have included … soil and water conservation measures.'

In South Africa, more than 600,000 households engage in farming to produce the main source of food for the family. In addition, '*over a million households farm to supplement what they purchase*' (Watkinson and Makgetla, 2002, p. 2, my emphasis). Zimbabwe is also water insecure as demonstrated by repeated cycles of drought-related crop failure (Bird and Shepherd, 2003). The climate change projections for Zimbabwe paint an increasingly risk-prone picture for food security: 'Downscaled empirical models for Zimbabwe reflect similar expectations' for southern Africa of reduced precipitation coupled with high evapotranspiration in some seasons (Brown *et al.*, 2012, p. 4). The economy of Zimbabwe depends on agricultural production to a considerable extent (RBZ, 2005). According to the Reserve Bank Governor 'Agriculture is at the heart of the Zimbabwean economy, accounting for as much as 17% of GDP, about 27% of employment and 33% of total foreign exchange earnings' (RBZ, 2005, p. 6).

Educational processes can improve farmer, extension and educator agency by supporting learning from existing sustainability practices to improve biodiversity and food production (CBD Secretariat, 2012; Atchoarena and Delluc, 2002). But these need to be done well, i.e. they need to be responsive to changing conditions, extension and especially farmer needs. In previous educational research on investigating learning interactions in small-scale farming communities of practice, I found that it was important to understand the causal mechanisms that influence farmers' choices of cultivated food plants (Pesanayi, 2008, 2009), and the influence of persistent poverty on farmers' opportunities and freedoms. Farmers' choices are an expression of freedom that precedes or expands agentive action for sustainable development (Freire, 1998). Reflecting on persistent poverty from a critical realist perspective, Jones (2006) draws on Bhaskar's notion of 'presentism' – the overwhelming presence of the past's undesirable influences. However, the past and the present can be understood together. This need to connect with history and culture to

provide a structural explanation to contradictions calls for a dialectical approach to research, which accounts for non-fulfilment of things such as aspirations (Bhaskar, 1993, 2008). 'Dialectics states that the way change takes place is through *conflict* and *opposition* … always looking for the contradictions within people or situations as the main guide to what is going on and what is likely to happen' (Rowan, 2000).

Dialectical critical realism stresses the ontological superiority of absence, where in this case the concept of dialectic means 'absenting of absence' (Bhaskar, 1993). This view of the dialectic goes beyond the Hegelian construction of the dialectic, and challenges postmodern relativist notions of truth. It suggests that absenting absences can be a process of dialectical negation of contradictions that reveal absences, as will be discussed later in this chapter through a historical analysis of water supply and use practice in Lloyd Village in the Eastern Cape, one of the sites of my study.

In my research I am concerned with cross-boundary learning in selected small-scale farming practices nested in and across activity systems. I have been working with Engeström's (1987, 2000; Engeström and Sannino, 2010) cultural historical activity theory and expansive learning approaches to surface tensions and contradictions. This methodology provides potential for enabling learning *as passage* through the dialectic. In this process, absences must be identified so that learning 'emerges as the need to absent what has been left out' (Nunez, 2014, p. xvii). A critical realist approach to activity theory 'sees a relationship between the learner and the world' (Nunez, 2014, p. 3) and involves learners as investigators who can potentially engage in processes of collective and self-emancipation. The dialectic in such a context must 'empower us to understand reality' (ibid.). Basic critical realism states that we have a stratified and differentiated world, and structures and associated generative mechanisms are found in the domain of the real, differentiated from the domain of the actual and empirical (Bhaskar, 1998).

Njihia (2011) argues that critical realism provides tools and concepts that can contribute to transformative emancipatory learning amongst African policy makers, and can generate knowledge that leads to institutionalization of change as it is taught in institutions of learning.

In this study, in combination with cultural historical activity theory (discussed below), dialectical critical realism provides for 'the deepening of ontology (that) enables us to expand the range of categories, e.g. to take in *absence* and negativity, including *contradiction*, *internal relations*, etc., which may be employed in our laminated explanations of open-systemic phenomena' (Bhaskar, *et al.*, 2010, p. 13, my emphasis).

Methodology and theoretical underpinnings

At a broad level, this research attempts to answer the question: *What learning processes, interactions and opportunities can scale up innovative sustainability*

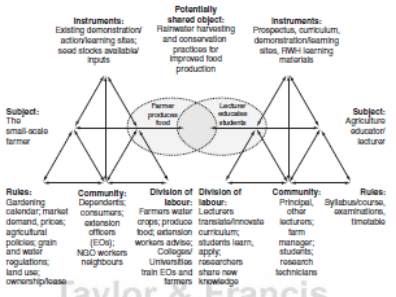

Figure 13.2 Third generation of activity showing small-scale farming activity system interacting with agricultural education activity system with potentially shared boundary object (source: adapted from Engeström, 2001, p. 136).

Historicity and 'following the object': the case of water supply, delivery and use for food gardening in the Lloyd Village Garden

A first phase of analysis involved identification of contradictions, which are deep-seated structural tensions shaped by generative mechanisms as explained by Engeström (1987). Identification of these contradictions requires careful historical analysis, combined with retroductive analysis to identify the generative mechanisms at work. This research process is significant for 'laying the foundations' for praxis oriented expansive learning, and is particularly important for boundary-crossing research and for beginning a process of learning as a 'passage through the dialectic' (Nunez, 2014).

Identifying the contradictions and tensions involves a process of questioning, which is significant in the further expansion of learning. Thus the first phase of the change process recommended by Engeström (2007, 2008) and colleagues (Warmington *et al.*, 2005; Virkkunen and Newnham, 2013) involves actors in an activity system or connected activity systems

(Engeström, 2007, 2008). Engaging in questioning of the activity helps to establish the 'need state' or 'learning as product' as explained by Bhaskar (1997; see also Nunez, 2014). This is also where primary contradictions are identified which provide the foundation for expanding learning (Engeström, 2001). In this regard, Engeström (1999) recommends giving attention to historicity, and suggests 'tracing the object': 'An expansive cycle is a re-orchestration of those voices, of the different viewpoints and approaches of the various participants. Historicity in this perspective means identifying the past cycles of the activity system' (Engeström, 1999, p. 35).

The case of 'tracing the object' in the Lloyd Garden case study (described in more detail below) demonstrates how when one 'follows the object' in cultural historical activity theory as recommended by Engeström *et al.* (2003), it is possible to see the emergence of new human activity over time. Critical realism helps to *explain this emergence* from the perspective of transformative social action, which is also a temporal perspective that accounts for the emergence of action in relation to structure via human agency (individual and collective in relation to four planar social being which includes intrapsychological and material planes) (Bhaskar, 2008). It also helps to identify absences for enabling further learning (Bhaskar, 1993; Nunez, 2014). As can be seen from the example below, emergence is also socio-cultural, socio-political and ethical in addition to being bio-physically linked, and temporal. Not all expansions of learning are transformative in an emancipatory sense, and critical realism helps us to decide 'which way is up' (Engeström, 1991) or how praxis may be considered transformative or not, and how one might develop an emancipatory perspective on praxis.

As recommended by Engeström in the citation above, 'historicity means identifying the past cycles of activity'. To do this, however, it is important to be clear on the object of activity which in this case is *water supply, delivery and use for productive food gardening* (referred to as Object A). This has been a key concern throughout the history of the Lloyd Village as will be seen below, but it has also taken different forms (Objects A1–4). In following the 'object' of water supply, delivery and use of water for productive food gardening in the context of the Lloyd Village Garden area in the Eastern Cape, I identified four object-historical distinctive cycles of expansive learning and change in human activity focusing on supply, delivery and use of water for food gardening. For ease of reference I call these Object A1 – traditional rainwater harvesting practices; Object A2 – pipe and pump supply; Object A3 – river to drum/tap to drum water supply practice; and Object A4 – emerging new practices for rainwater harvesting and conservation (RWH&C). Each of these is tied to forms of land use governance, market chain, and other social-historical circumstances as will be described below. Each of these are also shaped by the generative mechanisms that surround the historical social engineering projects of the colonial and apartheid states and which

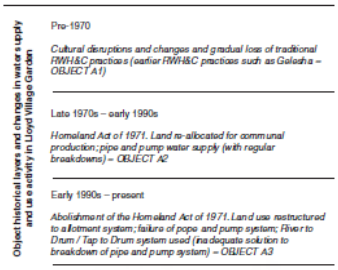

Figure 13.3 Historical layers of the object of water supply, delivery and use in Lloyd Village garden (source: developed by author).

continue to hold the core contradiction shaping the activity in place, which appears to be strongly related to persistent inequality and capability deprivation that exists in spite of aspirations for change, and available resources and knowledge (see below; Westaway, 2012).

The importance of time and place in an analysis of the generative mechanisms that shape and connect political economy, institutional culture, capacity development and human emancipation is described by McGrath *et al.* (2004, pp. 5–6) who 'show that systems are not static.… The linking of the historical and contemporary … bring(s) into clear focus that new meanings, policies and practices are based firmly in readings of the old' (see also Westaway, 2012). Bhaskar (1993) suggests that absenting of absences is a tensed-spatio-temporal affair.

Object A1. Pre 1970: historically constituted forms of water supply, delivery and use in community gardening contexts

Historical evidence from the Eastern Cape Province of South Africa shows that there has been a longstanding culture of practice focusing on rainwater harvesting and conservation. Denison and Wotshela (2009, p. 19) describe a practice of *Gelesha* as 'probably the oldest southern African recorded practice that entailed water harvesting and soil conservation'.

The Xhosa terminology *Gelesha Umhlaba* means 'hoeing or the tilling of the soil after a crop harvest'. In some areas it is described as *Ukuphethula Umhlaba* which means 'turning over the soil'. This practice was used to ensure that rain or dew could infiltrate the tilled soil so that it would provide moisture for the next planted crop. Denison and Wotshela go on to explain that: 'Historically Gelesha was done when a digging star (the Orion constellation) *Isilimela* appeared in the autumn and after the harvesting of the summer crops' (ibid., p. 19). This temporal approach via the appearance of a particular star constellation 'that signified the renewal of the soil hoeing season also marked the renewal of the year for sowing purposes' (ibid., p. 20). It coincided with the time of year (also reported as mid-winter, i.e. July) when cattle – usually oxen (for draught power) – were still strong enough due to food availability.

Gelesha-related practices were/are also part of the traditional farming culture in Zimbabwe where in some parts of the country it is known as *Kuvundukura*, literally meaning 'turning over the soil'. Other indigenous rainwater harvesting and conservation practices existing in this area include contouring which developed from the introduction of the ox-drawn plough. Other traditional water harvesting methods practised in the Eastern Cape of South Africa include homestead ponds and stone terracing (largely promoted by missionaries in the eighteenth century (Denison and Wotshela, 2009) and also practised in pre-colonial times in eastern and southern parts of Zimbabwe), among others.

This early practice showed that indigenous people used a form of retroductive or abductive analysis (judgement based on experience and observation of the elements and earth system cycles) to maximize the harvesting of precipitation (rainwater, dew or frost) for food production. It also shows the deeply intimate relationship between land, land use practices, agri-culture and the historically constituted forms of water supply, delivery and use in community food production practices. In the Lloyd Village Garden site in the Eastern Cape memory of this practice still existed, although this was only in the form of 'fragmented memory'.

As is well known, traditional forms of agriculture in the Eastern Cape in South Africa were severely disrupted by the various social engineering projects of the colonial and apartheid governments which were established to maintain white supremacy and to channel resource flows to those in power, issues which persist to this day (Westaway, 2012). Key amongst these social engineering policies, which have had a particular impact on the 'object of human activity' in focus in this paper (productive food gardening supported by successful supply, delivery and use of water) is the phenomenon of Bantu or Black Education which legislated for the limited development of the black person towards menial labour and associated vocations, and which also led to poor quality education for black people in South Africa (GoUSA, 1953; McGrath *et al.*, 2004). It reflects Antonio Gramsci's notion of the 'subaltern' who

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was subjugated by colonial policies, and its evolution into the new subaltern as contemporary reproduction of the inequity embedded in post-colonial policies and practices (Hoare and Smith, 1999) and opportunities for freedom. It also turned a longer-term tradition of agricultural practice amongst the amaXhosa into a practice that was seen to be a 'practice for the poor' and thus lacks appeal amongst modern-day youth.

The second major social engineering project of the apartheid state relates to ownership and distribution of farmland. In earlier colonial times in the Eastern Cape, productive farmland was concentrated into the hands of colonial masters (hence also the name of the village 'Lloyd Village'). The Bantu Homelands Citizenship Act of 1970 (Act No. 26 of 1970; successively renamed the Black States Citizenship Act, 1970 and later proclamation of the National States Citizenship Act, 1970) consolidated the apartheid state's policy of separatist development. This was to lead to legislated black de-naturalization, exclusion from participation as citizens in their own country, enforced ethnic nation-state development with meagre resources and hence a systemic institutionalized dual economy. Under this social engineering framework large tracts of land were reorganized and ownership transferred, restricting the Black population to about 13 per cent of the land. These two social engineering projects have had a profound and ongoing impact on the present capabilities of people who today occupy the area called 'Lloyd Village'.

Object A2. Late 1970s–early 1990s: pipe and pump water supply, delivery and use in a Bantustan structured communal gardening setting

Following the Engeström model of expansive learning actions it is possible to retrospectively analyse the emergence of the 'pipe and pump' water supply, delivery and use activity. The activity started soon after the proclamation of the 1971 Homeland Act when the land which was previously in the hands of the white famer family 'Lloyd' was transferred to the Ciskei 'homeland' government, who then allocated the land for communal land use (villagization) and food production. A decision was made to establish a communal garden on the site.

- **Questioning:** The key questions being deliberated soon after the land was allocated were related to how to establish a communal gardening system, and how to bring water to the garden. Some of the current questions were expressed as aspirations:

> We would like to repair our pump … but there are other problems. We don't have the funds at the moment, and our delivery pipe from the tank was damaged during road construction by the Municipality.
> (Garden Farmer, personal communication, 2 December 2014)

- **Analysis and modelling the new solution:** Historical records show that after some discussion the Ciskei government decided to install a pump and to pipe water to the garden from a nearby river. The supply of this water via the pipe and pump system thus enabled the communal gardening practice to become established.
- **Examining, testing and implementing the new model:** This farming model was then used for a number of years, but not without problems. Historical reports indicate that there were regular problems experienced with the pipe and pump approach to water supply, particularly related to ongoing maintenance of the pump to ensure an ongoing supply of the water for the food production activity.
- **Reflecting on the process:** Ongoing engagement with the activity surfaced a number of reflections which related to 1) ongoing problems with technical capacity to restore/maintain the pump for the 'pipe and pump' water supply system; 2) inequality in the shared benefits of the communal garden as some worked more in the garden than others, yet produce was shared. This problem was also linked to breakdowns in the marketing systems related to the produce.
- **Consolidating and generalizing the new process:** A broad view of the emergence of the pipe and pump approach to supplying water to the communal garden showed that the activity did not always work smoothly, given the problems reported on above. Thus, it is not surprising that, when given the chance, the community members involved in the farming practices in the Lloyd Village garden area chose to restructure the activity. This activity changed or a turning point in the activity occurred with the government change in 1994 after the first democratic elections in South Africa, when the Homelands Act of 1971 was repealed and land was then differently distributed.

Object A3. 1994–present: river-to-drum water supply, delivery and use in democratically structured allotment gardening setting

Following the Engeström model of expansive learning actions it is also possible to retrospectively analyse the emergence of the next phase of the object's history which can be termed 'river to drum' water supply, delivery and use activity. This cycle of activity emerged after the failure of the previous form of activity, as reported above.

- **Questioning:** Questioning in this phase was not disconnected to the reflections and dissatisfactions voiced in the earlier cycle of expansive learning and activity. However, the change in the Homeland Act created new questions which related to how to continue food production but within an allotment system, and also within the reality of the failing 'pump and pipe' approach to water provisioning

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- **Analysis and modelling of the new solution:** Historical evidence shows that the people involved in the gardening practices within the allotment system in the Lloyd Village context turned to 'self driven' solutions to the water supply problems. They figured out that it would be possible to carry water from the river and temporarily store it in drums on the gardening site.
- **Examining, testing and implementing the new solution:** The river-to-drum approach has been used for a number of years, but with difficulty as the gardening community are mostly pensioners and struggle with the labour demands required by this practice. Also reported (but not officially) is the practice of running water from the local municipal tap (which is considered by the practitioners themselves to be a less than legal practice) into the drums.
- **Reflecting on the process:** There is some dissatisfaction with the current way of supplying, delivering and using water in the garden. Extension services have also failed to resolve the technological problems of maintaining the pump and pipe watering system, and economic conditions are such that the community members are not able to afford additional fuel for filling up the drums regularly. This leads to periodic crop failures. Additionally, the young people do not want to engage in agriculture because Bantu education has stigmatized rural agricultural practices and they prefer 'quick money' and jobs in the cities. Additionally, there appears to be little knowledge of, or engagement with alternative rainwater harvesting and conservation practices.

Object A4. Emerging interest in RWH&C practices in the allotment garden context

The three historical cycles of the object of water supply and use provided useful orientation to further expansion of the activity, as probed through empirical engagement in a new cycle of expansive learning, which, as yet remains incomplete.

- **Questioning:** At the time of the expansive learning intervention (2013/2014) a number of questions had therefore already arisen in the context. These were to do with the difficulties with ensuring a viable and sustainable supply of water to the food garden. In addition to these difficulties, an issue of questioning and making sense of their own apparently shifting and multiple identities seemed to be important in redefining the participating farmers' capabilities and agency. Sen (2004) describes this plural identity formation or emerging consciousness as an important emergent property in seeing beyond oneself and a group's capability (a limiting socially constructed categorization often reflected in tensions and contradictions)

as being important in conceptualizing a wider choice of freedoms, possibilities and associations (negotiating internal contradictions); a journey through a dialectic. In the data generated for the study, the shift from incapacity-driven thinking associated with ageing and a history of dependence to a realization of an alternative self-driven path was expressed by participants in the following way: 'We are old, so how can we dig trenches?' (Garden Farmer personal communication, 1 February 2015); 'Maybe we could dig small dams in our garden?' (Garden Farmer, personal communication, 18 February 2015).

- **Analysis:** There was also some evidence of boundary crossing interactions taking place between the Lloyd Village garden farming community (the farming activity system) and the neighbouring activity systems (especially the training and extension activity system). Through these interactions, some analysis of the situation was taking place, and proposals were being put forward for implementing more sustainable Rainwater Harvesting and Conservation (RWH&C) alternatives. For example, some of the farmers had started tracing a diversion furrow stretching in an arc formation from the path leading to the garden gate down towards the fence on the southern side of the garden. These physical tracings were interpreted as manifestations of an aspiration to absent the absence of an adequate water supply and use system, and to implement the newly learnt but not yet fully understood water capture alternatives that were being shared by the local university and extension services, and our field research team.

Deepening insight into contradictions and identifying absences

As formative interventionist researcher, I was, at the start of the expansive learning process focusing mainly on Object A4 expansion above, as informed by mirror data that was based on the above historical analysis and the ethnographic observations. However, a key focus of the production of mirror data is also to mirror the contradictions so that these can be debated and deliberated as a potential starting point for expanding learning (Engeström, 1987). This requires the researcher to formulate an hypothesis or transfactual theory on what appears to be the central contradiction/s shaping the object of activity, and which influences the entire activity system. In doing this, I found critical realist analysis to be particularly helpful, as will be shown below. I formulated the following hypothesis on the contradictions shaping the central activity system and the object as follows:

- **Primary contradiction:** This appeared to pertain to the presence of persistent poverty, lack of realized alternatives and capability deprivation

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versus human rights-based policy and societal objectives for well-being and sustainability. This manifests in disjunctures in the actual use of the water technology (e.g. broken water pump) versus intended use (to facilitate easy food production); and disjunctures in actual agriculture and water policy implementation versus intended policy (municipality and the way the water allocation policies are functioning in practice).

- **Secondary contradiction:** A secondary contradiction was identified as being related to old ways of water supply, delivery and use (the object as historically emerged) versus the aspirations and livelihood needs of the pensioners who are the main actors in the Lloyd Village garden food production system (subjects who are old and are struggling with the labour demands) (object-subject contradiction).

Both of these contradictions stem from long-term structural inequalities and cultural disruptions which appear to be manifesting as generative mechanisms (see below). This has led to capability deprivation amongst the gardening community members, a lack of engagement in gardening practices amongst the youth, ongoing technological and extension support failures and persistent poverty that does not allow for resources to resolve the technological challenges (empirical).

Related absences are an absence of capability, appropriate and more sustainable technologies and technological skills, more benign and equitable structural and social-economic conditions, and the valuing of agricultural practices in the modern day, especially amongst youth, reflecting dynamics of Bhaskar's (2010) laminated system. These contradictions can be represented diagrammatically as shown in Figure 13.4 in relation to the activity system

As stated by Virkunnen and Newnham (2013, p. 11) contradictions can be viewed as obstacles encountered by participants in an activity due to

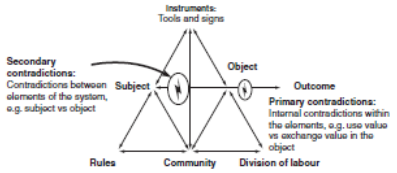

Figure 13.4 Primary and secondary contradiccions identified in the Lloyd Village Garden activity system (source: adapted from Engestrom, 1987).

inconsistencies or ambivalences 'between the dominant logic of the activity and the logic of the new concept of the activity'. These, however have deeper roots and are shaped by underlying generative mechanisms, and as shown below, they manifest more widely than in just one activity system. The contradictions in the Lloyd Village garden area case identified are not the only ones identified in the study. I briefly share insights into some of the other contradictions that I have identified, after which I synthesize the chapter with some perspectives on the underlying mechanisms that shape the boundary crossing learning possibilities in this study.

Further and wider manifestations of the primary contradiction

As identified above in the Lloyd Village Garden case, the primary contradiction that I identified is: *Persistent poverty, lack of realised alternatives and capability deprivation versus human rights-based policy and societal objectives for transformation, well-being and sustainability.* This contradiction had wider manifestations than those found only in the Lloyd Village Garden case study. I highlight some of the related manifestations below that have emerged from some of the phase 1 data as these pertain to the agricultural education activity system. I frame them here as 'related contradictions' since they tend to exacerbate or contribute to the primary contradiction in the farming activity system, showing the related emergence of contradictions in a laminated system.

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Wider contradiction 1: The agricultural college mission versus the capabilities of its graduates

Extension officers are unable to adequately advise farmers in climate constrained rain-fed farming conditions due to lack of or inadequate knowledge of rainwater harvesting options. Agricultural educators indicated that the curriculum does not prepare extension officers adequately. This was expressed by extension officers in the South African case study when they said that 'We teach for an ideal environment while farmers encounter often adverse and difficult conditions' (Extension officer, personal communication, 24 September 2014). This exacerbates the capability deprivation and lack of knowledge of alternatives found in the small-scale farming activity system. This is reflected in an evaluation of the South African Agricultural Curriculum which found issues of misalignment and inappropriateness of the curriculum with Agriculture Department Policy:

> despite policy changes to develop a single integrated extension service (serving both the commercial and emerging/small-holder farming sectors) most educational institutions offering agricultural programmes *still have commercial agriculture as their primary focus. Issues*

> *related to small-holder farming,* food security, *rural livelihoods and sustainable agriculture hardly feature* in the agricultural curricula.
>
> (DAFF, 2008, my emphasis)

Capability deprivation is not only a phenomenon related to South Africa, however, but similarly in the Zimbabwean case study, an agricultural educator observed that extension workers that she worked with in outreach were unable to advise farmers adequately on gulley-reclamation and rain-fed farming, due to inadequacies in the colleges' pre-service curriculum.

Wider contradiction 2: Isolated specializations in agricultural education versus demand for relational agency

Agricultural education has grown within a culture of separate development, which problematizes the relational agency required in creating new forms of human activity. This study has found that agricultural educators struggle to work out of the subject silo. This problem is illustrated by the difficulty found among agricultural college lecturers in Zimbabwe in rolling out the new environmental education (EE) curriculum across the traditional agricultural education disciplines: 'It was initially very difficult to mobilise other lecturers and even leaders to implement the new official EE curriculum… However, after five years, there are still challenges to fully involve lecturers who are still locked in their disciplines' (Lecturer, personal communications, 13 February 2015). The EE curriculum was introduced in Zimbabwe in 2009 to respond to the problems of agricultural damage to ecosystems. This move is supported by an intensive extended study by the World Bank and UN which found that agro-ecological solutions to hunger are more effective than GM seed and other technicist solutions (McIntyre *et al.*, 2009). Progress of integrating environment and sustainability is slow in the classroom as agricultural educators are not yet committed to going beyond the familiar and the convenient, despite an increased international tendency in institutional change (ibid.). This was lamented by one lecturer who has been tasked with co-ordinating EE at an Agricultural College in Zimbabwe who said:

> Lecturers are still resisting visiting surrounding communities in our EE outreach activities … yet I have found these activities useful in helping extension workers … to deal with such problems as gulley reclamation and soil conservation … which they were previously shying away from because they did not learn these practically when they were in college.
>
> (Lecturer, personal communication, 13 February 2015)

These two contradictions show the key role that *could potentially be played by agricultural educators* in relation to farmers in farming activity systems.

The data above shows that agricultural college educators need to develop the capability to work with fellow educators and with extension officers, and practising farmers in order to understand the meaning of their own work better. In this regard, Edwards (2007, p. 4) proposed cultivating relational agency as the 'capacity to align one's thoughts and actions with those of others to interpret aspects of one's world and to act on and respond to those interpretations'.

Wider contradiction 3: Elevation of techno-centric approaches versus simple and accessible solutions

The perceived need for advanced technology has been reified to the extent of excluding or undermining simple solutions typical of most effective RWH&C practices as also found in local indigenous knowledge practices. This has also happened at the expense of local and indigenous knowledge practices and innovations (Chambers, 1983). As shown in the historical review of the Lloyd Village garden case, earlier forms of RWH&C (e.g. *Gelesha*) were replaced by pump and pipe solutions that, when the technology was working, worked well, but failed the farmers at technology breakdowns. Increasingly, RWH&C is often associated with agricultural engineering solutions which are difficult to obtain in contexts where resources are scarce or not forthcoming due to other structural problems which hold persistent poverty in place. For example, when the pump and pipe technology failed in the Lloyd Village, garden community members were forced to use a river-to-drum solution which required elderly people to carry the water from the river to garden which put them under severe physical strain. A lecturer at an Agriculture College in Zimbabwe lamented the lack of financial resources to buy more advanced equipment as a drawback to effective teaching of RWH&C. 'We still use old technology such as dumpy levels to peg contours which make us move behind the rest of the advanced world' (Lecturer, personal communication, 12 February 2015). It was interesting to note that while memory existed of earlier culturally established RWH&C practices, these were not being used in the sites, due to the devaluing of cultural practices under colonialism and apartheid. Related to this is the lack of use of demonstration sites for learning in agricultural colleges, a problem identified in both research sites.

Wider contradiction 4: Curricula promoting intensive high-input conventional (mono-cultural) farming versus mixed cropping and organic farming systems

The agricultural curricula that are being used in both the South African and Zimbabwean case studies are based on conventional green revolution agriculture which is 'high input' regarding agro-chemicals, and externally supplied seed. High input poses a risk to small-scale farmers who usually have

Appendix 4.2: A Detailed Case Description of Fort Cox College

Fort Cox College of Agriculture and Forestry offers two programmes; namely Diploma in Agriculture and Diploma in Forestry (FCC, 2015[30]: v). These academic programmes received full accreditation from the South African Council for Higher Education (CHE) in 2002, a status which was re-affirmed in 2004 (re-accredited in 2012) and remains to date. The College vision, mission and motto point towards farmer-friendly ("for the people"), innovative, quality and sustainable agricultural education practice (see Plate A1 in appendix 2) (FCC, 2015: ii).

1.1 Historical and cultural background of Fort Cox College and its surroundings

The College was established in 1930 making it one of the **Historically-Black public institutions**. It is endowed with rich historical, cultural and diversified socio-economic and biological heritage. It is significant to note that prior to the establishment of the college, interactions between the Xhosa Chiefs and the British settlers resulted in a series of events that saw the establishment of a British Military post during the sixth frontier war (1834-1835), **change in land ownership from Xhosa Chiefs to settler farmers and white magistrates** (to whom the land was sold by the Cape Colony Government) after the eighth Frontier War (1850) and change in governance from traditional black authority to total white settler administrative power over the land and its people. "The Chiefs were given land by magistrates for their personal use…" (FCC, 2015: iii). In 1926 the Magistrate of Keiskammahoek Mr. E Beal, under the guidance of great influential leaders like Professor D.D.T. Jabavu and Mr. M. Peteni, successfully recommended the purchase of Fort Cox and a portion of land surrounding it with the vision of establishing what became known as the then 'Native Agricultural' School. The school grounds were a result of land purchases of area totalling 1354 ha (made up of 650ha from Mr Timlett in 1927 and 704ha from Xhosa Chief Sandile in 1934). In the early years the college provided training in agriculture only until 1969, by from 1970 forestry training was instituted with a Forestry Diploma course. The "New College" campus was constructed on land bought from Chief Sandile and officially opened by the Ciskei Government in 1977. College entrance requirements have been upgraded gradually over the years as follows:

1930	1950	1982	
Standard 6	Standard 8	Standard 10 (equivalent of grade 12 or National Senior Certificate)	Duration of training increased from 2 ½ to 3 years

Fort Cox College was granted **autonomy** in April 1990 through Decree No 5 of the former Ciskei Government, a status which it has to date. In 1991 the College became **affiliated to the University of Fort Hare** through an MoA between the Department of Agriculture, Forestry and Rural Development of Ciskei and the UFH. Among its **training facilities and amenities which feature among the best in southern Africa** are new classrooms, laboratories and residences, a diagnostic centre, a college farm, a new library, a new livestock handling facility and a new field irrigation system (new at the dawn of the democratic dispensation, 1993-1994).

The quality and standard of training of Fort Cox have been reviewed regularly. In 1985 the agricultural training programme was thoroughly scrutinised by a Ciskei Special Committee and recommendations were taken up. **In 2010 the Fort Cox College curriculum "was reviewed** and implemented in line with the industry and socio-economic needs of the country" (FCC, 2015: iv).

Fort Cox College also has a unit dedicated specifically to rural development. The Rural Development Centre at Fort Cox College facilitates accredited and non-accredited adult learning. This is delivered through short course training courses such as pig and broiler production, vegetable production, maize production, tractor maintenance, farm business management Agricultural Science - Content gap training.Training in Agriculture and Forestry is also responsive to demand and customised according to the expressed needs of clients from the farming community.

[30] FCC. (2015). Fort Cox College of Agriculture and Forestry 2015 Prospectus. Middledrift: Fort Cox College.

Appendix 5: Extract of Book Chapter by Author Analysing Contradictions in Agricultural Water among Smallholder Farmers in Zimbabwe

Scaling water-for-food stewardship: collaborative innovations across southern African dryland farming and extension training systems

by Tichaona V. Pesanayi

Abstract

Huge socio-ecological problems such as food and nutrition insecurity connected to inadequate water sometimes require humble home-grown solutions. Humble here does not mean simplicity but use of locally available epistemic and material resources. This entails complexity and therefore requires multiple layers of learning. This paper explores the processes of learning and local agency in agricultural water in rural farming communities in South Africa and Zimbabwe. It reveals learning opportunities, enablers, barriers and channels for identifying and scaling of 'germ cells' based on rainwater harvesting practices. The germ cell is the partial, simplest and smallest fundamental unit which has the characteristic properties of the whole water-for-food system. Water stress is a characteristic of many Southern African states and local communities. This is due to inadequate rainfall, poor water-holding capacities and rapid evapo-transpiration. It is worsened by marginalisation, climate change and variability, weak policy implementation and epistemic injustice. Globalisation, (mis-)representation, poor leadership and corruption are implicated. Various solutions have been tried that include selective damming of rivers, sinking of boreholes and targeted conservation farming with varying degrees of success. In many cases, the bigger solutions have been abandoned or postponed as either expensive or unsustainable. Some of the smaller solutions fail due to inadequate training and/or are labour-intensive. Rainwater harvesting has been applied by many families for domestic use, but by a few innovative individuals for farming with very good success. Some CBOs have promoted it in limited areas making big differences for sustainable livelihoods. Small-scale farmers, extension officers and agricultural educators participated in this study, and generated data from their own livelihoods, stewardship and work.

Key words: rainwater harvesting, scaling, germ-cell, collaborative learning, small-sale farming, stewardship, agricultural education

Form finding 1 it can be deduced that there are various RWH&C practices that contribute properties building the germ cell. For example constructing deep contours as common sense measures to sink water in the soil were innovated from a "desire to restore God's creative principles of the garden of Eden" Zepheniah Phiri (Personal communication, renowned innovator, November 4, 2011), reflecting on stewardship charges in Genesis 2verse15 and

3verses17-19 (The Remnant Study Bible, 2010). This productive practice was ironically judged a transgression of colonial conservation laws (see plates 10 and 11), which led to incarceration of the farmer by the colonial administration (for details see Witoshynsky, 2000; Pesanayi, 2012).

Plate 10 Embodied internal contradiction: The 'offending' structures versus innovative structures (above, and plate 11) that transgressed the regulations as interpreted by some colonial officers: over 1m deep in-field contours retaining water (versus regulation ~0.2 m drainage contours)

In the Zimbabwean case it was also found that there were several ways of conserving moisture, harvesting and conveying water within the field or off-field. Agricultural extension services in parts of the Runde Rural District were engaged in facilitating farmer-to-farmer training in RWH&C;

> *...we demonstrate to farmers at field days and shows so that they can actually see what it means to do well ... to conserve water you dig infiltration pits like this...in the contours so as to conserve moisture which will work for you when rainfall stops.* (Agricultural Extension Officer AEOZ1, Runde RDC, Zimbabwe, Personal communication, April 1, 2013).

Extension officers evidently value working examples of RWH innovations led by farmers, which provide experiential learning mediated and jointly facilitated with host farmers. These trainings include conservation farming (*dhiga udye*, Sh. – dig and eat). The practical and technical factors of these RWH&C practices are elaborated in the two dialogues that follow.

Excerpts from a dialogue 1 with extension officers:

(1) *Researcher: What is it that you can say farmers are actually doing very well?*
(2) *Agricultural Extension Officer AEOZ1: We have a group of farmers who are actually doing rainwater harvesting; they have contours which stay with water throughout the year. In particular we have a certain renowned farmer called Mr Phiri. His work has attracted many people from faraway countries who come to learn from his expertise. No water is lost. Rainfall is caught on the granite rock catchment near his home, all the runoff is directed to the ground on its way to his contours. It then collects in the contours and in small dams dug in his field, so that the place is always moist. So he is a farmer who provides learning to many farmers (AEOZ1, Agritex Runde RDC, Zimbabwe, Personal communication, April 1, 2013).*
(3) *Researcher: What can those without granite catchments do?*
(4) *EOZ1: Oh yes they are able to harvest. If they dig their contours during the off-season, around June after harvest time up to August when farming work is still few. In these contours they should put 'infiltration pits' ("zvikodobo",* Sh.–holes).

The dialogue above shows how RWH has been done by a RWH innovator using a granite outcrop as a catchment, and raised embankments to channel water to contours that have been deepened in sections using infiltration pits to sink water. Below a RWH adopter explains the value of RWH.

Excerpts from a dialogue 2:

(1) *Farmer FZ3: In his fields a farmer must look after water, when it rains we do not leave it to waste. ... If you were to get into a field say Mr Phiri, mine or any of the farmer innovators nearby, there are factors there we follow from what we are learning. We no longer have those small... drainage contours. We are now doing*

In Zimbabwe, RWH has recently gained impetus due to the frequent drought events, and has been documented by the print (e.g. Makwanya, 2016) and radio/television media (e.g. Mavhudzi, 2015). There has also been a recognition of the importance of RWH by formal education as seen by its appearance in the official primary school agriculture curriculum (GoZ MoESAC, 2012), with textbooks to back it up. However agricultural colleges have not yet taken it up formally, and are still exclusively focussed on conventional irrigation development and SWC due to the translation of government policy emphasising mechanisation (GoZ MAMID, 2009). There is also a lack of practical knowledge among the lecturers in colleges. Solutions integrating science and indigenous/local knowledge innovations, what Muchena (1990) called an 'emic-etic' approach, were found to work through expansive learning.

Alteri & Koohafkan (2008) document that there has been a remnant of resilient and enduring rural farming communities and practices whose germ cell properties are worth scaling from. These occur across Africa, Asia e.g. Rajasthan, India (Sharma, undated) and South America (Browder, 1989). Some examples of communities in Africa that use RWH effectively include zai pits in Burkina Faso and Mali (Altieri & Koohafkan, 2008: pp 48–49), in the Eastern Cape of South Africa and in the Midlands, Mashonaland East (Mutoko) and Manicaland Provinces (Chikukwa in Chimanimani, and Nyanga, Soper, 2006) of Zimbabwe.

From finding 3 it can be noted that scaling started taking place when networked partners started anticipating value and realising benefits of RWH&C. According to Wenger, Trayner & de Last (2011) these benefits would fall into a number of phases where certain value elements can be identified, for example 'formation of new friendships' can be viewed as an intermediate value emanating from interactions. Such a value grew into some realised values such as discovering "the prospect of being innovative in applying RWH&C practices" (ALS2) through establishment of demonstration sites (e.g. plate 12 below).

Full chapter available at: Pesanayi, T. V. (2016b).

Appendix 6.1: Sample of Amanzi for Food Training of Trainers Course Modules

amanzi FOR FOOD

Training of Trainers Programme

Module 3

Assess and Collaboratively Develop Productive Demonstration Site(s) for Learning of New Practices

Introduction

Module 3 is very strongly focussed on the collaborative development of 'Productive Demonstration Sites'. There will be discussion on what we mean by productive demonstration sites, and by collaboration. We will work together to identify potential sites and the groups who may collaborate to develop them. There will be an opportunity for these groups to plan the development of their sites.

We will also discuss the importance of recording and documenting the development and use of these sites, and how we can use photographic and video records to share the experiences with others through different materials, and through the use of radio, perhaps television, and the website.

There will be further activities and discussions around the Amanzi for Food Teaching Gardens, and their value as supplementary training sites.

The final part of this module will allow us to reflect on the learning that has taken place so far in the Training of Trainers Course, and through the Learning Network. In so doing we will plan to develop joint solutions together to some of the challenges we are facing regarding lack of adequate agricultural water and how we can implement these solutions over an agreed period. This will require each one of us to commit to a process of deliberation, negotiation and openness to new emerging ideas

The Assignments for this module will focus on the planning of the development of the sites, and the roles that each person will play in the development.

1. Productive Demonstration Sites

The development of productive demonstration sites is central to the learning in this Training of Trainers Course. The idea is that not only will their development be of great value to the course participants, but also to others in the future who

At this point we have probably developed some confidence regarding what we want to do, with whom, where, how and why. The 'how to do it' may be a complex process as there are several ideas, interests, challenges and motives that have been raised and there may be new ones still to be discussed. This section will help us to deal with some of the challenges we are facing in connecting our ideas together to come up with a common approach where we need to work together as a group. We will use a specific mediation method called the 'Change Laboratory Method' to seek solutions within an activity system of a farmer association, an extension service or a college and its associated method for working with more than one organisation called the 'Boundary-Crossing Laboratory Method'.

5.2 Small-scale farming as an Activity System

We will work with the idea of farming as **activity systems**, i.e. small-scale farmer associations, individual / family farming; extension; and agricultural education. An activity system is a way of representing the work that we do, acknowledging that individuals (e.g. farmers) interact with their environment (land, soil, water, seed, livestock) to satisfy a need (food production and consumption to satisfy the need for good nutrition).

People —*acting on*→ *Environment* —*to satisfy*→ *Needs*

'**Activity**' here is when people act on their environment (such as by growing or harvesting food or natural resources) in order to satisfy a need (e.g. hunger, thirst, or the need for shelter).

The focus is on how we develop understandings of the world we farm in, draw meanings from that understanding, create learnings from those meanings and are motivated to respond to those learnings. Such learning is sometimes mediated by others (such as by extension officers, other farmers, development workers, etc).

This activity system idea is also based on the principle that **learning is a social and cultural process**. The dynamic interaction between tools, individuals, and other people contributes to the social formation of the individual mind and shapes individual knowledge construction.

We use **tools** or artefacts to use or change our environment and to get information from the environment. The tools we use shape the way we do the work. A tool is anything we use to help us change the environment to meet our needs. A tool can be language, concepts, mental models, books, curricula, mobile phones, etc. The interaction of people with tools on their environment can be shown as follows.

Tools and Artifacts —*mediate*→

People —*acting on*→ *Environment* —*to satisfy*→ *Needs*

The social, cultural and organizational within which we work also mediate the ways in which we conduct our farming (or agricultural education and extension) activities. Since humans are social beings, we come together in activities. The social relationships we have or form and the organisational structures under which we operate, are the products of the cultural and historical traditions. This can be represented as shown in Figure 6 below.

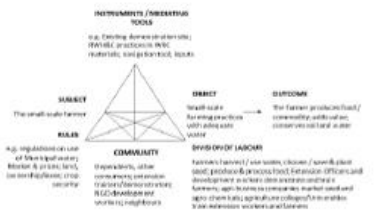


Fig. 6: Small-scale Farming Activity System

Focus Group Activity 2

Supported by the tutors, the learning network members (as a group or in sub-groups):

1. *Identify the **challenges** you are facing or foresee facing in implementing RWH&C practices (demonstration sites) at your workplace (farming plot, agricultural college or faculty department)*
2. *Identify **challenges** you are facing in collaborating or working with colleagues in other organisations which you know you should be working with or wish to start working with. Be very specific*
3. ***How** do you think you could **respond to or solve** these challenges / problems? These could be preliminary ideas which should be actionable*
4. *Identify opportunities that exist for working together more effectively in implementing RWH&C practices / demonstration sites.*
5. *Identify, agree and commit to a process of jointly exploring solutions and keeping connected. (Share what you know or propose from your organisation or in another organisation).*

Assignment 3

This Assignment builds on the Focus Group Activity 1, and provides the opportunity for you to record in detail the decisions made about the productive demonstration site you will be working on with your group. It also asks you to describe your own roles and responsibilities in relation to the implementation of the plan you developed, and how you can use this process in your curriculum, your training programme or to share with other farmers.

All participants wishing to achieve a Rhodes certificate (at either NQF Level 6 or Level 5) must successfully complete this Assignment.

Stream 1 (NQF Level 6), Assignment 3

Planning the development, recording and documentation of the development and use of a productive RWH&C demonstration site.

Describing your own role in this process, and how you can build this process into your RWH&C curriculum.

Produce a report of 5-6 pages (2500 – 3000 words) describing:

1. The composition of the collaborative group you worked with in planning the site
2. The location of the site that was chosen and the current use of the site
3. The vision for use of the site in the future
4. The practice the group agreed to develop, and why this was selected
5. The information and materials you drew on in making this decision
6. The planning process you followed with your colleagues
7. The plan that you developed (this should be a summary of the plan your group drew up in F
8. Focus Group Activity 1, using the headings suggested in the activity)
9. How you intend to ensure the sustainability of the site
10. Your own roles and responsibilities in the development process
11. How you could integrate such a planning process into your RWH&C curriculum

Above: Samples of module 3 showing CHAT orientation

Appendix 6.2: List of Agricultural Colleges and selected FET Colleges in South Africa

Name of Agricultural College	Location	Management	Relevant Offerings and known encounters with RWH&C	Some relevant changes
Cedara	KwaZulu Natal Province	Provincial Department of Agriculture	Higher Certificate in Agriculture; National Diploma in Agriculture at NQF level six; Received RWH&C materials form WRC; BSc Agriculture accredited by University of KwaZulu Natal; Introduced to Amanzi for Food project in 2014	Did not take up WRC RWH&C training of trainers' course offered in 2014
Elsenberg (Cape Institute of Agricultural Training)	Western Cape Province	Provincial Department of Agriculture	National Diploma in Agriculture at NQF level six; Bachelor's degree in Agriculture; Participated in an Amanzi for Food workshop in 2016	
Fort Cox College of Agriculture and Forestry	Eastern Cape Province	Provincial Department of Agriculture; Autonomous	National Diploma in Agriculture at NQF level six; skills training of farmers (AgriSETA, NQF levels 2-4); Received RWH&C materials from WRC 2012/2013; Introduced to Amanzi for Food project in 2014 and participated in Training of Trainers course in 2015/2016	Became Fort Cox Agriculture and Forestry Training Institute in 2016
Glen College	Free State Province	Provincial Department of Agriculture	National Diploma in Agriculture at NQF level six	
Grootfontein Agricultural Development Institute ('Grootfontein College of Agriculture')	Eastern Cape Province	National Department of Agriculture and Forestry (DAFF)	National Diploma in Agriculture at NQF level six; skills training of new farmers (NQF levels 2-4)	
Lovedale FET College	Eastern Cape Province	Provincial Department of Agriculture	National Certificate in Primary Agriculture; National Diploma in Farm Management.	

Lowveld College	Mpumalanga Province	Provincial Department of Agriculture	Higher Certificate in Agriculture; National Diploma in Agriculture at NQF level six; Received RWH&C materials form WRC in 2012/2013; Introduced to Amanzi for Food project in 2014	Became University of Mpumalanga (Mbombela Campus) in 2015 (South Africa. Department of Higher Education and Training [DHET], 2014)
Madzivhandila College of Agriculture (in Thohoyandou)	Limpopo Province	Provincial Department of Agriculture	Certificate in Agriculture; National Diploma in Agriculture at NQF level four Introduced to RWH&C in a SADC workshop in 2013	
Owen Sithole	KwaZulu Natal Province	Provincial Department of Agriculture	National Diploma in Agriculture at NQF level six	
Potchefstroom College of Agriculture	North West Province	Provincial Department of Agriculture	Higher Certificate in Agriculture; National Diploma in Agriculture at NQF level six; B. Tech (Agricultural Management); Participated in an Amanzi for Food national workshop in 2016	
Taung Agricultural Colleges	North West Province	Provincial Department of Agriculture	National Diploma in Agriculture at NQF level six; Received RWH&C materials from WRC in 2012/2013; Introduced to Amanzi for Food project and RWH&C learning possibilities in 2016	
Tompi Seleka School of Agricultural Sciences	Limpopo Province	Provincial Department of Agriculture	National Diploma in Agriculture at NQF level six	
Tsolo College of Agriculture	Eastern Cape Province	Provincial Department of Agriculture	National Diploma in Agriculture at NQF level six	

Appendix 6.3: Sources of Data for Boundary Learning and Boundary-Crossing Issues in the South African Case Study

Table A6.2 Summary of sources of data generated from documents, individual interviews, focus group interviews and observations

Data source	Index Code	Remarks
Documents		
Document 1: WRC Project Report, Volume 1: Research And Development Report	WRCAfF1	Full reference: Lotz-Sisitka, H., Pesanayi, T., Weaver, K., Lupele, C., Sisitka, L., Denison, J., Phillips, K., O'Donoghue, R., Sithole, P., & van Staden, W. (2016). Water Use And Food Security: Knowledge Dissemination And Use In Agricultural Colleges And Local Learning Networks For Home Food Gardening And Smallholder Agriculture. Volume 1: Research And Development Report. WRC Report number (to be provided by WRC documentation system), Pretoria/Grahamstown.
Document 2: Register of participants signed up for course & their interests / motivations IBLN workshop 1 of 12 August 2014	DIBSA1a	
Document 2B: Transcript of IBLN workshop 1 of 12 August 2014 (audio)	DIBSA1b	
Document 2C: Transcript of discussion at field visit to Fort Cox's farm demonstration plot assisted by ARC, 12 August 2014 (audio)	DIBSA1c	
Document 3: Amanzi for Food Training Module 1, September 2014	DIBSA2a	
Document 3B: Report of Imvotho Bubomi learning network workshop number 2 / Amanzi for Food Training session module 1 report	DIBSA2b	
Document 3C: Transcript of IBLN workshop 2 held 16 September 2014	DIBSA2c	
Document 3D: Assignment 1 farmer 3	DIBSA2d	FSA3
Document 3E: Assignment 1 lecturer 2	DIBSA2e	ACLSA2
Document 3F: Assignment 1 lecturer 3	DIBSA2f	ACLSA3
Document 3G: Assignment 1 lecturer 4	DIBSA2g	ACLSA4
Document 3H: Assignment 1 extension officer 1	DIBSA2h	EOSA1
Document 3I: Assignment 1 LED agriculture specialist 1	DIBSA2i	NEDSA2
Document 4: Amanzi for Food Training Module 2	DIBSA3	
Document 4B: Transcript of IBLN workshop 3, October 2014	DIBSA3b	
Document 4C: Assignment 2 farmer 3	DIBSA3c	FSA3
Document 4D: Assignment 2 lecturer 2	DIBSA3d	ACLSA2
Document 4E: Assignment 2 lecturer 3	DIBSA3e	ACLSA3
Document 4F: Assignment 2 extension officer 1	DIBSA3f	EOSA1
Document 4G: Assignment 2 extension intern 5	DIBSA3g	EISA5
Document 4H: Assignment 2 LED agriculture specialist 1	DIBSA3h	NEDSA2
Document 5: Amanzi for Food Training Module 3	DIBSA4	

Document 5A: Transcript of IBLN BCCLW4 (module 3 training)	DIBSA4a	DIBSA4a1: Reflection and introduction to activity systems DIBSA4a2: Group work
Report of Imvotho Bubomi learning network workshop number 4 / (Amanzi for Food Training session module 3)	DIBSA4b	
Document 5B: Assignment 3 farmer 1	DIBSA4c	
Document 5C: Assignment 3 lecturer ACLSA2	DIBSA4d	
Document 5D: Assignment 3 lecturer ACLSA3, July 2015	DIBSA4e	
Document 5E: Assignment 3 extension officer 1	DIBSA4f	
Document 5F: Assignment 3 LED agriculture specialist 1	DIBSA4g	
Document 6: Amanzi for Food Training Module 4	DIBSA6a	
Document 6A: Transcript of IBLN workshop 5	DIBSA6b	
Report of Imvotho Bubomi learning network meeting number 5 / Amanzi for Food Training session module 4	DIBSA6c	
Assignment 4 farmer 3	DIBSA6d	FSA3
Assignment 4 lecturer ACLSA2	DIBSA6e	
Assignment 4 lecturer ACLSA3, July 2015	DIBSA6f	
Assignment 4 extension officer 1 EOSA1	DIBSA6g	
Assignment 4 LED agriculture specialist 1	DIBSA6h	
Assignment 4 ACLSA4	DIBSA6i, June 11, 2015	
Document 7: Report of Imvotho Bubomi learning network meeting number 5 / Amanzi for Food Training session module 5	DIBSA6j	
Document 5A: Group assignment 5 stream 1	DIBSA6k	
Document 5B: Group assignment 5 stream 2	DIBSA6l	
Document 9: Report of Imvotho Bubomi learning network meeting number 6 / Amanzi for Food Training session module 5	DIBSA7a	DSAIB7a
Transcript of Boundary crossing laboratory workshop1 at Lloyd Village, 6 February 2015	DIBSAL1	
Transcript of Boundary crossing laboratory workshop2 at Lloyd Village, 28 April 2015	DIBSAL2	
Report of Boundary crossing laboratory workshop2 at Lloyd Village, 28 April 2015	DIBSAL2b	
Transcript of Boundary crossing laboratory workshop3 at Lloyd Village, 11-12 May 2015	DIBSAL3	
Transcript of Boundary crossing laboratory workshop4 at Lloyd Village, 31 July 2015	DIBSAL4	
Transcript of Boundary crossing laboratory workshop5 Lloyd Village with Fort Cox College, 28 October 2015	DIBSALF	
Transcript of Boundary crossing laboratory workshop6 at Lloyd Village, 10 December 2015	DIBSAL5	
Transcript of Boundary crossing laboratory workshop7 at Lloyd Village, 30 March 2016	DIBSAL6	
Report of Amanzi for Food National Workshop, 11-12 May 2016	DAfFS2	
Document 10: Transcript of Imvotho Bubomi learning network meeting number 7 (21 July 2016)	DIBSA8a	
Document 11: Transcript of Imvotho Bubomi learning network meeting number 8 (7 September 2016)	DIBSA9a	
Report of Imvotho Bubomi learning network meeting number 8	DIBSA9b	
Fort Cox College Prospectus 2015	DIBSA10	

Transcript of Knotworking boundary-crossing laboratory curriculum analysis workshop - University of Fort Hare and Fort Cox College lecturers (September 24, 2014)	ALCASA1	
Report of Knotworking boundary-crossing change laboratory workshop 1 for Fort Cox College network (April 14, 2015)	DIBSAF1a	
Transcript of Knotworking boundary-crossing change laboratory workshop 2 for Fort Cox College network (July 31, 2015)	DIBSAF1b	
MoU between Fort Cox College and Rhodes University (March 29, 2016)	DIBSAF1c	
Monitoring and Evaluation Plan of MoU between Fort Cox College and Rhodes University (November, 2016)	DIBSAF1d	
Transcript of monitoring and evaluation meeting #1 on MoU between Fort Cox College and Rhodes University (June 8, 2016)	DIBSAF2	
Transcript of monitoring and evaluation meeting #3 on MoU between Fort Cox College and Rhodes University (November, 2016)	DIBSAF3	
Transcript of lesson observed integrating RWHC at Fort Cox College (25 August 2015)	DIBSAFL (…Fort Cox Lesson)	
Minutes of WRC Steering Group project penultimate meeting 3 March 2016	DIBSA9	Water Research Commission. (2016). Water Utilisation in Agriculture: Minutes of a Project penultimate meeting of the WRC Project Steering Committee on 'Action Oriented Strategy (AOS) for knowledge dissemination and training for skills development of water use in homestead gardening and rainwater harvesting for cropland food production' (project no. K5/2277) held on 3 March 2016, Rhodes University, Grahamstown, South Africa.
Project Contextual Profile of FET and HET agriculture training institutions in South Africa	DAfFS1	Responses to Questions for FET and HET Institutions by Cedara College of Agriculture
Transcript of Knotworking boundary-crossing laboratory workshop 1 at Matole Basin (May 27, 2016)	DIBSAM1	
Transcript of Knotworking boundary-crossing laboratory workshop 2 at Matole Basin (June 7, 2016)	DIBSAM2	
Transcript of Look and learn visit with visiting Danish colleagues and interview at Matole basin (1 August 2016)	DIBSAM3	
Agricultural Education interviews		
Transcript of paired Focussed Group interview with Fort Cox students, 27 October 2015	FCCSFGSA1	
Transcript of terminal WhatsApp interview with agricultural college lecturer #3	WhatsApp Chat Interview #ACLSA3W	
Local authorities / local economic development (LED)		
Interview with LED agency agricultural specialist (smallholder farming extension)	Interview #NEDSA1	
Interview with senior LED agency manager, 6 November 2015	Interview #NEDSA2	

Communications		
WhatsApp chat on July 3, 2016 with smallholder farmer innovator FSA10.	WhatsApp Chat transcript #FSA10W	
Imvotho Bubomi Learning Network WhatsApp chat history from 23 November 2016 to 31 March 2017	DIBSAW	
WhatsApp chat on December 14, 2016 with agricultural college lecturer ACLSA3	WhatsApp Chat transcript #ACLSA3W	
Research journal entries		
Research journal entry	RJE, date	

Appendix 6.4: Samples of Learning Network Communications From Various Media

Appendix 6.4A: Sample Minutes of Imvotho Bubomi Learning Network Meetings (DIBSAM)

Minutes of IBLN meeting held on

Date: 21 July 2016
Venue: Fort Cox College of Agriculture and Forestry

1. **Introductions and Prayer**

The meeting started at 10h00 with a welcome by the Chairperson and a prayer led by Mrs Maso. The Chairperson facilitated self-introductions by people present. The Chairperson then facilitated registration of members present and those who indicated apologies.

2. **Present**

19 members were present as follows:
i) Mrs Mbotho new member, Agricultural Research Council (ARC) RWH project-Alice; ii) Ms Jeanette Mathe - permaculture trainer-new member; iii) Mrs Biko, Dimbaza - seed guardian, agro-ecology; iv) Nomasomi Mjacu, new member from Quzini community seed bank; v) Mr Sifiso Molemone - media Forte FM, vi) Mr Edmore Parichi- Zingisa- agro-ecology and gender education new member affiliated with Ilizwi lamafama; vii) Mr Richard Moyo-University of Fort Hare; viii) Mr Mxolisi Nziba-farmer, new member; ix) Mrs Busisiwe Peter, agro-ecology farmer from Matole (Amathole) Basin; x) Mr Tichaona Pesanayi- Rhodes University; xi) Prof Rob O'Donoghue-Rhodes University, xii) Mrs Lumka Maso- Seven Stars Keiskammahoek Dairy Trust; xiii) Mr Alfred Mcasi-farmer Keiskammahoek 7 Stars Dairy; xiv) Miss Chisala Lupele-Rhodes University student-communication; xv) Mrs Louise Madikiza-Fort Cox College lecturer; xvi) Dr B Moyo- Fort Cox College acting HOD Agriculture; xvii) Miss Phindile Sithole-researcher Rhodes University, xviii) Mr Chamu Matambo (chairing), xix) Ms Ngele Makhaga (minuting).

	Farmers	Agricultural Education (Fort Cox College & UFH)	Local Municipality / LED	Extension Services	Rhodes University	NGO	Media
Number	8 (6F, 2M)	5 (2F, 3M)	0	0	4 (2F, 2M)	1 (M)	1 (M)

3. **Apologies**

i) Kim Weaver
ii) Passmore Dongi

4. **Acknowledgements:**

The Chairperson recognised Mrs Peter on her winning a District agriculture award in the women's category

5. **Tabling of minutes of the last meeting**- adopted

6. Corrections

-Dohne and Lloyd village spellings
-The minutes were accepted with the above corrections.

7. Matters arising

i) Trainings in Matole basin
ii) Demonstration site follow ups

8. New Business

Mr Matambo gave a background on how the network started. Highlighting that water is a scarce resource. He explained that Rhodes University came and facilitated the coming together of members.

i) **Training and capacity Building**- Members need to participate in the trainings that will be decided upon through the discussions where strategies and suitable methods will be chosen. Members need to invite other people. The training that was meant for Mrs Peter has been scheduled for the month of August.
ACTION: By C Matambo & Mrs Peter; date: tba. (To inform other members including researchers at Rhodes University)

Training offered at Gwali needs to be followed up.
ACTION: By tba (name); date: tba

ii) Demonstration Sites

- Fort Cox RWH&C pond not functional at present due to livestock interference.
- Lloyd village garden has ponds. These need maintenance. Regular updates from Lloyd village garden needed.
- Mrs Peter's garden has some RWH structures now. There are challenges since there is no rain yet, Mrs Peter mentioned.
- Mr Matambo suggested that it is best to prepare the structures to be ready for rainfall events. Mr Pesanayi mentioned that it is best we prepare since we do not know when rainfall will come and we should not lose the water when the rainfall comes. Emphasis were made on preparedness.
- A farm with a structure will become a demonstration plot. Mrs Peter asked on how far the IBLN can stretch geographically. Mr Matambo responded that the network can cover as far as Eastern Cape can go.
- Prof Rob O'Donoghue reported that the college and Rhodes University have signed a partnership MOU. There is a small garden model that was developed which was prepared for the student learning and it will be demonstrated on the 1st of August 2016. The partnership will also encourage the publication of the experiences. Mrs Peter appreciated the small garden drip irrigation method and wishes to implement such in their gardens with the help of Mr Parichi from Zingisa

iii) Feedback from the national workshop

A brief feedback was provided by Mr Tichaona Pesanayi with input from other members who were present.

- The national workshop was held at Rhodes University on the 16 May 2016. Different organisations attended from as far as Western Cape, Gauteng, and Northwest.

- Mr Sifiso Molemone mentioned that there is a weekly slot for agriculture at Forte FM but there is no news coming to the radio and they will be forced to sell the slot
- The good work done by the Imvotho Bubomi Learning Network was shared at the national workshop through the network; Rhodes University; ARDRI, University of Fort Hare; Fort Cox College and NEDA were recognised for efforts at supporting farmers.
- A Concern was raised by UNISA, Zingisa and farmers that Institutions of Higher Learning are not teaching food security, let alone food sovereignty
- As a follow up to information received from WRC, a proposal for extension of Amanzi for food has been submitted by Rhodes University to WRC. A response from the review process is awaited.
- The need to empower the youth to be entrepreneurs was discussed.
- Farmers highlighted that there is a need for a curriculum change to produce farmers than just extension officers.

iv) Food sovereignty

The issues of food sovereignty were discussed in the meeting, starting with a discussion of what it means led by Mrs Peter and Mr Parichi.

- Food sovereignty is about families having enough food of choice. Mr Pesanayi followed up the concern raised on food sovereignty and arranged a meeting at ma'am Peter's home where indigenous seed is promoted. It deals with the choice of seed (open pollinated varieties), cost, local sharing and exchange, and water availability. It means the farmer has to be in control of all the means of production. Mrs Maso mentioned that it has been a practice of old days that seed, manure and other inputs were used from the home and neighbourhood, and not bought. This is a wakeup call to go back to where we came from in terms of local seed systems, but with respect to emerging new knowledge which does not destroy these seed systems. Agro-ecology is the control of means of production, land being part of it. Also sensitive to policies that deal with ownership. Farmers are feeling that they have lost their identity because they are losing food sovereignty to other forces. Food sovereignty does well with people working together and it has to be controlled. Mrs Peter has a problem with getting information on getting fertilizers and non-chemical pesticides and herbicides
- Prof O'Donoghue informed the meeting that Rhodes University – ELRC had been approached by some people who want to fund a research on food sovereignty.

v) Media

- A Focus group discussion was done some recent time previously with farmers in Middledrift on the community radio programme. Farmers said rainwater harvesting is not new but they were not practicing it. But after listening to the experiences that were shared they went back into implementing it.
- The Facebook has touched people in Zambia, Sweden and Kenya.
- The farmers have learned about preparing their fields for the rains and they have implemented it.
- Mr Matambo mentioned that members need to share their experiences
- From previous community radio sessions, students were also asking the panellists questions on air
- Members were asked to make videos when they prepare their land and implement their rainwater harvesting and conservation constructions

vi) Extending/ reaching out- Training at Gwali

The need to follow up training done at Gwali was discussed.

vii) Consolidating and concretising collaborative learning and working together

Members expressed their value for the learning network and their desire to maintain it through joint work. Below is detail on the agreement to concretise the learning network.

viii) Discussion

Group discussion on Consolidating and concretising collaborative learning and working together

Two groups were formed to discuss different issues concerning the network focussing on expansive learning of new and emerging knowledge and skills and boundary crossing opportunities

Group 1 Fort Cox College curriculum - Improve relevance of curriculum in sustainable agricultural water and food sovereignty to smallholder farmer contexts

1.1. What can Fort Cox College do with extension and farmers
1.2. Group Members (Mrs Mbotho, Mr Nziba, Mr Parichi, Mr Mcasi, Ms Tema, FCC-?)

Ideas from the group discussions

Group 1

- Permaculture demos at Fort Cox College will be done:
  ACTION: **Ms Tema** with **Ms Madikiza** at Fort Cox; by **date to be advised.**
- Training on seed sowing and related information by Zingisa and Fort Cox College.
- A seed bank will be established at Fort College. **ACTION**: **name tba** at FCC; **date to be advised.**
- Mobilisation meeting will be held: date, venue and leader to be discussed,
- Food and herb processing to be done
  ACTION: date, venue and leader to be discussed,
- Biological/ organic control of pests and diseases by IBLN with Ilizwi lamafama & Zingisa. **ACTION**: date, venue to be discussed,
- Permaculture designs with water harvesting structures to be done

Group 2 lead Nkokobe farmers- How can we make farmers' concerns be heard by extension and other institutions

1.3. What can be done?
1.4. Members (Mrs Peter, Mr Matambo, Mrs Maso, Mr Moyo, Mr Molemane, Ms Mjacu, Ms Biko)

Plenary Discussions

- Extension officers have to be motivated to come to the farmers meetings, including the proposed meeting on food sovereignty
- Engage the extension early in the seasons on campaigns for food sovereignty.
- Researchers to inform government on policies that are acting against food sovereignty
- Engage extension officers to speed up water rights licences
- Inform government on RWH
- Learning from one another

ix) Table 1: Activity plan

Activities	Responsible person (highlight name of the one main responsible person)	Time Frame 2016
1. Mobilization meeting (strategic, approaching Mr Boko for Extension)	Fort Cox & farmers' association / Rhodes University. Mrs Madikiza	Secure Appointment- by end of August 2016
2. Ilima on • Permaculture • RWH&C demonstration site training & installation • Other stations • Seed banking	• Ms Tema & **Mrs Madikiza** • Mrs Peter, **Mr Matambo** & Miss Makhaga @ Matole basin • **Mr Moyo** (UFH), Ms Biko, Mrs Mbotho • Ms Mjacu, **Mrs Madikiza**, Mr Khamkham @ FCC	• End of August • Mid-September • November 2016 • November 2016
3. Research publications and policy briefs	Rhodes University- **Mr T Pesanayi,** Prof R O'Donoghue, C Lupele, P Sithole; UFH- **Mr Moyo** Fort Cox- **Mrs Madikiza,** Zingisa - Mr Parichi	August 2016 x1 (TP); September 2016 x1 (TP, NM)
4. Food Herbs Processing	Ms Tema & FCC - **Mrs Madikiza**	October 2016
5. Combined practical / hands-on training on organic control, pests & diseases	Ilizwi lamafama, Mrs Tema and Fort Cox College - **Mrs Madikiza**	End of September 2016

x) Presentation on media

This was facilitated by Ms Chisala Lupele with the aim of sharing what has been taking place in the media and opportunities for doing more.

Question on whether we still need the media: Mrs Peter and Miss Makhaga supported continuation of the media work because it is a point of expansion and the means to reach the old and youth. Mr Molemone said the slot is open but if there is no news being shared, it becomes a loss. He mentioned that as Forte FM they are geographically placed in an area where people are financially disadvantaged. And a lot of land is not utilized due to the lack of water and knowledge. Chisala mentioned that people should send blogs to her (or any of the Amanzi for Food team members) on the work that is being done.

xi) Presentation on permaculture

Mrs Tema briefly presented on the permaculture principles and how she trains communities. It was suggested that members can help by having her to help in the trainings related to permaculture and food processing to be done in the area.

xii) Seed exchange and sharing

Some OPV seeds were shared by agro-ecology farmers that included maize, pumpkins, beans etc.

9. The meeting ended at 1pm.
10. The exact date of the next meeting will be communicated at least two months in advance.

Date of the next meeting: **Mid November 2016**

11. Signed:

_____ _____

Ms N Makhaga **Mr C Matambo**
Secretary Chairperson

Appendix 6.4B: Sample of Imvotho Bubomi Learning Network WhatsApp Chat History (DIBSAW) from 23 November 2016 to 31 March 2017

1) 25/11/2016, 15:27 - Messages to this group are now secured with end-to-end encryption. Tap for more info.
2) 03/05/2015, 23:10 - Kim Weaver created group "Imvothu Bubomi"
3) 03/05/2015, 23:10 - You were added
4) 23/11/2016, 11:07 - Ngele Makhaga: Halloo farmers...
5) 23/11/2016, 13:24 - Dubasi DD: Hello colleague how do you do?
6) 23/11/2016, 13:28 - Ngele Makhaga: Im fine people are scarce
7) 23/11/2016, 13:29 - Dubasi DD: We have been quiet nyani sis!
8) 27/11/2016, 09:16 - ticha kunda1: Greetings everyone. I trust you are all alright.
9) 27/11/2016, 11:39 - Chamu Matambo: We are fine. Hw are you?
10) 28/11/2016, 16:51 - Dubasi DD: I'm doing fine Tich hope you fine too
11) 28/11/2016, 18:06 - ticha kunda1: I'm good thanks brother.
12) 28/11/2016, 19:18 - Dubasi DD: Good hearing from you
13) 28/11/2016, 19:20 - Ngele Makhaga: Any possibilityy for us to have meeting before year end...
14) 28/11/2016, 20:36 - Chamu Matambo: That will be great
15) 28/11/2016, 20:36 - Chamu Matambo: I think its doable
16) 28/11/2016, 20:39 - Ngele Makhaga: With some vegetable braai from Mr Ndziba....
17) 29/11/2016, 07:59 - ticha kunda1: Good morning. What's the meeting date?
18) 30/11/2016, 19:31 - Peter Mrs: Good evening team. I wish to share my joy and excitement. I have a tunnel that is 10m x 4m which World vision the NGO sponsored. They did not have a budget for it to be erected and suggested I wait till next year. I decided to ask for favors from our team members started with Fort Cox. Mr Mathambo did not hesitate to offer his help together with his students and walla on Monday the 28 the tunnel was erected within a day. Fort Cox ibhoso yona. Thank you very much. As if that was not enough, I told Prof Mupangwa at UFH today that my tunnel is up but not running yet, lol. He was so excited and offered me moringa seeds and planting bags. I went to fetch the seeds and to my suprise I was given 2kg seed and 200 bags to propagate seedlings. Come January active, brant, willing, passionate farmers will be given seedlings to grow in their places as an initiative to have more farmers produce moringa meal(powder) with the future aim o have a common milling plant for our municipaliy, Passmore's initiative. Bravo NEDA. Together we shall conquer poverty. Thank you once again. God bless you more.
19) 30/11/2016, 19:32 - Peter Mrs: Vibrant
20) 30/11/2016, 19:40 - Passmore: This is sweet news Mrs Peter. I got the news from Prof Mupangwa about your tunnel and the seeds and bags. He was very excited and on behalf of NEDA I would like to extend our gratitude to all the stakeholders in Raymond Mhlaba Local Municipality and those outside of our municipal boundaries for their support to the cause of our farmers. God bless you. Just to formally inform you of the name change of NEDA. It's now called Raymond Mhlaba Economic Development Agency as a result of name change of the municipality after the merger with Nxuba with effect from the 3rd of August.
21) 30/11/2016, 19:43 - Peter Mrs: Thanks Passmore. We will miss the acronym NEDA.
22) 30/11/2016, 19:57 - Louise Madikiza: Great news indeed.
23) 30/11/2016, 19:57 - Passmore: Surely and as for myself I am still stuck with that acronym. Each time I have to introduce myself in a meeting I always say Passmore from NEDA
24) 30/11/2016, 19:59 - Peter Mrs:
25) 30/11/2016, 20:00 - Dubasi DD: Great news ma'm Peter!
26) 30/11/2016, 20:01 - Peter Mrs: Thank you guys.
27) 30/11/2016, 20:03 - Peter Mrs: Its a pity this phone isn't taking pics anymore and the other one has no whatsapp yet but will surely post them later.
28) 30/11/2016, 21:00 - ticha kunda1: Well done ma'am Peter and Mr Matambo for the true collaboration you have shown connecting farmer, Fort Cox students and lecturers! And to World Vision, UFH and RMEDA. This is what networked learning does - pooling resources and knowledges together.
29) 30/11/2016, 21:04 - Kim Weaver: Networking at its best! Congratulations to all of you especially Mrs Peter on the wonderful resource
30) I would love to visit early on in the new year
31) 30/11/2016, 22:27 - Peter Mrs: Thank you team and YES please Kim do visit. The chicken structure I won too is finished no more stealing now.
32) 30/11/2016, 22:28 - Passmore: Mrs Peter everything is double double for you
33) 01/12/2016, 04:39 - Peter Mrs: I am blessed and its not reversible. Lol. I learn from the best.
34) 01/12/2016, 04:40 - Passmore:

35) 01/12/2016, 04:40 - Passmore: □□□□□□
36) 01/12/2016, 06:00 - ticha kunda1: Good morning. The farmers were up quite early! Yes ma'am Peter. Learning from and with each other is so productive as we see in this example. We get the best results & blessings as you have put it!
37) 01/12/2016, 06:00 - ticha kunda1: The sounds like great input for the year end Imvotho Bubomi learning network meeting proposed by Ms Makhaga!
38) 01/12/2016, 06:24 - Ngele Makhaga: A blessing and a half it is Mrs Peter. Congratulations! These is a good way of closing the year with tangible testimonies on our network.
39) 01/12/2016, 06:31 - Ngele Makhaga added Siya
40) 02/12/2016, 12:40 - Ngele Makhaga added Edmore Parichi
41) 02/12/2016, 12:41 - Edmore Parichi: Thanks for adding me admin
42) 02/12/2016, 12:55 - ticha kunda1: Welcome Siya and Eddie. We look forward to your contributions which we value a lot.
43) 02/12/2016, 13:24 - Peter Mrs: Hi Eddie how's Bloem?
44) 02/12/2016, 13:45 - Edmore Parichi: Came back yesterday dear. I'm good thanks
45) 02/12/2016, 13:55 - Peter Mrs: Ok
46) 03/12/2016, 07:25 - Siya: Thanks for adding me
47) 05/12/2016, 17:37 - Edmore Parichi: WATER MELON SEEDS

48) The most delicious food in the world is watermelon. It has great and sweet and refreshing taste. But, not all of the people like the seeds from watermelon, so at the end they end up in the garbage. What you don`t know is that these seeds contain immense amount of nutrients, including essential proteins, fatty acids, vitamins and
49) minerals. Watermelon seeds are abundant in B vitamins such as thiamine, niacin, folate and minerals like potassium, magnesium, zinc, iron, phosphorus and copper.
50) □ □ □ □ □ □ □□□□□□
51) Health benefits of watermelon seeds
52) Diabetes
53) Diabetic patients can boil a handful of watermelon
54) seeds and cup of water and drink it as a tea.
55) Male fertility
56) They are rich in essential amino acids which are
57) good for sexual health. They promote the sperm
58) production and treat erectile dysfunction.
59) Anti- aging
60) Consuming this awesome seeds will help your
61) skin to brighten and become healthy.
62) Healthy hair and nails
63) Abundant in proteins, watermelon seeds are great
64) for your hair and nails. It can prevent breakage
65) and make them strong and beautiful. In addition,
66) roasted watermelon seeds will make your hair soft
67) and shiny.
68) Heart Health
69) This is the perfect remedy for those who suffer from cardiovascular disease and high blood pressure. Due to their rich magnesium content, watermelon seeds can promote healthy heart function and maintain normal blood pressure levels. Moreover, they also contain good fats and amino acids which regulate heart pressure and protect you from heart diseases. Watermelon seeds recipe for tea. As a powerful diuretic, watermelon seed is going
70) to cleanse your kidneys and bladder.
71) Instructions:
72) Pulverize and crush a couple of watermelon seeds. Add one teaspoon of the crushed seeds to a cup of boiling water. Let it stir for about 15 minutes. Consume at least one cup of it daily, three times a week. Warm it each time before drinking.□□□□□
73) 05/12/2016, 18:38 - Peter Mrs: Yhooo this is good thanks Eddie
74) 05/12/2016, 18:49 - ticha kunda1: Thank you Eddie for the information.
75) 05/12/2016, 19:14 - Edmore Parichi: □
76) 05/12/2016, 20:11 - Dubasi DD: Enkosi Eddie it's quite educating
77) 16/12/2016, 07:05 - Louise Madikiza: Don’t Look Around, Look Up!

78) You shall make a window for the ark, and you shall finish it to a cubit from above…
79) Genesis 6:16

80) If you were to build a large ship, where would you put the windows? Most likely, you would put them at the sides of the ship so that the passengers and crew can look outside, wouldn't you? God, on the other hand, told Noah to put the window of the ark at the top. God said, "You shall make a window for the ark, and you shall finish it to a cubit from above…"

81) I believe that God didn't want the ark to have windows at the sides for three reasons. First, God didn't want Noah and his family to hear all the mockery of the people outside: "Noah's building a boat on dry land. Silly old man!" Second, He didn't want Noah and his family to look at all the corruption and pollution on the outside either. Lastly, God didn't want Noah and his family to look at the death and destruction all around them. He wanted them to look up—toward heaven, toward Him.

82) My friend, it's the same for you today. God doesn't want you to focus on the naysayers, who may mock the dreams that He has birthed in your heart. He doesn't want you to focus on the death and destruction that's happening in the world and become afraid. God wants you to look upwards to Him. He is your peace, your provider, your healer, your protection, your refuge—He is your true ark! Keep looking to Jesus and you will be at rest and enjoy His blessings no matter what is happening all around you today!
83) 16/12/2016, 07:33 - ticha kunda1: Good morning Imvotho Bubomi team. How are you? I trust you are all braced for the festive season. May I wish you a blesed and safe holiday and a productive New Year with successful interactions, meetings and collaborative work. As we take stock of our plans vs achievements in 2016 we need to think of what we want to achieve in 2017, how, where, when and with whom.
84) 16/12/2016, 07:39 - ticha kunda1: With a team like IBLN the sky is the limit! (⁉"look up."). Thank you team for all your great works. The real present is ot what santa puts in the shoe or under the pillow. It is the time and respect we give each other. Thanks a lot to our chairperson, coordinator and all active members. There is always a reward to good selfless work!
85) 16/12/2016, 20:39 - Bulelani Phezisa changed from +27 73 297 1842 to +27 83 859 0918
86) 16/12/2016, 20:39 - +27 83 859 0918 changed to +27 73 297 1842
87) 16/12/2016, 08:40 - Edmore Parichi: Thank you
88) 16/12/2016, 10:56 - Ngele Makhaga: Enkosi dear
89) 16/12/2016, 15:02 - Dubasi DD: Thanks a lot may everyone enjoy the festive season with all it's festivities, till we meet again in 2017
90) 16/12/2016, 16:37 - Louise Madikiza: Happy happy festive season and prosperous new year. Looking forward to more collaborative work. An early meeting in the coming new year would help us to plan for the year. Thank you everyone
91) 16/12/2016, 16:53 - Edmore Parichi: In support
92) 19/12/2016, 08:05 - ticha kunda1: Good morning friends in collaboration. I also support the proposed meeting early in the New Year.
93) 19/12/2016, 08:06 - Ngele Makhaga: A blessed morning. Supported too
94) 01/01/2017, 00:03 - Chamu Matambo: Happy 2017. God bless.
95) 01/01/2017, 00:04 - Passmore: Happy happy
96) 01/01/2017, 00:07 - ticha kunda1: Greetings. Enjoy the excitement. It lasts a few moments. Most of all be blessed by the Creator of time.
97) 01/01/2017, 00:09 - Louise Madikiza: <Media omitted>
98) 01/01/2017, 01:26 - Ngele Makhaga: Happy new year
99) 01/01/2017, 06:11 - Edmore Parichi: Happy Happy!!
100) 05/01/2017, 13:28 - +27 79 312 7814: 2016 Matric Results (Please forward to others)...
101) 08/01/2017, 13:08 - Peter Mrs: Happy new year team. We have a locust disaster here at Matole basin, DRDAR, Perovincial office, District, Dohne Agric research centre, Raymond Mhlaba municipality officials and local extension are involved in eradicating them but could not spray due to rain. Hopefully tomorrow or Tuesday will be the day as we were asked to indicate once the weather clears. Please join us if interested and bring your protective clothing and if I am not available in this phone, call or sms to 0794868249 or Mr Peter 0723598935. The locusts are destroying everything in the gardens, not mine only, others in the village too.
102) 08/01/2017, 13:10 - ticha kunda1: Happy 2017 indeed everyone.
103) 08/01/2017, 13:14 - ticha kunda1: We empathise with you Mrs Peter and Matole team. What methods are they planning to use to eradicate the locusts Mrs Peter? What socio-ecologically friendly alternatives are abailable?
104) 08/01/2017, 13:15 - ticha kunda1: I hope some of us in IBLN will respond to this call for help from our member colleague. Any takers?
105) 08/01/2017, 13:24 - Peter Mrs: Prof Poswal from Dohne and Mrs Skenjana took samples to lab and prescribed a chemical which Mr Boko's office bought and its the one they 'll be using to spray. I did not take its

name but Mr Gege the extension officer took it back to the office for safe keeping and will bring it back on the day of demonstration involving farmers

106) 08/01/2017, 13:30 - Peter Mrs: Here is Prof's number for further details; 0609974485.

107) 08/01/2017, 13:34 - Peter Mrs: I could not get Eddie for advice on non chemical treatment, my phone froze and had no numbers of people but since it is a disaster I thought let me not fuss as I'll be starting from scratch with new seedlings

108) 08/01/2017, 13:38 - ticha kunda1: Thanks for sharing your challenge in detail and your attempts to engage non-chemical methods. Hopefully othrrs will share other workable alternatives.

109) 08/01/2017, 13:39 - Ngele Makhaga: A blessed year Mrs Peter and all members. hopefully we will get time next week college programme permitting. Locusts are really problematic.

110) 08/01/2017, 13:43 - Peter Mrs: Hi Ngele, when r u back? Hoping u brought my presents, avacado, mango seedlings and moringa seed

111) 08/01/2017, 13:45 - Ngele Makhaga: Mangoes on the way. Avos are out of season

112) 08/01/2017, 13:45 - ticha kunda1: Thanks for the reminder of the same Mrs Peter

113) 08/01/2017, 13:46 - Ngele Makhaga:

114) 08/01/2017, 13:56 - Peter Mrs: Yipppee, thanks m farmer.

115) 08/01/2017, 14:00 - Peter Mrs: I can't wait for these locusts to leave, I fortunately planted seed in my tunnel so that I can transplant immediately the problem is over. **My sorghum and millet seedlings from seed that I got from Enaleni farm in Maitzburg are ready to be transplanted**.

116) 08/01/2017, 14:03 - ticha kunda1: Wow you planted sorghum and millet! That is great ma'am Peter. Any other Ilizwi lamafama neighbours growing these?

117) 08/01/2017, 14:04 - ticha kunda1: Please send photos of tge seedlings, tunnel and of the locusts.

118) 08/01/2017, 14:07 - Peter Mrs: Yes we got seed from Richard at Enaleni. I don't know who planted in Ilizwi since it was holidays. Eddie did you plant? Lol.

119) 08/01/2017, 14:07 - Peter Mrs: I'll send pics Tich.

120) 08/01/2017, 14:09 - Peter Mrs: I'll use your email Ticha then you can upload them on whatsapp. Will do it tomorrow though, Mr Peter is taking me out to Ngumbela cricket tournament in Alice today.

121) 08/01/2017, 14:11 - ticha kunda1: Thanks I'll look forward to your email tomorrow. Enjoy the match and outing !

122) 08/01/2017, 18:40 - Edmore Parichi: Hello good people. Im now back. What a dissappointing locust outbreak. Lets keep each other updated of the development. Will also make a follow up on the type of pesticide they intent to use

123) 09/01/2017, 06:48 - ticha kunda1: Welcome back Eddie. Sure your advice is much needed timeously.

124) 14/01/2017, 17:41 - Siya: Does anyone know what they eat

125) 14/01/2017, 17:41 - Siya: <Media omitted>

126) 14/01/2017, 17:45 - Ngele Makhaga: Im blank

127) 14/01/2017, 19:12 - Louise Madikiza: Can buy from shops fishmeal

128) 14/01/2017, 19:12 - Louise Madikiza: Bread crumbs too

129) 17/01/2017, 13:41 - Passmore: Good day colleagues

130) 17/01/2017, 13:43 - Passmore: Just to announce that Eleornore the Intern from Germany is now with us at Raymond Mhlaba Economic Development Agency

131) 17/01/2017, 13:43 - Passmore: <Media omitted>

132) 17/01/2017, 13:43 - Passmore: <Media omitted>

133) 17/01/2017, 13:45 - Passmore: Our colleagues from Rhodes University facilitated this arrangement

134) 17/01/2017, 13:47 - Ngele Makhaga: Great deal

135) 17/01/2017, 13:48 - Ngele Makhaga: Power of networking...imvotho bubomi international

136) 17/01/2017, 14:02 - Passmore: Yes Ngele, the power of networking

137) 17/01/2017, 14:16 - Ngele Makhaga: Yhaa

138) 17/01/2017, 14:36 - Kim Weaver: This is wonderful news!! Welcome to her. We must arrange a visit sometime soon

139) 17/01/2017, 14:43 - ticha kunda1: Welkom Eleornore!

140) 17/01/2017, 14:44 - Passmore: This is wonderful news!! Welcome to her. We must arrange a visit sometime soon

141) 17/01/2017, 14:45 - Passmore: That will be great Kim

142) 17/01/2017, 14:46 - Ngele Makhaga: Welcome to her. Wamkelekile

143) 17/01/2017, 18:18 - Dubasi DD: We welcome her!

144) 18/01/2017, 07:33 - ticha kunda1: Good morning team. What has become of the 'locust disaster' in Matole Basin?

145) 18/01/2017, 08:17 - Chamu Matambo: Welcome to our German colleague

146) 25/01/2017, 09:33 - Ngele Makhaga: <Media omitted>

147) 25/01/2017, 10:01 - ticha kunda1: Wow this is good news madame Makhaga thanks. More good news is coming...
148) 25/01/2017, 10:04 - Ngele Makhaga: True
149) 25/01/2017, 10:09 - Passmore: Thanks for sharing the news
150) 25/01/2017, 20:47 - Edmore Parichi: Thanks so much Madam
151) 14/02/2017, 15:57 - Peter Mrs: Good day team Imvotho. **We had good rains last night**. How is everybody?
152) 14/02/2017, 15:58 - Peter Mrs: <Media omitted>
153) 14/02/2017, 15:59 - Peter Mrs: <Media omitted>
154) 14/02/2017, 15:59 - Ngele Makhaga: Oo beautiful. We bless the Lord
155) 14/02/2017, 16:00 - Peter Mrs: Childrem and teachers couldn't go to school today due to low lying bridges.
156) 14/02/2017, 16:02 - Ngele Makhaga: The we are halfway towards the end of the quarter....maybe time think of our general meeting....
157) 14/02/2017, 16:29 - ticha kunda1: Wow we thank the Almight for the much needed rains. Doing well thanks.
158) 14/02/2017, 16:30 - ticha kunda1: We also wish and pray for safety to all having to cross bridges.
159) 14/02/2017, 16:31 - ticha kunda1: Great thinking.
160) 15/02/2017, 08:54 - Edmore Parichi: Good news for the rains
161) 16/02/2017, 12:07 - Kim Weaver: Let me know when the meeting is and if I can attend then I will be there go see out new blog on amanziforfood.co.za welcoming Eleanore!!

162) We welcome the rains too!! If anyone would like to contribute the amanzi blog then please feel free to email me a piece with a picture
163) 16/02/2017, 17:26 - Peter Mrs: <Media omitted>
164) 16/02/2017, 17:33 - Peter Mrs: Hi Kim here are some pics for my garden after locust destruction though not completely eradicated.
165) 17/02/2017, 10:12 - Peter Mrs: <Media omitted>
166) 17/02/2017, 10:12 - Peter Mrs: <Media omitted>
167) 17/02/2017, 11:05 - ticha kunda1: Molweni. Is this the sorghum crop mom Peter?
168) 17/02/2017, 18:33 - Peter Mrs: No its maize e masimini zM 1523. Sorghum is in the garden.
169) 23/02/2017, 10:36 - Peter Mrs: <Media omitted>
170) 23/02/2017, 10:38 - Peter Mrs: Ilizwi la mafama on training,, we are busy constructing a tower garden as one of garden cesigns knAgroecology and rain water harvesting. Morning tea .
171) 23/02/2017, 10:39 - ticha kunda1: Good morning. Great the looks and sounds good.
172) 23/02/2017, 10:40 - Peter Mrs: <Media omitted>
173) 23/02/2017, 10:40 - ticha kunda1: How many people are being trained?
174) 23/02/2017, 10:42 - Peter Mrs: <Media omitted>
175) 23/02/2017, 10:43 - Peter Mrs: <Media omitted>
176) 23/02/2017, 10:43 - Ngele Makhaga: Wow beautiful
177) 23/02/2017, 10:44 - Ngele Makhaga: We also ha uMgwali youth being trained for a year
178) 23/02/2017, 10:45 - Peter Mrs: <Media omitted>
179) 23/02/2017, 10:45 - Peter Mrs: We were 28 including other NGOs from P.E and Transkei
180) 23/02/2017, 10:48 - Peter Mrs: That zas Mrs Mapukatha's initiative and she is in our IBLN. She asked for funding from Agriseta for those students
181) 23/02/2017, 10:49 - Ngele Makhaga: Yes she was here Monday. It is a breakthrough
182) 23/02/2017, 10:50 - Peter Mrs: Good deed, empoering rural youth.
183) 23/02/2017, 10:55 - Louise Madikiza: Thank you for the information Mrs Peter, where is the training taking place?
184) 23/02/2017, 11:07 - Peter Mrs: It was at Berlin at Zingisa premises where the learning site is.
185) 23/02/2017, 11:18 - Siya: Hi ndicela ubuza uba zikhona na ihagu ezimhlophe efortcox
186) 23/02/2017, 11:22 - Ngele Makhaga: Will check for you when im back in the office ngomso
187) 23/02/2017, 11:25 - ticha kunda1: Molo Siya. Are you part of this training?
188) 23/02/2017, 11:25 - Louise Madikiza: Thank you
189) 23/02/2017, 12:04 - Siya: Yes Ticha I am
190) 23/02/2017, 12:14 - Peter Mrs: <Media omitted>
191) 23/02/2017, 12:15 - Peter Mrs: There's Siya, Ticha.
192) 23/02/2017, 12:17 - ticha kunda1:
193) 23/02/2017, 12:20 - Kim Weaver: Wow that looks amazing, what great training!!! Well done team! You are such an inspiration and a blessing to our community ❤

194) 23/02/2017, 12:38 - Siya: **We are becoming real farmers now thanks to everyone who made sure the youth of Matole Basin is not left behind**
195) 23/02/2017, 12:44 - Peter Mrs: Thanks Kim, waiting for the visit.
196) 23/02/2017, 12:52 - ticha kunda1: Yeah! We are proud of our upcoming youths! Thanks to the innovative youths, the farmer mentors, Fort Cox College, Lovedale College, NEDA, Zingisa and others. Keep it up. I'm glad to see that in 2017 we are having a spirit of leaving no one behind.
197) 23/02/2017, 13:38 - Peter Mrs: The Department of Rural Development and Agrarian Reform, Research and Technology Development division invite Farmers, Officials, Policy Makers, Academics and Interested Youth to a Seminar series – AQUACULTURE EDITION

198) Venue: Dohne Auditorium
199) Date: 24.02.2017
200) Time: 9:30 – 10:20 Tea & Registration

201) Chair: Mr Mfundo Macanda

202) Opening & Welcoming remarks: 10:20 – 10:35

203) Seminars
    1. Dr. D. Augustine – Goettingen University
204) Biogas Production: An Option for Rural Eastern Cape? 10:35 – 10:55
    1. Vusi Mthombeni – DRDAR
205) Xenopus laevis in freshwater aquaculture ponds of South Africa 10:55 – 11:15
    1. Siyamthemba Madyibi – Walter Sisulu University
206) Effect of pond and feed on growth of tilapia Oreochromis mossambicus in the Mthatha Dam Station 11:15 – 11:35
    1. Mr Phillip – Karoo Catch Pty (Ltd)
207) Establishing an aquaculture incubator for sector development in the Eastern Cape. 11:35 – 12:25
    1. William Selapa – DAFF
208) Potential aquaculture species in the Eastern Cape 12:00 – 12:25
209) Lunch: 12:30 – 13:20
    1. Qurban Rouhani – Rhodes University
210) Freshwater aquaculture in the Eastern Cape – ideas on the way forward 13:20 – 13:45
    1. Dr Niall Vine – University of Fort Hare
211) Opportunities of mariculture in the Eastern Cape 13:45 – 14:10
    1. Dr. Christian Lodder – University of Goettingen
212) Aquaculture: German Experience and its Relevance into Eastern Cape Situations 14:10 – 14:35

213) General Discussion to Shape Provincial Initiatives 14:40 – 15:20
214) Contact Person:
215) M. Macanda
216) Director: Livestock Production Research & Development
217) Dohne ADI
218) Stutterheim
219) Tel: +27 43 683 5479
220) Cell: +27 82 8575 810
221) Fax: +27 43 683 2890
222) Email: Mfundo.macanda@drdar.gov.za
223) 23/02/2017, 13:39 - Peter Mrs: I am attending..
224) 23/02/2017, 14:30 - Ngele Makhaga: Oo great. Thanks for the info
225) 23/02/2017, 16:37 - Peter Mrs: Pleasure m famer.
226) 01/03/2017, 13:29 - ticha kunda1: Greetings everyone. How did that seminar go?
227) 01/03/2017, 13:57 - Siya: Hi did you find out about the pigs
228) 06/03/2017, 10:09 - Siya: <Media omitted>
229) 06/03/2017, 12:18 - ticha kunda1: Greetings. Wow is this your latest harvest?
230) 06/03/2017, 12:24 - Siya: Yes Ticha it is I'm learning
231) 06/03/2017, 12:32 - ticha kunda1: Well done Siya. The results of learning are evident! Now you have much more seeds than you planted.
232) 06/03/2017, 12:32 - Siya: Thank you
233) 06/03/2017, 12:36 - Ngele Makhaga: Wow this is great

234) 06/03/2017, 12:56 - ticha kunda1: Do you mind sharing the story behind this harvest Siya? I am sure it will motivate our Imvotho Bubomi Learning Network community.
235) 06/03/2017, 13:30 - Siya: No I don't mind at all but right now I have to submit some forms with NEDA
236) 06/03/2017, 13:34 - Passmore: Can you see me when you're at NEDA
237) 06/03/2017, 13:43 - Siya: Yes I can
238) 06/03/2017, 13:43 - Siya: I don't have your name though
239) 06/03/2017, 14:18 - ticha kunda1: Don't miss the opportunity to meet Passmore.
240) 06/03/2017, 14:44 - Passmore: Passmore
241) 06/03/2017, 15:51 - Edmore Parichi: <Media omitted>
242) 06/03/2017, 15:52 - Edmore Parichi: **ZM1523 Maize trial at Berlin. The crop doing very well**.
243) 06/03/2017, 15:54 - Edmore Parichi: The plastics are in place to curb bad damage
244) 06/03/2017, 15:54 - Edmore Parichi: * bird damage
245) 06/03/2017, 16:29 - Ngele Makhaga: Owesome
246) 07/03/2017, 01:07 - ticha kunda1: Well done Eddie and team. We are now looking forward to trials planned for by Fort Cox College, you and team.
247) 09/03/2017, 14:37 - Kim Weaver: Ngele, honorable chairlady, have you set a date for the next IBLN meeting? Ticha and I would like to come visit
248) 09/03/2017, 14:55 - Ngele Makhaga: Thank you Kim for reminding
249) 09/03/2017, 14:57 - Ngele Makhaga: Farmers good day... could we please decide on what day could be best for the 1st 2017 IBLN term meeting and a meeting place.
250) 09/03/2017, 14:59 - Ngele Makhaga: This is the last month of the quarter
251) 10/03/2017, 16:07 - Peter Mrs: <Media omitted>
252) 10/03/2017, 16:20 - ticha kunda1: Hi Mrs Peter. This is indeed very exciting and commendable. Well done.
253) 10/03/2017, 16:27 - Peter Mrs: Thank you Ticha, seed saving thereafter sharing to multiply it as this is an OPV seed thwt was shared from Enaleni farm. Only 5 seeds nhe per perskn?
254) 10/03/2017, 16:28 - ticha kunda1: Many methods have been tried to protect millet from especially red-billed Quelea birds. These include tins that make continuos rattling noise as they collide in the wind, scarecrows, covering heads with grass, leaves or cloth but not plastic. I hope this helps. Maybe we should add this to our IBLN agenda?
255) 10/03/2017, 16:29 - ticha kunda1: Yes! From 5 seeds we will end up with a granary.
256) 10/03/2017, 16:30 - Peter Mrs: Thank you very much yhoo its good to ask, we nearly made a blunder.
257) 10/03/2017, 16:35 - ticha kunda1: <Media omitted>
258) 10/03/2017, 16:37 - ticha kunda1: <Media omitted>
259) 10/03/2017, 16:50 - ticha kunda1: The best insurance is sharing *and planting* so many of us plant the crop. The more the crop in the neighbourhood the greater the spread of risk. Those seed banks planned for in the community and at Fort Cox College will be essential.
260) 10/03/2017, 16:52 - Peter Mrs: Yes Ticha it is readable thanks.
261) 10/03/2017, 17:01 - Peter Mrs: I receivec cow peas and beans seed from Mrs Madikiza today. Viva seed sharing viva.
262) 10/03/2017, 17:04 - ticha kunda1: Viva seed sharing!
263) 10/03/2017, 17:07 - ticha kunda1: Belatedly allow me colleagues to say happy Women's Day to our chief seed guardians in the community - the women.
264) 10/03/2017, 17:27 - Peter Mrs: Siyabonga.
265) 10/03/2017, 17:42 - Passmore: Good day. You can visit our new website. It's www.rmda.co.za
266) 10/03/2017, 17:50 - ticha kunda1: It's looking good. I have filled in the form.We must link with Amanzi for Food website.
267) 10/03/2017, 17:58 - Kim Weaver: Awesome Passmore I will link it to the Amanzi Website on Monday
268) 10/03/2017, 18:00 - ticha kunda1: Thanks Kim.
269) 10/03/2017, 18:01 - Kim Weaver: When can we meet fellow farmers??
270) 10/03/2017, 18:17 - ticha kunda1: Very soon we should share recipes for preparing health meals from pearl millet, sorghum and cow peas. By the time go for Agric Shows these are some of the sustainable water and climate adaptive artefacts to share.
271) 12/03/2017, 21:32 - Ngele Makhaga: Oo wow great things are happening in Amathole. We need to visit this site. People like me do not know millet.
272) 12/03/2017, 21:34 - Ngele Makhaga: May I suggest that we meet on the week of the 28th March if it is too early then the week of the 4th April?

273) 12/03/2017, 22:08 - ticha kunda1: Isn't learning together 'new' knowledge practices in our learning network such a treasure and much fun! I look forward to be with you all once the farmers and extension officers agree on a preferred date. Thanks for offering alternatives.
274) 12/03/2017, 22:11 - Ngele Makhaga: Very true Ticha. This kind of learning method is more exciting and practical
275) 13/03/2017, 14:39 - Peter Mrs: I suggest 4 ,April as we are having our Coop Indaba on the ,30 March . We shall be busy preparing on the 28.
276) 13/03/2017, 15:17 - Kim Weaver added Patience Shawarira
277) 13/03/2017, 15:15 - Ngele Makhaga: Noted Mam Peter
278) 13/03/2017, 15:19 - ticha kunda1: I have another meeting elsewhere on 4-6 April unfortunately.
279) 13/03/2017, 15:22 - Peter Mrs: How is 11 April? You are all invited to the Indaba that will be held at Fort Beaufort on the 30 March.
280) 13/03/2017, 15:23 - Ngele Makhaga: Noted Ticha....farmers may I request that we comment on this as quick as we can so that we can have a collective agreement to move on
281) 13/03/2017, 15:23 - Kim Weaver: It will be very difficult for to get away the first week of April. Can we not combine with the indaba???
282) 13/03/2017, 15:24 - Edmore Parichi: The 11th is fine for me
283) 13/03/2017, 15:25 - Edmore Parichi: *of April
284) 13/03/2017, 15:26 - Kim Weaver: How is Monday, the 10th for eveyone?
285) 13/03/2017, 15:27 - ticha kunda1: It will be important for extension to be present too. I hope we hear from them too.
286) 13/03/2017, 15:29 - Ngele Makhaga: Balimiso khanithetheni please oo
287) 13/03/2017, 15:56 - Dubasi DD: I will try by all means to avail myself on any set date as long it's not on Fridays. I request that a date be set then I will adjust according
288) 13/03/2017, 15:57 - Ngele Makhaga: Thank Sir
289) 13/03/2017, 16:41 - Louise Madikiza: Which date are we discussing 10th or 11th April?
290) 13/03/2017, 16:50 - Kim Weaver: I can do the 10th but not the 11th. Kim
291) 13/03/2017, 19:56 - Chamu Matambo: Molweni mafama. 10 and 11th will be school holidays in Fort Cox. Some of us may be travelling. How about Monday the 3rd of April. From the perspective of the above contributions, its a date that is untouched.
292) 14/03/2017, 08:40 - Edmore Parichi: Hello good farmers. Why cant we settle for the 4th. Im not sure what time i wl arrive from joburg on the 3rd
293) 14/03/2017, 08:42 - Ngele Makhaga: Kim and Tich have commitments on the 4th
294) 14/03/2017, 09:28 - Edmore Parichi: Noted Madam. I will see if i arrive in time. Otherwise all the best
295) 14/03/2017, 09:34 - Kim Weaver: If Tich and my dates don't work for everyone then maybe we should come to the indaba and you have the meeting without us and fill us in if Tich is happy with that?
296) 14/03/2017, 11:37 - ticha kunda1: Good morning team.
297) 14/03/2017, 11:39 - Ngele Makhaga: Your suggestion sounds fine for me Tich
298) 14/03/2017, 11:42 - Chamu Matambo: Which one?
299) 14/03/2017, 11:51 - ticha kunda1: I suggest you please go ahead and set a date when most people are available. From my analysis it looks like end of March and 3 April are out as well as 10 April onwards and Fridays.
300) 14/03/2017, 12:13 - ticha kunda1:
301) 14/03/2017, 16:32 - ticha kunda1: What time is the Indaba? My calendar is filling up fast!
302) 14/03/2017, 18:45 - ticha kunda1: How are we engaging those with no WhatsApp to notify them on date?
303) 14/03/2017, 18:55 - Ngele Makhaga: We do calls when there is clarity on what dates to choose from
304) 14/03/2017, 19:16 - ticha kunda1: I remember off hand Ms Jeanette Tema from Khayalethu, Lloyd Village farmers, Gwali farmers, Mr Mcata, Mrs Mboto from near Khayalethu among others.
305) 14/03/2017, 19:20 - Ngele Makhaga: Okay will check the register
306) 15/03/2017, 07:57 - Peter Mrs: Indaba is on the ,30 March usually starts in the morning for breakfast at 9 then programe at 10 depending at the time the MEC and or mayor arrive. Its quite a packed programme taking a!most the whole day that no other activity can be slotted in.
307) 15/03/2017, 08:34 - ticha kunda1: Ok thanks.
308) 17/03/2017, 13:50 - Peter Mrs: <Media omitted>
309) 17/03/2017, 13:54 - Ngele Makhaga: Woow
310) 17/03/2017, 13:55 - Peter Mrs: Hi Ngele howzit? You guys promised us a visit (Fortcox).
311) 17/03/2017, 13:56 - Peter Mrs: Thanks
312) 17/03/2017, 13:57 - Ngele Makhaga: Yes it is still on the plan just been very busy
313) 17/03/2017, 13:59 - Peter Mrs: Sure dear. TGIF.

314) 17/03/2017, 14:06 - ticha kunda1: Weldone Peter family. Weldone Imvotho Bubomi learning network supporters.
315) 17/03/2017, 14:13 - ticha kunda1: I look forward to sorghum and millet looking like this too at Matole Basin and at Fort Cox ATI.
316) 17/03/2017, 14:14 - Chamu Matambo: We will plan the visit Madam
317) 17/03/2017, 14:15 - Chamu Matambo: Great staff there
318) 17/03/2017, 14:17 - Peter Mrs: Thanks Chamu.
319) 17/03/2017, 18:12 - Kim Weaver added Live Matiwane
320) 17/03/2017, 15:58 - Kim Weaver: Awesome Mrs Peter, where is the indaba exactly in fort Beaufort?? Kim
321) 17/03/2017, 15:59 - Peter Mrs: At Cape College. Thanks Kim.
322) 17/03/2017, 16:04 - Peter Mrs: We used manual weeding with tractor and "skoffel", followed by ILIMA where men from the village came to assist, we cooked for them and had to buy a case of Black label beer for quenching thirst. The only challenge is pest control for the maize in the fields.
323) 17/03/2017, 18:18 - ticha kunda1: Wow great to see Ilima in action. Please invite some us to ilima next time. Which pests are being troublesome.
324) 18/03/2017, 09:18 - Peter Mrs: Morning Ticha. I'll keep the request in mind for next time, that would be awesome. Its the maize stalk borer that is a problem.
325) 20/03/2017, 20:13 - Peter Mrs: Morning team. Please be advised that the Indaba has been postponed for a date still to be announced in May. Our Mayor was briefed late by LED so the present date was too early for him. I'll keep you posted. Sorry for inconvenience.
326) 20/03/2017, 21:13 - ticha kunda1: Noted with thanks.
327) 20/03/2017, 23:28 - Ngele Makhaga: Thank you madam. Then is it safe for us to conclude the meeting date to be the 30th March. .
328) 21/03/2017, 06:42 - Chamu Matambo: Good idea that..
329) 21/03/2017, 08:23 - ticha kunda1: I second the motion .
330) 21/03/2017, 08:23 - ticha kunda1: Good norning.
331) 21/03/2017, 08:30 - Ngele Makhaga: Noted Chamu and Tich. A blessed morning
332) 21/03/2017, 08:32 - Dubasi DD: I am in support of the 30/03 date
333) 21/03/2017, 08:36 - Ngele Makhaga: Noted Sir Dubasi
334) 21/03/2017, 14:07 - Peter Mrs: In suport of the 30 for our meeting and abrief visit to Mathole badin. Things are happening there watch the space
335) 21/03/2017, 14:48 - Peter Mrs: <Media omitted>
336) 21/03/2017, 14:48 - Peter Mrs: <Media omitted>
337) 21/03/2017, 14:55 - Peter Mrs: <Media omitted>
338) 21/03/2017, 14:56 - Peter Mrs: <Media omitted>
339) 21/03/2017, 15:01 - Peter Mrs: <Media omitted>
340) 21/03/2017, 15:24 - Edmore Parichi: Good work good farmers
341) 21/03/2017, 15:26 - Peter Mrs: This was all today's work. . Thanks Eddie, your visit motivated members.
342) 21/03/2017, 15:27 - Edmore Parichi: Amen!!
343) 21/03/2017, 15:58 - Louise Madikiza: Great work indeed! Your effort will surely be rewarded
344) 22/03/2017, 15:25 - Kim Weaver: Well done, awesome to see all the pictures of our inspired farmers!
345) 22/03/2017, 15:28 - Kim Weaver: We are putting together a nomination for a University prize for the Amanzi for Food project. We need two letters of reference from our community partners which is all of you. Would two of you come forward and write a letter of reference of the project and what it has done for you or your community or your practice? You can focus on any aspect- practice, networking etc...
346) 22/03/2017, 15:28 - Kim Weaver: This would be greatly appreciated by all good of us at Rhodes
347) 22/03/2017, 16:40 - Peter Mrs: Thanks Louise.
348) 22/03/2017, 16:44 - Peter Mrs: My band is up. By when is the letter neeeed?
349) 22/03/2017, 16:49 - Peter Mrs: Hand
350) 22/03/2017, 17:06 - Kim Weaver: Thanks Mrs Peter by Monday preferably if that is okay? Could you e-mail it to Ticha or myself?
351) 22/03/2017, 18:23 - Peter Mrs: Sure Kim, I dont have your email though.
352) 22/03/2017, 21:25 - ticha kunda1: Well done farmers. Well done Zingisa.
353) 22/03/2017, 21:27 - Kim Weaver: Yes sorry it is kimweaversa@Gmail.com
354) 23/03/2017, 08:09 - ticha kunda1: Good morning farmers (including lecturers, extension, researchers and supporters). Molweni.
355) 23/03/2017, 08:12 - Edmore Parichi: Molo mhlekazi

356) 23/03/2017, 08:12 - ticha kunda1: It is so wonderful to see so much learning and working together for a common community good. I hope that we can see more such action in other villages and in our education and training institutions.
357) 23/03/2017, 08:14 - ticha kunda1: Molo mhlekazi. Unjani? Thank you for the great work you are doing with farmers and your pledge to support demonstration plots in agricultural training institutes.
358) 24/03/2017, 11:30 - Ngele Makhaga: Good morning farmers....
359) 24/03/2017, 11:31 - Ngele Makhaga: We agreed on the date, could we also discuss/suggest date and time for our very first meeting in 2017...
360) 24/03/2017, 11:33 - Ngele Makhaga: We can suggest a farmer's/ farm site, institutions eg Fcc, Rhodes, departments...
361) 24/03/2017, 11:33 - Ngele Makhaga: Fort Hare too
362) 24/03/2017, 11:35 - Chamu Matambo: Venue and time...i guess you meant
363) 24/03/2017, 11:35 - Ngele Makhaga: Yhaa thanks sihlalo venue I meant
364) 24/03/2017, 19:29 - Peter Mrs: Hello all, can we go to UFH? I am not sure if it will be possible then to visit Matole basin from UFH
365) 24/03/2017, 19:29 - Peter Mrs: Thanks Kim for the email address.
366) 24/03/2017, 20:37 - Peter Mrs: <Media omitted>
367) 27/03/2017, 10:01 - ticha kunda1: Good morning network colleagues. What *time* are we meeting on Thursday 30 March and *where?*. There are just 3 days to go. Thanks
368) 27/03/2017, 10:32 - Dubasi DD: I suggest we meet @ 09H30 at the Fort Cox College
369) 27/03/2017, 10:36 - Richard Moyo: my apologies for not responding as someone from UFH. We would hve been happy to host the network meeting bt unfortunately there are chances that on that suggested I might away
370) 28/03/2017, 09:28 - Peter Mrs: Evening team, network at Matope is a problem I sent the ref letter lsst night but it still says its trying but the data is getting finished
371) 28/03/2017, 09:28 - Peter Mrs: I am still trying though, fortunately tomorrow I'll be at Zingisa and will send it from there.
372) 28/03/2017, 10:12 - ticha kunda1: I didnt see the coordinator confirming this suggestion of time and venue. Anyway I second the motion.
373) 28/03/2017, 10:13 - ticha kunda1: Thank you very much for making this effort.
374) 28/03/2017, 10:49 - Ngele Makhaga: You are right Tich was waiting for more responses. We are fine with 9:30@ Fortcox
375) 28/03/2017, 10:49 - ticha kunda1:
376) 28/03/2017, 10:57 - Edmore Parichi: I concur with the suggested time and venue
377) 29/03/2017, 18:34 - Edmore Parichi: These things hinder success...
    1. Always giving excuses
    2. Laziness
    3. Being jack of all trades...master of none. One must distinguish between good and right. It is good to eat but it may not be the right time for you!
    4. Too much sleep
    5. Lack of self-motivation
    6. Bad company (corrupts good habits)
    7. Pride (failure's forerunner)
    8. Fear of failure.
    9. Poor decision making or lack thereof
    10. Lateness and/procrastination.
378) 29/03/2017, 18:35 - Edmore Parichi: Hello good cmrds
379) 29/03/2017, 18:35 - Ngele Makhaga: Hi Eddie.
380) 29/03/2017, 18:36 - Ngele Makhaga: And evening every one. Hope to see you tomorrow @fortcox
381) 29/03/2017, 18:37 - Edmore Parichi:
382) 29/03/2017, 18:41 - Peter Mrs: Please be mindful of time team. Good eve ing.
383) 29/03/2017, 18:42 - Peter Mrs: Your number 10 Eddie
384) 29/03/2017, 18:43 - Ngele Makhaga: Yes mam Peter 9:30 am @ the gymnasium
385) 29/03/2017, 18:44 - Edmore Parichi: Lol. We wl try our best madam
386) 29/03/2017, 21:54 - ticha kunda1: Good evening. Sure expect 4 from Rhodes University, 1 from Lloyd and two from NEDA. Good night.
387) 29/03/2017, 22:10 - Kim Weaver: See you tomorrow comrades
388) 30/03/2017, 09:24 - Ngele Makhaga: Meeting venue changed, please ask for the board room at the reception.
389) 30/03/2017, 09:24 - Ngele Makhaga: Team Rhodes is already here

390) 30/03/2017, 09:38 - Edmore Parichi: Noted
391) 30/03/2017, 09:39 - Edmore Parichi: We have also bn told to wait here at the gymnasium
392) 30/03/2017, 09:48 - Chamu Matambo: Good to hear some members have made it on time... looking forward to a successful meeting
393) 30/03/2017, 18:10 - Peter Mrs: Trusting you had a safe journey team. Thank you for a productive day despite the heat and for allowing "hand holding".
394) 30/03/2017, 18:12 - Peter Mrs: Team Fort cox's hospitality is very much appreciated.
395) 30/03/2017, 18:17 - ticha kunda1: Good evening team. Thanks for a wonderful day together. Great hosting by Fort Cox team - thanks for the eats! We thank our Chairperson for the day DD - great job. Thanks to Peter family for hosting a motivating learning visit at your home.
396) 30/03/2017, 18:26 - Ngele Makhaga: You are welcome good people together we made meeting productive. And thank you mam Peter for the bread...umbhako . I hope everyone traveled safe
397) 30/03/2017, 18:29 - Peter Mrs: Pleasure is mine.
398) 30/03/2017, 18:54 - Edmore Parichi: Thanks so much everybody. Together we can move our communities forward
399) 30/03/2017, 19:13 - Louise Madikiza: Productive day indeed! Thank you everyone, stay blessed
400) 30/03/2017, 21:50 - Dubasi DD: It was a day well spent keep it up team IBL
401) 31/03/2017, 06:33 - Chamu Matambo: Good morning all. May i thank the team for the job well done. It seems the meeting was a real success. May the secretary of the day circulate the minutes on email so that we are all in sync with the goings-on of the meeting. Thanks once more to everyone who managed to turn up for the meeting.

Appendix 6.4C: Samples of Community Radio Show Scripts (DIBSAR) and Studio Presentation Summaries (DIBSARS)

Radio Script
Programme 1: 26 September 2017
Topic: Infusing Amanzi for Food Water Research Commission (WRC) learning materials and water harvesting and conservation techniques into university community and extension service in small-scale farmers (crop and livestock) and homestead food growers.
Objective: The objective of this radio programme is to explore ways for small-scale farmers (crop and livestock) and homestead food growers, university lecturers, entrepreneurship and community members to discuss the infusion of water harvesting and conservation and food security techniques in university curriculum and extension service.
Presenter:
Panel Members
Amanzi for Food Representative from Fort Cox Agricultural Training Institute (formerly college): **Ms Makhaga Ngele**
University of Fort Hare **Richard Moyo**
Raymond Mhlaba Municipality **Passmore Dongi**
Rhodes University **Crispen Dirwai**

Questions to panellists (10minutes)
1. Last time you were on air we talked about Amanzi for Food and who you are. Kindly remind the listeners about Amanzi for Food and what you do?
(To be answered by **Ngele:** Highlight what it is, when it started, who is involved in the Amanzi for Food)

Example: Amanzi for Food is a project funded by the Water Research Commission (WRC), led and facilitated by the Environmental Learning Research Centre at Rhodes University and implemented by rainwater harvesting learning network members that include farmers, agricultural college lecturers, extension officers from DRDAR and so on.
The people involved with Amanzi for Food include farmers, extension officers, lecturers and trainers, agricultural education and training institutions (colleges and universities) and agricultural NGOs, CBOs municipal LED agencies. They learn together and implement different ways of harvesting, storing, and using rainwater according to their needs, to improve food production. We refer to all these activities as
'Rainwater Harvesting and Conservation' (RWH&C). The project aims at facilitating collaborative learning by everyone involved in the growing of food to implement different ways of harvesting, storing, and using rainwater to improve food production.

2. On radio this time, what would you like the listeners to watch out for?
To be answered by **Crispen:** We would like to make more visible the Water Research Commission (WRC) produced materials to our listeners, agricultural colleges and universities in order for colleges and universities to access and embrace them in their teaching and agriculture curriculum. These Water Research Commission (WRC) produced materials are on: a) application of rainwater harvesting and conservation in Fresh water fisheries, b) Sustainable use of grey water in small scale agriculture and gardens, c) application of rainwater harvesting and conservation in the Production guidelines for leafy vegetables, d) Sustainable techniques and practices for rain water harvesting and Conservation (1&2), e) application of rainwater harvesting and conservation in improving rural livelihoods through Biogas generation, f) guidelines on Best management Practices for RWH and Conservation. These emphasise

on innovations that are suitable for our small-scale farmers (crop and livestock) and homestead food growers who currently are not very visible in the college and university curriculum. The selected WRC learning materials are found on the Amanzi for Food Website which is www.amanziforfood.co.za.

Presenter:
 Remind listeners who the panel are and why Amanzi for Food is on air, where they can find Information www.amanziforfood.co.za and Facebook page – Amanzi for food.
 Give listeners the call number, SMS number 073 641 3872, Facebook page.
 also encourage listeners to share their stories of using rainwater-harvesting practices.

3. What are some of the issues related to water and food security that you offer in your university curriculum that can be shared with small-scale farmers (crop and livestock) / homestead food growers?
(To be answered by **Richard**: Highlight what the university agriculture curriculum offers in terms of water harvesting and conservation and food security and this can help the small-scale farmers (crop and livestock) / homestead food growers. Show areas where the WRC materials can be infused in the university curriculum.

4. Can you provide us with an outline of the agriculture value chain work that you are doing with communities in Raymond Mhlaba Local Municipality with respect to water harvesting and conservation and food security in small-scale farmers (crop and livestock) and homestead food growers?
(To be answered by **Passmore**: To highlight the project Raymond Mhlaba Municipality is doing with respect to small-scale farmers (crop and livestock)and homestead food growers.

5. What attempts have you made as University working with Alice Extension and Research Service to improve the water and food security issues facing small-scale farmers (crop and livestock) and homestead food growers?
(To be answered by **Richard:** Highlight the research and extension work that you engage with in respect to small-scale farmers (crop and livestock) and homestead food growers.

6. What possible prospects are there to infuse the water and food security situation in small-scale farmers (crop and livestock) and homestead food growers in college and universities?
(To be answered by **Richard, Ngele**: Highlight areas or topics where the 8 WRC materials can be infused in college and university curriculum.

Presenter:
 Remind listeners who the panel are and why Amanzi for Food is on air, where they can find Information www.amanziforfood.co.za and Facebook page – Amanzi for food.
 Give listeners the call number, SMS number 073 641 3872, Facebook page.
 also encourage listeners to share their stories of using rainwater-harvesting practices.

7. Mr Moyo as a researcher who works directly with extension service at University of Fort Hare what issues can you embrace in your activities to benefit the small-scale farmers (crop and livestock) and homestead food growers in water harvesting and conservation and food security?
Richard to elaborate on such issues.

8. Phone in session (listeners) – 5minutes

9. Where could listeners find the advice or see the options about Amanzi for food and most

Importantly on rainwater harvesting and conservation practices?
(Answer to include the Website: www.amanziforfood.co.za, Tel: 073 641 3872
Facebook Page: Amanzi for food, Imvotho Bubomi Learning Network 'stakeholders')
Highlight a brief description of the next show based very much on the practices people are particularly interested in from the WRC materials that are found on the website.

The next radio programme will be on the ***31 October 2017*** and it will be focusing on the seed bill and its implications for small scale farmers and household food growers practicing the various techniques in water harvesting and food security as guided by the 8 WRC materials.

Radio Scripts - DIBSAR
Programme 1: 26 July 2017
Presenter: Forte FM Radio Presenter
Panel Members

- Mr Tichaona Pesanayi
- Mr Chamu Matambo
- Mrs Peter

Questions to panellists (10minutes)
1. Last time you were on air we talked about Amanzi for Food and who you are. Kindly remind the listeners about Amanzi for Food and what you do?
(To be answered by Tichaona: Highlight what it is, when it started, who is involved in the Amanzi for Food)
2. How different will your time on radio this year be from last year, what would you like the listeners to watch out for?
(To be answered by Tichaona: highlight with emphasis that we will be talking about the different WRC RWH sustainable practices and that the audience should share with us what they know about these practices.)
Presenter:
 Remind listeners who the panel are and why A4F is on air, where they can find Information www.amanziforfood.co.za and Facebook page – Amanzi for food.
 Give listeners the call number, SMS number 073 641 3872, Facebook page.
 Also encourage listeners to share their stories of using rainwater-harvesting practices.

3. What are some of the challenges that you are facing as farmers operating in Amathole District?
(To be answered by Mrs Peter: highlight and explain challenges faced by the farmers such as persistent drought across the country and in the area, crop veg and livestock losses faced by farmers).
4. Can you provide us with a brief overview of your history of water use in this area, and its impact on household livelihoods and incomes?
(To be answered by Mrs Peter: to highlight the history of water use/challenges in the area and how things have changed over the years, that is if there are any changes)

5. What attempts have farmers made to improve the water challenge?
(To be answered by Mrs Peter: highlight RWH practices and any other practices being used by the farmers to improve the water challenge).

6. What possible solutions are there to address these challenges?
(To be answered by Mr Chamu Matambo: highlight possible solutions such as grey water, black water and pasture and explain further what these measures entail).

Presenter:
 Remind listeners who the panel are and why A4F is on air, where they can find Information www.amanziforfood.co.za and Facebook page – Amanzi for food.
 Give listeners the call number, SMS number 073 641 3872, Facebook page.
 also encourage listeners to share their stories of using rainwater-harvesting practices.

7. Mr Matambo you are a lecturer and you are part of the Imvotho Bubomi, kindly tell us what does Imvotho Bubomi do?
(Highlight how Imvotho Bubomi helps people in sharing information and if it helps train people)
8. Phone in session (listeners) – 5minutes
9. Where could listeners find the advice or see the options about Amanzi for food and most importantly on rainwater, harvesting practices?
(Answer to include the Website: www.amanziforfood.co.za, Tel: 073 641 3872
Facebook Page: Amanzi for food, Imvotho Bubomi Learning Network 'stakeholders')
Highlight a brief description of the next show based very much on the practices people are particularly interested in.

Appendix 6.4D: Sample Transcripts of IBLN Boundary Crossing workshops

A. Sample of Transcript of Imvotho Bubomi learning Network meeting #1 (BCCLW1) held on 12 August 2014 at Fort Cox College of Agriculture and Forestry, Middledrift, Nkonkobe, Eastern Cape

Document number: DIBSA1b

Transcript

1. **Spool 1 of 4: 1hour 11min 35sec long**
2. Gys Vermeulen: My name is Gys Vermeulen; I am head of the Department of Agriculture here at Fort Cox. We have two departments, one for Forestry and one for Agriculture. I am heading the one department. I think that we are actually co-hosts here today if I'm correct. Rhodes University or this unit actually proposed the meeting, and they will run the workshop and they will also lead it. Anyhow from Fort Cox side the principal, unfortunately the most of our executive management is on a strategic planning session and they won't he here today so …(makes a joke). …
3. All: (Laughter).
4. Gys Vermeulen: …you are most welcome here and we hope that … you know we have done a little bit of rainwater harvesting projects here at Fort Cox and it actually amazes one to see the effect of it, and although we saw that effect none of us are changing our old traditional ways of ploughing and farming to incorporate these new ideas. For us I think whenever there is something new we should maybe open our minds a little bit and let's take the restrictions of the past thinking, put it a little bit aside, observe what is the new knowledge and on that decide where will I fit in in the new approach. So with that I will hand over to … Kim or whoever is going to go from there. I am sure you will ask everyone to introduce themselves. Our lecturers will also join us a little bit later, they are just busy organising their classes.
5. *Spool run = 2 min 18 seconds*.
6. Kim Carlyon: So I think as Gys said if everyone would like to introduce themselves so that we know who is here, who you are representing, so if we could start with … Rob.
7. Rob O'Donoghue: I think it's quite appropriate for me to respond by saying thank you very much for hosting us. It might seem a little bit strange as Rhodes University is not actually an agricultural university … so what are we doing here? How did it come to be that Rhodes (University) was invited by the Water Research Commission to support the introduction of the water conservation materials to colleagues? Well we are from an environmental learning research centre where we have been looking at how does learning take place. And we have been supporting professionals both in colleges and universities to do change practices and also people working in support of community learning to do change practices - those are the two arms that are here. So we know nothing really except what we have learnt from you about rainwater harvesting and from the Water Research Commission. But the main reason we are here as you probably know climate change is really strong on the agricultural agenda. I was at the CSIR (Council for Science and Industrial Research) last week and one of their main outcomes now in terms of agricultural practices is what they are describing… If you take Southern Africa what they are saying is that with Southern Africa warming – global warming – there is climate change. Because one of the factors in winter is the southern forcing of the frontal systems so that what they are anticipating we can see it this season already. We have had a warmer, drier winter… so they are anticipating that we are going to have warmer, drier winters through the southern forcing of the winter high pressure systems that are over the sub-continent. So that means that as farmers, and as agricultural teachers and as people working with farmers we are going to have to deal with a dry start to the season and what does that mean? That means that water conservation practices for starting the agricultural crops are going to be really important. We can also find in early part of pre-colonial Xhosa history particularly among the Mapondo there was a practice called *gelesha,* and for *gelesha* what happened was that people broke the sod at the end of the season so that when there was any winter rain and if the season was delayed that there would be water in the ground. So it's really interesting… (background noise interference) there is a lot of new and old ideas that can be

brought into the curriculum in response to climate change. So we will try to put together a course that will support both the teachers in the colleges to bring in the new important ideas on water conservation farming and also the farmers to work together in learning networks. So that's why we are involved, it's a real pleasure to be here. Thank you very much for your hospitality, for your hosting of the meeting. We are very grateful.

8. *Spool run = 6 min 29 seconds*.
9. Tichaona Pesanayi (TP): I think we need to clap hands for each other…you know… no one will do it for us.
10. All: (laughter and hands clapping)
11. Jongile Dinga: I am Dinga, and Dinga is my surname. I put this surname because it is the easiest to get to understand otherwise I have a Xhosa name which would be difficult for some of the people to recognize it. I am from Umtata in the region of O R Tambo. I am working with the Department of Rural Development and Agrarian Reform, working under an extension advisory services unit there. I am working in OPHG and (unclear) local municipality. Thank you all.
12. All: (hands clapping)
13. Khaya Mahlati: I am Khaya Mahlati from O R Tambo District. I am responsible for extension services in that district. … (inaudible). We have been invited to attend this session and unfortunately the person who said I must come and attend when I asked him what's the gist of the meeting he was not sure. But I can see that it's relevant for the section that we are working for the department (DRDAR).
14. All: (hands clapping)
15. (background noise)
16. Gys Vermeulen: Maybe if you can carry on.
17. Welile Cakwe: My name is Welile Cakwe I work here at Fort Cox but at RDC that is at the Rural Development Centre. … (inaudible due to background noise). I am just a trainer.
18. (background noise due to new people filing into the venue)
19. TP: Alright mama let's just re-arrange for a few seconds then you will continue. … Ok. Thank you for your patience we can continue
20. Lumka Maso: Good morning… I am Lumka Maso. I am coming from Keiskammahoek. We are farmers there, dairy farmers, the name is Seven Stars Co-op. We are partners with Amadlelo. Thank you.
21. All: (hands clapping)
22. Lwambeso Mbopa: My name is Lwambeso Mbopa. I am a training officer here at Fort Cox, RDC.
23. All: (hands clapping)
24. Thembakazi Qampi: Morning. Miss Qampi Thembakazi. Working here at Fort Cox as a training officer under RDC.
25. Thandazwa Komsana: Molweni. My name is Thandazwa Komasana. *Ndiyasebenza e* (I work at) Middledrift as an extension officer.
26. All: (hands clapping)
27. Thembinkosi Klaas: Klaas Thembinkosi, Extension Middledrift Agric office.
28. All: (hands clapping)
29. Dambile Dubasi: I am Dubasi. I work in the extension office here in Middledrift. But I am wearing two caps. I am also standing in for the manager extension Amathole District, Mr Nqayekwazi (check name). He has apologized.
30. All: (hands clapping)
31. Louise Madikiza: I am Louise Madikiza. I am lecturing in the crop production.
32. Irene Madondile: I am Irene Madondile. I am working as an extension officer in the Alice Office.
33. *Spool run = 11 min 44 seconds*.
34. Unathi Gulwa: Molweni. Ndi Unathi Gulwa eDohne e pasture research section. I am working as a pasture scientist. I am also a student at the University of Fort Hare.
35. All: (hands clapping)
36. Tanki Tubela: Morning. My name is Tanki Tubela. I am from Dohne, I am working with pasture science section specifically in rangeland science. I am also a student at the Fort Hare.

37. Alfred Mcasi: I am Mr Mcasi from Keiskammahoek. I am a farmer.
38. All: (hands clapping)
39. Hendrik Vas: My name is Hendrik. I am from Alice, I am a farmer there, and I am a representative of the farmer association there.
40. All: (hands clapping)

B. Transcript of IBLN BCCLW3 videos

Spool 1 group work session – discussing activity systems
File name: MVI_0024 Group work Analysis, Modelling & Planning demo sites.MP4
File (recording) length: 12min 22 sec
Please see accompanying DVD for details of transcript

C. Transcript of lecture / lesson integrating RWHC at Fort Cox Agricultural College

Date of lesson observation: 25 August 2015
Venue: Fort Cox College of Agriculture and Forestry

Spool 1: class room activity 1
ACLSA3: Yesterday, I told you that today we will have some quiz, and turned out to be a person and I told you that, he is available today. He is not assessing anybody, so nothing has changed today, the class will continue as normal.
We have Tich, Tich will introduce himself. **This is my second year class, doing soil and water conservation**.
R1: Good morning ladies and gentlemen.
Students: Good morning sir.
R1: How are you?
Student: Fine, thank you
R1: **I'm glad for your allowing me to be part of the class, you as the students. I'm also learning.** Thanks for allowing me to your class. I am from Rhodes University, involved in the project that is doing water harvesting, so I will be working with the college and also Miss X [ACLSA3] and other lecturers here. So, I am glad for the chance to be with you, second year students. That's two years?
Students: Yes
ACLSA3: I always tell them that they are the seniors, they are about to go out.
R1: Yes
ACLSA3: So, Yes, we are always talking about water harvesting in this class, right?
Student: Yes
ACLSA3: We mainly deal with this conservation of water. **Did we agree that we had water scarcity in this country South Africa**?
Students: Yes.
ACLSA3: Why do you think there is water scarcity in this country? How many of you have experienced water shortage in your communities, and how was the experience? … Ok, let me put it this way, how much do you think … At school, do we experience water shortage?
Student: Yes
ACLSA3: How often
Students: Many times.
ACLSA3: How is it affecting water, in the urban of the Fort Cox?
Students: *Laughing*
ACLSA3: Its urban, isn't it? The facilities that we are using here are they not the same as the ones that are at home. Has there been anyone affected in the worst way in this area? How many days has it affected you? Now we're still talking on the domestic, we haven't gone to other cultures, right?
Students: Yes

ACLSA3: So, **I want us to link what we experience here, with the huge part because agriculture is…, we believe that it is part of the economy of South Africa. Before we go to the economy, agriculture is the way that is going to feed us in the morning. Isn't it?**
Students: Yes
ACLSA3: **So, any experience with the college loss of water**?
Student A: …(inaudible)
ACLSA3: The problem we want to see it. Ok, anybody who isn't at the college, let me say are experiencing the Fort Cox … The day when there was no water, if there was such a day.
I told you my experience, where I was to carry the water by the bucket from my mother's house to the other house at the college, right? I told you, I hadn't wash for …
For months without water, look for you what is it.
ACLSA3: Did you eat?
Students: No/ Yes
ACLSA3: How many of you did eat? Ok, let's leave it as it is. Ok now, oh, we did most of the experiment on … (inaudible).
Students: Yes
ACLSA3: What was the aim of that experiment? What is the aim of that experiment? To show that as it rains, we experience more than we expect. We think maybe water should get into the soil, right? But, what is happening, how is it collected from the soil, when we experimenting? How much rainfall lack from root to root? Someone is whispering somewhere else. How much water rainfall of? No, You can tell me in the way you collected. No idea?
Student A : In … (inaudible)
ACLSA3: why? Ok, the experiment was 250 ml soil with beaker and soil without mulch. Soil without. So you are saying?
Student B: Soil with mulch was 10 ml
ACLSA3: With 10 ml?
Student B: Yes
ACLSA3: Did any other group experience 10 ml or different, or maybe we didn't do the experiment. How much did you collect?
Student C: 15 ml
ACLSA3: 15 ml, ok. Soil with mulch. Any other group with a different measure?
Student D : 12 ml.
ACLSA3: Then, we are saying here "almost 235 ml entered the soil (infiltrates) that is with mulch. Soil without mulch?
Student E: 250 ml.
ACLSA3: was it 250 ml for all of us. Yes or no? Is there anyone with a different one?
Student F: 255 ml.
ACLSA3: How many. *Beg your pardon*
Student F: 255 ml
ACLSA3: What does this say (255 ml)? We say that out of the 250 ml, 200 ml goes into the soil. The difference here 50 ml minus 10, is 40ml that is the run-off, on the other side. **Then it means, then if we were to collect all the water that is going on as run-off for future use, wasn't it going to make a difference**. Ok, let us talk about this way, **this water that we are losing if we were to pay for it**. If 1L was equal R2. How much Rands have you lost if 10L. How much?
Students: R20
ACLSA3: alright, if we have lost 50L, how much have we lost in rands?
Students: R100.
ACLSA3: Does it mean, if we have lost R100, it was irrigated?
Students: No

ACLSA3: So, that means **you still need to re-irrigate**. Ok, here is the picture that I want you to have. **In irrigation there is cost**. So, there is **labour and pipes need to be fixed**. Ok, let's come to the fixed, why?
Students: it takes the distance
ACLSA3: and the type of irrigation, what else, do we have? The water, that means **availability**. Ok, now. What does this mean? It means. **What is our source of water**?
Students: Rainfall
ACLSA3: We all agree, that our source of water is not the river?
Students: Yes.
ACLSA3: It is rainfall
Students: Yes
ACLSA3: Ok. **If our water comes from the rainfall, and the rainfall this year is 1000 mm and we make it easy like that, out of, let's say it is this much in one storm, are we sure that this is going to the soil?**
Students: No
ACLSA3: We have experienced this run-off from the smaller portion, we are now having these figures of the rain that is coming that it is continuing for two days. **It means a certain amount of rainfall is getting to the soil and it depends on how the soil looks; remember here we said we have experienced some differences**. **It depends on what practices are happening into your soils, and it will have minimum infiltration that depends also on the type of the soil, remember here we have sand, we have clay and silt**. Let's confine ourselves into these three. Which one will have more water at one storm?
Students: Sand
ACLSA3: Why?
Students: Because of the pores.
ACLSA3: It means now, whenever it rains, we are confident that the soils will not have the same amount of water. Some will have run-off, some this and others that. Now, how can we aid the cost of labour as we already said, it would be already calculated into your farm capital. Pipes will depend on the distance. Water won't depend because is national, right? So, have to have an area that catches water. Now that is raining in one night, that is to say '**can't we utilize this water fully?**' Can't we use our source of water as our advantage? **That is what and why we are talking water-harvesting and conservation, right?** *Lento ifana nantoni?* This is when you have surplus of cabbages, what we have to do, say that you are the cabbage farmer. When you have harvested, you have people buying and buying and you are left with 50 cabbages, what do we need? Throw it away?
Students: No
ACLSA3: We should, devise that in other way, to **make it preserved**. What could you do if you are the cabbage farmer, if you don't see people are coming?
Student: We reduced the price.
ACLSA3: Yes, reducing the price is the other way. It is not lost but eaten. What else do we do? There are agricultural methods that you can use to process the food, maybe you freeze it, dry it.
Students: Yes.
ACLSA3: That is to say you conserved it when you are, maybe by using the refrigerator, you will use it as it is fresh from the freezer. How many of us have eaten dried food such as raisins, yes, does raisins appear as it is, do we pick it from the tree as the raisins?
Students: No
ACLSA3: So, **that is meaning you are saving, right**?
Students: Yes
ACLSA3: **That means, if this was water, and we used water the same way, even water can be preserved alright**. That can be preserved water that is water preserved. Ok, have you ever or how many of us have interacted with harvesting of water, and how come to hold it, at home issue.

Student: A: Using water tank.
ACLSA3: You are using water tanks?
Student A: Yes.
ACLSA3: How do you fill it?
Student A: **We fill the gutters, and when it rains the water moves from the gutters, down to the tanks**.
ACLSA3: and how does it fall?
Student: The water moves
ACLSA3: So, you have the Jojo tanks, more of them? Is it one gutter that fits there?
Students A: All the sides are like there. The water moves from the gutter to those tanks
ACLSA3: So, every gutter has directed to there
Student A: Yes.
ACLSA3: Any other way that we are experiencing at home? That gutter is already mounted and is going its own way. At your home, what are you doing? Any other way we experience at home? That gutter is already mounted and is going straight. How is it at home that you are doing? I'm sure you are not staying with him. Ok, who at home just look at the rainfall at the area that is falling? And you don't, lets have our practical's. How many of you have just watched the rainfall as it happens, and we don't have any problem with that? One……two……three, so you just watch and don't do anything? Where do you get water?
Student B: We get from the tap
ACLSA3: Just like we are doing here, in outside?
Student B: No, is inside.
ACLSA3: Inside, ok and alright. Their route to Cwaru is like the one to Fort Cox. So, all of you don't just watch rainfall. Let's see those who don't just watch rainwater. Ok, why? Do you enjoy watching through the window when it is raining? What is it, what you watch through the window?
Student B: Nice showers.
ACLSA3: Do you also look the flows? **Ok, next time when it flows, I wish you look at how it flows**. Ok, why do you not just watch it? Do you watch it?
Student C: No
ACLSA3: Why?
Student D: Ayaphela amanzi (Water runs out)
ACLSA3: Do you get that? Because we all know that the water will be finished. But don't talk with the foreign language. **Because she knows the water will be finished, he has to do something about it**. You know that the water will be finished and have to do something about it, or what advice would you use if there is no water.
Student B: I would use the area with water.
ACLSA3: So, you are going to ask them? What if you don't get the water?
Student B: **You are going to use the buckets to collect the water**.
ACLSA3: Then, what are you going to call that?
Student B: Water harvesting.
ACLSA3: Now that you are harvesting water. It is not about getting water to the bucket, he has to do something. For the future, he has to do something. Sometimes she has to, because we have been told that water has to be cut bit by bit. What you do? You have to do something and taken. It seems that there is a problem; yes she knows that the water would be finished and she has to do something. If you don't do something, where should he take the water if it finished.
Student C: Will take the water from the river.
ACLSA3: You drink that water?
Students: Yes/ No
ACLSA3: So, if water is finished and having done anything to harvest water, what would you do?
Student D: Go to other area with taps

ACLSA3: Go to other area with taps? Which is far at distance? Is it harvested, right?
Students: Yes.
ACLSA3: We still talk about water in small basis. Because we are talking at your compounds, without many people, but we still say there is water issue, sometimes we get surplus and sometimes less. This has to come with the type and sometimes. I was thinking of only these three or rainwater harvesting. Only three people. **Of why do you do. We are going to tell you, when the rain has started at 10 pm and we sleep at, I wake up and use the drums and that would save me for three days without going to water, from I used to fetch the water. I know, I would be able to do my washing, right?** I am going to do the garden at home. Ok, how many of you are going to harvest water at home. Why? Sometimes three, why? Depending on the size of your garden. If it is difficult for you to dig, when there is no water, where we have valley water harvested. Ok, lets say there is no water, and you are just left with 1L at home, what would you do? Everything just stops. No irrigation, no nothing. So, you will feel dirty and how are we going to feel with that. You see, water become as the source, in the urban areas, so what do you do when there is no water? Where you only collected water from the bucket that makes only 25 L of water, with water running every day. So, what happens, what would you cut and not to cut?
Student E: Cooking
ACLSA3: Cooking you will eat at the restaurant. So, what is that issue you wouldn't cut?
Student F: Bathing
ACLSA3: Bathing and what? Is only bathing at first
Student G: And water for drinking.
ACLSA3: Your toilets, so what do you do with them? There is something that happens that time. What happens to the toilet when that is started?
Students: Flushing
ACLSA3: You now know that toilets have to flush, after you have pooed on them. So, there is water in the system. That is the struggle. For some three days. **I am trying to show that water plays an important part into our lives**. **It is very important to show that without water life stops**. Up to now, people are harvesting water, right? Because from what we are saying water is, after if there is rainwater, you can drink on something else. How many people offered to harvest rainwater? **You say you have the Jojo tanks that you used water for drinking and cooking, right and all that? So, all of us are not harvesting rainwater? Ok, now, this is the most common we know, right?** We can all say that they are not harvesting right? The gutters, you might not know that is happening but it….you see it happening. And once you have collected, you know that the freedom, because I don't know the distance you are using, right? To carry the water, right? We at least know that we cannot collect the water. If you collected 60L you know that, at least cooking is covered, bathing is covered and in fact in my home I know that I can use the big dish and I can soak myself, they know that those who are at the urban areas, right**? But, what do we do with that water, I am saying we have the freedom of time……for using bathing**. **Now what do I do with the water that I have used?** In my home, it is dry and my mother has the lawn that growing flowers, when you finished bathing she could tell you what to do with the water. Please, **when you finished bathing, please don't throw away the water**. Put it into the bucket that has the special for that, so that we can used for the lawns and the flowers. What do you do with the water?
Students: Throw it away
ACLSA3: Ok, but you understand that my mother has harvested water here, for future time to be able to use. Its worst when there is no rain and when is dry. She would travel us if there is no water in the buckets for us. Now, it's says, if we look as debt, bath in area where there is water shortage. Isn't true? What you see in next showers, is life to. They see as nice showers through the window, you cannot wait to gather it, **when it is raining, when it is raining, there is one thing you think of it, it is gathering that water, right**. **Now, we have many methods of water-harvesting. Do you think it is important for us to gather water for you?**

Students: Yes
ACLSA3: You also think so?
Student: Yes
ACLSA3: That is important for us to harvest. Do you think for you to harvest water for you people at the urban areas?
Student: Sometimes for us. Because for most of us water is available
ACLSA3: Where is that water coming from?
Student: It is coming from the municipality.
ACLSA3: The water is from the municipality. I want us to go back from our places. Let us check where the water is coming from. If it needs to check from the municipality where the water is coming from, because the water from the municipality isn't from the office. Isn't that true? So, water if isn't the municipality office, so **there is a source of it somewhere**? Just from your own say you need to have that. We need to talk about the methods of rainwater harvesting and conservation. RAINWATER HARVESTING AND CONSERVATION. Did we define what rainwater harvesting is?
Students: No
ACLSA3: What is rainwater harvesting?
Student C: Water for future use
ACLSA3: Someone is agreeing with this? You all agree? When, I go to the river to fetch water for future use, is that rainwater harvesting? Anyone with the different definition? My people, anyone with the different definition? Ok, let us use that one of collecting water for future use. Are we all with the collecting water for future use, but for me when I am colleting water for future use from the river, is it rainwater harvesting? I know you guys, isn't …… ok. It is written in books as the way of collecting water, the technology for collecting water and storing, from storing it, you can use it from where do you want to use at an area you want to. Alright, so we collect, you store, the diversion furrows. **Ok, then it leads us to many…we wouldn't just have one type of rainwater harvesting. Up to now, we are familiar with one**. Methods and types. 1. Rooftop harvesting, we have the rooftop rainwater harvesting technique, that most of us know and have a feel of it, that involves the (1) gutters. What else does it involves? (2) Tanks,
Student: Home
ACLSA3: Sorry (*beg your pardon*)
Student: Home or House.
ACLSA3: What else? Ok, now we have the rooftop that involves, gutters, and tanks, I mean the drums depending on what do you have to collect water, right?
Student: Yes
ACLSA3: How many have the huts house? The houses that are made of grasses. You are not having from your homes?
Students: No
ACLSA3: How many grew up seeing that? Ok, at your home. What is it happening during when it is raining? Did you used to check the colour of the water? How is it? It is brown when you are collecting that. So, it means that the …
Student: It depends on the type of the grass you used.
ACLSA3: Sorry. Depends on what?
Student: Inaudible.
ACLSA3: Yes, but still the more, they have the house, the different is the colour. How many have the cemented roof? The cemented roof? Is the water runs up the same?
Students: No
ACLSA3: **So, you see, when we harvest rainwater, there are many things you need to consider**. It means now, some of the things, it is some of the water will be used in a particular way as harvested. Ok. The advantage of roof top water harvesting, 1. Depending on the place, the water collected will be good at

31#37
End of transcript spool 1 of 2

Spool 2: ACLSA3 class room activity 2

ACLSA3: it is safe **to save you time**. Doesn't it?
Students: Yes
ACLSA3: Those who know that are fetching water from very far. It makes you to know that to when you come back from school, I will need to get the wheelbarrow and go to fetch some water and come back, right? And you know it's time for me to do some homework's. Isn't it? **What else do we think we benefit from rainwater?**
Student: Prevent time of the wastage water
ACLSA3: Are we agreeing with them?
Students: Yes
ACLSA3: How? Did we mean that rainfall, we did collect from somewhere else? Your practical? Did we mean that thing were doing its like you are copying rainfall, bring it to the laboratory. Isn't it? So, did we collect the run-off?
Student: Yes
ACLSA3: Ok, Now, if that water we collected as run-off, where was it going? If we are looking through the window when it is raining, do we see anything happening outside? You will just looking from the window and you just not collecting water. What do you see?
Students: Floating water.
ACLSA3: Water floating. Whenever, it is going, do you know where it is going?
Students: No
ACLSA3: **In this Fort Cox, when it rains like this, there are areas where you can find things like this that you find outside - wet for some very long time, because water has just accumulated right there**. This is what she is trying to explain, when she is saying, it prevents water wastage. That is wastage from a thing that is happening naturally. Yes, rainfall comes naturally; do we dictate when should it come?
Students: No
ACLSA3: It could have rained two weeks back, are we sure it could rain this week.
Students: No
ACLSA3: **How many litres do we lose through run-off, if we could have collected that rain?** How many litters do we used to costs that 250mL that is used for rainfall. Every group wasn't it 250 ml?
Students: Yes
ACLSA3: Is collected from the soil, how many minutes does it take?
Students: 5 minutes
ACLSA3: 5 minutes. If it rains for every 5 minutes and it rains 250 ml, and we are losing 50 ml, in every 5 minutes. Do you get what I am trying to say here? How many hours do we have in a day?
Students: 12 hours.
ACLSA3: How many 50ml in 12 hours? There are so many. How many 50 ml we could have lost? It comes back to wastage**. Rainwater is free from what we think but it is very expensive because it doesn't depend on us to have it**. Unless we think it is really depending on us.
Students: Yes and No
ACLSA3: It depends on us to have rain?
Student: Yes
ACLSA3: How? How do we do it? You can do it for us
Student: By praying.
ACLSA3: The fact you go and pray, it could take you to leave what you are doing, to go to the mountain to pray for someone to release it

Student: Eventually
ACLSA3: Not eventually, there are prayers that are answered now, but there are prayers that says wait, there are prayers that are not answered. We don't want to get biblical, remember Elijah prayed for three years, do you remember that?
Students: Yes
ACLSA3: So, do you think that there was no other Christian that was praying? They were praying, but because God has said to Elijah no wait, he stops there. Depends on us?
Student: **No, I don't want to go to that one. Usually people go to the mountain and pray for the rainfall. No we ask God to release it for us**.
ACLSA3: It's going to be too long, we can go to the…..rain should just coming but it is depending from someone. It's like when you are coming to you and ask we are begging you to not write the test, let us not write the test. **The fact that you beg doesn't mean, I will give what you are asking for, right?**
Students: Yes
ACLSA3: So, I am trying to say, let us, we can maybe go and I can make a suggestion on that, but that doesn't mean us, maybe yesterday you prayed just like begging.
Student: I don't have time for this
ACLSA3: Thank you, because if we can talk about any other would say no, in our urban area, it is never came but in this area came. It is depending on lot of things and you know that, and you know the enviroACLSA3ental factors issues, right? So, your factor is strong, the more you pray you will get the rain. Now, we are thinking that it is wastage, that water just run-off.
Student: Yes
ACLSA3: What colour is the water that is running-off?
Student: Brown
ACLSA3: Why? Does rain comes as brown?
Students: No
ACLSA3: What does it mean?
Student E: Its mixture of water and soil.
ACLSA3: So, what does it take to collect rain water harvesting through. So, **it reduces soil loss**. Right?
Student D: How
ACLSA3: You said the water that is running off, what is their colour?
Students: Brown
Student D: It depends on the colour of the soil.
ACLSA3: Why? Yes the colour of the soil is brown. Yes, it depends on the colour of the soil. Why is that?
What you see can be yellow, no it cannot be yellow. What the colour do you see? It can be the transparent? It can be the particles of the soil that has now dissolved. So, now it has the water that is carrying particles of the soil. Alright? After that you will see the colour of the soil changes?
Students: No
ACLSA3: No, it means that it was not the colour that was just washed away, so, it was the soil particles that were washed away. Are you getting it?
Students: Yes
ACLSA3: So, now, it means in every liters of water that is moving, milliliters that is moving, we have so much that is running-off, soil that is being lost. Siyavana (Do we understand each other)
Students: Yes
ACLSA3: Is it important for us to harvest water? Does it affect other natural resources like soil?
Students: Yes
ACLSA3: Now, what could be the disadvantages, from your own point of view? From your own point of view. Do you think it would have some **disadvantages**?
Student:

ACLSA3: The **quality can be questionable at times**. That is true; those who have experienced first rainwater harvesting. How many times have you experienced the quantity at times on the road? Say the rain is starting today, maybe it's running for three week, I mean the colour of the water is the same? I'm saying it has been raining for two weeks. Maybe there is the issue of wind. What could be the first water we could collect? Do you read before, you do water harvesting?
Students: No
ACLSA3: What could be the first water we could have collect? It usually won't be blue in colour. It might have some soil; it might have some leaves, and many other things that could be collected. It means now your first water is very questionable at times. Alright. Then it means what can we used for it, do you can throw it away.
Students: No
ACLSA3: What do you do with it?
Students: You store it
ACLSA3: You store it for what? You store it for irrigation and also something for what?
Students: Irrigating and bathing.
ACLSA3: You let the thing to settle, the particles, you take those that you can take out, and then you will wash the clothes. Then, you will throw it away.
Students: No
ACLSA3: Then, what do you do with it?
Student: You store
ACLSA3: You store it for what?
Student: You store for irrigation.
ACLSA3: You store for irrigation and also for what, something that is used for?
Student: Washing
ACLSA3: For washing and bathing, you let the thing to settle, the particles to settle, then you take those that can be taken out, then you will washed the clothes. You will then become harvest the water.
Student: No
ACLSA3: As the soil might be looking dirty, they will clean your clothes. As your, what might other problems do we have. Sorry!!!!
Student: Acid rains
ACLSA3: Some bases, some rains can be acidic. We can experience this. When do we usually experienced acid rains? What causes the acid rains? Is my question specific?
Student: In industries.
ACLSA3: Yes and factories, like we are saying, the air pollution, we have the air pollution. Yes, it means now the rain has been influenced, they produced from the factories, right? What else could be the problem, we talked about water quality, and we didn't zoom into deeper. This is acid rain, what else? I talked about you roofing, if it having paint, then we would have an effect of chemicals into our water, right? If you could drink that water, what would happened, or maybe we would never experience it, when you collected the water, that has the colour of the painting and you don't drink it. What would that water rather used for? Do we clean houses, how many of us? Really? When it is the issue of painting of houses it's not starts appearing, but hearing and knowing bathing, and I have seen almost all of us here like bathing. We bath, drinking, washing our clothes, so am trying to think, even if won't be appearing here. **But what are you studying? Specifically crop production isn't it like that? Ok, you think is important for farmer producers to harvest water?**
Student: Yes
ACLSA3: Why……why?
Student: **For the animals**
ACLSA3: For the animals drinking? So, how should we harvested it? Through the, so we have another level here, which is? You say, "Through ponds". We would deal with through our next meeting. How many minutes do we have left?

Student: Two minutes.
ACLSA3: Two minutes left, ok. So, we reduced soil erosion here. It means we have something to write about, we were talking of rooftop. Ok, because I was saying, we did that to chapter two, the one that for storage for the animals, talking that **it extends the raining season**. So, these are the things you need to look out for, when harvesting water, when having that strategy, you can use that water as it changes. Isn't it?
Student: Yes
ACLSA3: If this is the advantages and you are seeing it, it means you are using for the domestic and now to another job. It is not the loss. We did acid rain, usually we didn't experience in our rural, and it is usually from the suburbs next to the factories. I wouldn't say that in my life, I wouldn't drink the water, I have said the water, is different from the rainwater I drink last year. To me it seems like the same every day. Maybe you could ignore it, because of the pH that's through the pH you know. The painting issue, that water used at home is used for the garden. So, it is not a loss, alright?
Student: Yes
ACLSA3: We are going to talk to many other methods, in a way; here we have lots of methods that we are going to deal with. **Do you remember, I told you yesterday that we are going to have these nice books**?
Student: Yes
ACLSA3: and they are in the library?
Student: Yes
ACLSA3: I am going to ask and inform the librarian, that these books are came for this class. This is strictly rainwater harvesting and conservation, alright. Then, it means when you are saying with water harvesting, maybe rain, sprinklers irrigation. We might devise another way of harvesting water that runs-off from, in the sprinkler irrigation system, am I getting? So, I am going to leave. **These blue one's there are five and please guys share them**. What I mean like sharing, I mean you borrow it today, let it be that and don't keep it in your rooms and house for longer and forever, alright. Let the other groups, in fact, we are in groups and those groups are five (5).
Students: Six
ACLSA3: Six? What happened. One…Two…Three…Four…Twenty five. You are four, fours in the group?
Students: Yes
ACLSA3: Can I have the request, that you can have a study groups now? Out of those four, get someone, to be the fifth, alright? One per group, so this thing circulates per group, alright?
Students: Yes ma'am.
ACLSA3: Should anything happen to these books, I will inform the exam officer, not to release your results, until you paid for this book.
Students: Yhoooo
ACLSA3: Yes, it is because you know that conservation is not ending up to you.
Students: No
ACLSA3: We have people in the future line, so you will do the same to this book. **Make sure you use them and return it to the library**. If you don't, what I might going to do? No results. There is a lot of people and information, the methods and also because of the problem of our class is too small, and we cannot do the work into groups as our class is too small. You will have to borrow them and study a certain portion. Whenever, I said go and study a certain portion, you go and study that and then come back and discuss, am I right?
Students: Yes
ACLSA3: Ok, **Tomorrow, we have a practical, we are going to the field, we are going to visit a pond, that was developed here a Fort Cox**.
Students: Yhooooo (*Mumbling*)

ACLSA3: Sorry!!!, you know that we are going to Grahamstown, in fact R1, when I told them that I am coming to Grahamstown, they were saying that we should go to Grahamstown.
R1: Thank you. Thank you madam Makhaga and thank you very much guys for allowing me to be here. It has been great, some of you came late, so finished some sort of thanking you. I really enjoyed your lesson, I don't know how many of you really enjoyed it.
Student: We enjoyed, because today I put a bucket outside and it is always helpful and we also pray for water.
R1: Really, I have been filming the lesson also but madam Makhaga has been talking about these books. They were developed by the Water Research Commission of South Africa. If you opened the book, you will find the pictures of the people and other things. The reason why, I am mentioning it, because these resources are well research and some of the things were done here, in this area of Nkonkobe in Eastern Cape and various places, and what is quite significant about the materials is that they are very comprehensive and there is lot of information that you can find in these books. It is because some people made the contribution. Ok
Students: Yes
R1: So, the reason why I was taking the pictures and the videos is for educational purposes, so that others could also learn. There is a project called Amanzi for Food and that project is training other people. So, I will need your permission, whether I can use your material for educational purposes. We can remove other things that are not important. We don't want to embarrass anybody.
ACLSA3 and students: Yes (True)
R1: But, the educational aspects are the things that we require, so I don't know whether you allow me to use the video footage, for educational purpose.
Students: Yes
R1: If you do, raise your [right] hand. If you don't raise your left hand.
Students: *laughing*
R1: Ok. I'm going to kindly ask, Miss X [ACLSA3] just to make you sign something, so that you can commit to do something. We want to respect your decision and if you have signed, then we can use it as your permission. Ok, Thank you so much, *Siyabulela*. I enjoyed your lesson, I don't know, if you people are as nice as this one.
Students: *laughing*
ACLSA3: You had heard that he is going. I am sure that the president of ours is going to be out. So, I am going to photocopy you this is on the diversion furrows. I have said that we have different methods, so it means now we have to look at the differences. I'm sure that fifteen people didn't get this almost half
Student: Do you still remember that when we were using water….. That of water that is running
ACLSA3: Yes, it is the diversion furrows. **Yes you will see it yourself**. You will write a test**. We are going to see lot of them, and we are going to visit them, when we are going to the field, the different methods of harvesting water**. We are going to have a lot of that when. You know that we are going to have more cases, but you will go and visit. Alright?
Students: Yes
ACLSA3: So, class-rep you will work on this, and I will quickly go to the library to…**What I am going to do is take the books to the H.O.D to endorse them**. It is the project and you guys have to acknowledge that. So, we are going to do that.
R1: Yes
ACLSA3: So, the next lesson, sorry, we might show you the videos on these things, but I will just first go through with the books, we have a class so that we understand. **I will run the videos, you will be at the library, watching the videos of rainwater harvesting, alright**?
Students: Yes
ACLSA3: Sure, **then we will go to various areas later**.
Class-rep: **Ma'am, what is this**?

ACLSA3: It is in your notes, irrigation is part of conservation of water, because it is on point, it makes you to irrigate to the root. With sprinkler it makes to irrigate to the leaves. In plants water is absorbed on the leaves?
Student: No. is the drip irrigation not important.
ACLSA3: In citrus, they are using it and when we planted sweet-potato. I don't know whether you guys were in. it was on drip irrigation

Appendix 6.5: Cluster of Themes emerging from the data

Thematic cluster	Contributing to sub-research question number:	Thematic content and source
1. Sustainability perspectives and value of agricultural water and seed value chain systems	(i): How do small-scale farmers, agricultural educators and extension officers **understand and / or concretize sustainability problems and practices** in agricultural water and locally-adaptive seed systems?	**Social pillar**: Collective decision making: "*Because it's us who decides, it's not them* (DIBSA1b, College lecturer); Taking perspective of farmers into curriculum: *none of us are changing our old traditional ways of ploughing and farming to incorporate these new ideas*. ... I think whenever there is something new *we should maybe open our minds a little bit … observe what is the new knowledge and on that decide* where will I fit (DIBSA1b, College senior lecturer/ manager);…
2. Boundary learning interactions leading development, 'commoning', reframing of power relations and development	(ii): **What appears to be influencing uptake or absence of sustainability practices** in sustainable agricultural water (e.g. rainwater harvesting) and locally adaptive seed systems in and across related agricultural learning activity systems, and why?	• Deliberations around tensions in learning network boundary crossing change laboratory workshops: Learning at the boundary of farmer preferences and exclusive government top down extension support programmes: Extension Officer 1: "*if we are talking for the ploughing of maize, …* ***there is no other way I can take you, except for the cropping programme …*** if you want to participate … "***here are the rules***". Agro-ecology farmer: "We are not stopping those who are doing the GMO's, ***but let them (extension) pilot this group that is saying we don't want the OPV's"*** (DIBSA9a) Two accreditations in one course, inter-sectorial (government extension, agricultural education, municipal LED extension, NGO, farmer practitioners); transdisciplinary (agricultural lecturers from engineering, horticulture, social science; retired health & nutrition experts now in agriculture; retired teachers); group design and development of demonstration plots (change projects); Group assignment.
3. Intermediary action at sites of interaction (learning network; training course; demonstration sites as learning commons; radio; WhatsApp)	(iii): What boundary-crossing learning and mediational processes and opportunities can **expand learning** and **sustainability practices in agricultural water (e.g. rainwater harvesting) and locally-adaptive seed systems** amongst diverse agricultural actors?	
4. Transgressive actions, transformative agency and reframing of power relations		Developing RWH demonstration sites; locating demo sites on the class campus and subsequent disruptions;
5. Generative scaling of RWH&C, locally-adaptive seed value chains and co-engaged relational work as catalytic boundary crossing		'knotworking' among team of lecturers; growing of agency from connections between Jeanette and Mrs Peter and between FCC and Mrs Peter;

Appendix 6.6: Curriculum Analysis Tool used in BCCLWs and applied in Assignment 1 with Analytical Content

Name of curriculum document/practice and year	General and topic/s overview, level of implementation	RWH&C content or issues(explicit)	RWH&C content (implied)	comments
Fort college prospectus 2013	ACLSA2 and ACLSA3: Soil and water conservation course 4th semester (P.87)	ACLSA2, ACLSA3 and ACLSA4: RWH techniques (infield and ex-field); ACLSA2: Water conservation techniques, and Loss of water in the field; ACLSA4: Soil conservation techniques (contours, ridges, terracing etc.), water conservation techniques	-	ACLSA2 & ACLSA3: Construction of RWH structures not being done
Fort Cox prospectus 2013	ACLSA2 & ACLSA3: Irrigation Principles (pp 70; 87)	ACLSA2: Sources of water- rainfall, runoff, underground water; ACLSA3: None Rain only appear as a source of water	ACLSA2: Soil moisture relationships, available water, evapotranspiration, flood irrigation systems; ACLSA3; Irrigation where there are no dams or piped water can be done from harvested water	ACLSA2: Some of the flood irrigation techniques can be used in RWH; ACLSA3: RWH to be part of the syllabus since water for irrigation is scarce and expensive to crop producers
Fort Cox prospectus 2013	ACLSA3: Horticulture (vegetable &fruit production) (P.87); and ACLSA4: Horticulture 1 (Vegetable production – role of *organic matter; temperature, wind, rain, drought; cover crops, manure, compost*), Horticulture II (macro and micro *climate* and fruit production, irrigation)	ACLSA3: No		ACLSA3: Part of water conservation could be best
Fort Cox prospectus 2013	ACLSA3: Farm Structures (P.87)	-	ACLSA3: RWH&C works could be one of the farm structures?	ACLSA3: Construction of the RWH catchment areas and diversion should be entertained

Fort Cox prospectus 2013	ACLSA2: Introduction to agricultural engineering- P63.	ACLSA2: Tillage operations; Conservation agriculture Crop residue as mulch	ACLSA2: Ripping as a practice that breaks plough pan and allows water infiltration to higher depths	ACLSA2: Concepts covered in depth
Fort Cox prospectus 2013	ACLSA2: Introduction to soil science- P65		ACLSA2: Soil moisture	ACLSA2: Reflects the importance of soil moisture to plant growth and hence the need for RWH where/when rapid moisture loss is a high risk
Fort Cox prospectus 2013	ACLSA2: Experimental project- P72	ACLSA2: RWH&C projects	ACLSA2: Other experimental projects	ACLSA2: Projects can be tailor-made to relate to specific research areas

(Derived from DIBSA2e, DIBSA2f, DISA2g)

Appendix 6.7A: Memorandum of Understanding (MoU) entered into between Fort Cox College and Rhodes University on "Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food" (pages 1-3, and 5)

MEMORANDUM OF UNDERSTANDING BETWEEN RHODES UNIVERSITY AND FORT COX COLLEGE OF AGRICULTURE AND FORESTRY

NOVEMBER 2015 – DECEMBER 2017

1. PREAMBLE

The undersigned parties, Rhodes University, a public higher education institution and juristic person in terms of the Higher Education Act (No. 101 of 1997) as amended, existing under the laws of the Republic of South Africa and herein duly represented by Dr Stephen Fourie in his capacity as Registrar and Fort Cox College of Agriculture and Forestry, and herein duly represented by Dr Patrick Julius Masika in his capacity as Principal, will collaborate on a joint learning and research programme focussing on **Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food in 2015, 2016 and 2017, hereinafter called the Partnership Collaborative Learning Programme**.

2. THE COLLABORATIVE LEARNING, CURRICULUM INNOVATION AND PRACTICAL USE OF RAINWATER HARVESTING AND CONSERVATION FOR FOOD PROGRAMME

This MoU is based on an existing successful cooperation between Rhodes University and Fort Cox College of Agriculture and Forestry through the Amanzi for Food project and Imvotho Bubomi Learning Network which is now established in Nkonkobe Local Municipality and already proving to be a best practice in South Africa. These initiatives are supported by the Water Research Commission, led by Professors Heila Lotz-Sisitka and Professor Rob O'Donoghue from the Environmental Learning Research Centre at Rhodes University. The purpose of the Partnership Collaborative Learning Programme is to strengthen capacity for co-producing and practical use of knowledge of and for Rainwater Harvesting and Conservation among agricultural educators at Fort Cox College of Agriculture and Forestry and researchers at the Environmental Learning Research Centre (ELRC) at Rhodes University, in close collaboration with local farmers, extension, local economic development and researchers that has mutual benefit and alignment for all the concerned parties. This programme is motivated by the good working relations that have developed between Fort Cox College and Rhodes University's ELRC, and the finding by Water Research Commission that

> Social learning is interested ... (in) the actual social and practical changes that result from the learning; and also how such change can be facilitated through learning interactions and knowledge exchange. ... 7 of the 11 agricultural colleges expressed substantial interest in using the course materials developed with funding from WRC, but they had limited or no capacity to embed these into their existing curricula (Denison et.al., 2011)[1].

3. DURATION

The duration of this partnership is 27 months: 1 November 2015 to 31 December 2017.

4. AIM OF THE PARTNERSHIP

The collaborative partnership between Rhodes University's ELRC and Fort Cox College of Agriculture and Forestry aims to co-produce and tap into relevant existing knowledge on Rainwater Harvesting and Conservation (RWH&C) for Food generated by the Water Research Commission and other credible entities to inform and facilitate curriculum innovation and practical use of RWH&C practices that are relevant for quality agricultural education and for improving agricultural productivity for climate- and economically constrained farming contexts. The collaboration will strive for four outcomes:

4.1 **Rainwater harvesting is integrated into the Fort Cox College of Agriculture and Forestry's agriculture curriculum** as a means of

4.1.1 Empowering graduates to better respond to the water and economic needs of resource-constrained farmers especially at small-scale (transformation) who depend on rain-fed farming and in constantly changing climates (climate-smart agriculture),

4.1.2 Enhance response to policy recommendations of the DAFF 2008 *Evaluation of Agricultural Education and Training Curricula in South Africa* especially the ... "directive ... to be more responsive and directed towards addressing the needs and challenges experienced by the agricultural sector... (including) issues such as food security, sustainable development, land care, **water harvesting**, etc.)" (page 10).

4.2 **Learning of rainwater harvesting takes place collaboratively** by actively drawing on the distributed knowledges, expertise and experiences of farmers, extension workers, agribusiness facilitators, the Water Research Commission and University and College lecturers,

4.3 **Expertise in rainwater harvesting and conservation training and learning with demonstration sites is established at Fort Cox College of Agriculture and Forestry surrounds as a source of curriculum innovation and practical learning to be used** with local farmers and other agricultural education and training institutions where relevant to strengthen practical learning of diverse and relevant agricultural water innovations.

4.4 **Capacity building of Lecturers** in environmental and sustainability education.

5. RESPONSIBILITIES OF THE PARTIES

5.1 Rhodes University's Environmental Learning Research Centre takes it upon itself to:

i. Participate in collaborative learning with management and staff at Fox Cox College of Agriculture and Forestry with the aim of enhancing integration of rainwater harvesting and conservation in the college's agriculture curriculum,

2

ii. Assist the three lecturers who underwent Amanzi for Food training by co-reviewing how they incorporated rainwater harvesting in the curriculum with the aim of continuous improvement;
iii. Help the core participating staff menetioned in ii above to mobilise other staff who maybe interested to participate in integrating rainwater harvesting in the curriculum;
iv. One Masters Bursary is available for a Masters Scholar from Fort Cox College within the new SARChI Chair on Global Change and Social Learning Systems for 2016/17 at Rhodes University. For other bursaries joint fundraising will take place as indicated in clause (v) below. Bursary applicants must follow the normal applications procedures.
v. Collaboratively raise funding to support staff members to pursue Masters and Doctoral studies and/or a post-doctoral research fellowships in environmental and sustainability education to facilitate the collaborative partnership between Rhodes University (ELRC) and Fort Cox College of Agriculture and Forestry.
vi. Facilitate collaborative academic publishing on the curriculum innovation work.
vii. Meet with Fort Cox College of Agriculture and Forestry management at least once per year or as may be needed to provide each other updates on the programme.
viii. Communicate with Fort Cox College of Agriculture and Forestry management or its qualified delegated authority regularly as may be needed to provide each other updates on the progress of the partnership programme.

5.2 Fort Cox College of Agriculture and Forestry takes it upon itself to:

i. Actively support and undertake curriculum development and innovation in integrating rainwater harvesting and conservation in the agriculture curriculum at Fox Cox College of Agriculture and Forestry,
ii. Identify and nominate not more than two suitable and willing lecturers to undertake Masters and doctoral studies and/or postdoctoral fellowship in environmental and sustainability education to contribute to the collaborative partnership programme outlined above, should fundraising for the scholarships be successful,
iii. Participate actively in the Imvotho Bubomi Learning Network in rainwater harvesting of which Fox Cox College of Agriculture and Forestry is a part,
iv. Actively share the learning outcomes of the programme as an example of best practice for the agricultural education community,
v. Meet with Rhodes University - ELRC management at least once per year or as may be needed to provide each other updates on the programme,
vi. Facilitate and formalise research access and clearance through an official signed letter for Rhodes University's ELRC post-graduate researchers to conduct research in partnership with staff at Fort Cox College,
vii. Communicate with Rhodes University – ELRC to update on curriculum progress regarding integration of rainwater harvesting and conservation.

6. FINANCIAL OBLIGATIONS

This MoU has no financial obligations on the part of Rhodes University or Fort Cox College of Agriculture and Forestry except as regards the outcomes of the cooperative fundraising and activities being undertaken by both institutions on the Amanzi for Food project and staff costs. Should the MoU lead to successful cooperative fundraising a separate MoU or addendum will be developed.

i). if such failure is caused by any event or condition not within the reasonable control of the affected party, including without limitation, by fire, flood, earthquake, explosion, war, sabotage, embargoes, blockage, etc.

12. ACCEPTANCE OF AGREEMENT

Rhodes University
P.O. Box 94
Grahamstown 6140
South Africa

Tel: +27-46-603-8111

Date: 18 March 2016

Signature:

Dr Stephen Fourie
The Registrar
Rhodes University

Fort Cox College of Agriculture and Forestry
Cwaru Road
Middledrift 5685
South Africa

Tel: +27-40-653-8033

Date: 29 MARCH 2016

Signature:

Dr Patrick Julius Masika
Principal
Fort Cox College of Agriculture and Forestry

Appendix 6.7B: Extract of Monitoring and Evaluation Plan of MoU between Fort Cox College and Rhodes University on "Collaborative Learning, Curriculum Innovation and Practical Use of Rainwater Harvesting and Conservation for Food"

MOU Obligation	Activity	Leading institution	2015 Q1 (FQ4)	2015 Q2 (FQ1)	2015 Q3 (FQ2)	2015 Q4 (FQ3)	2016 Q1 (FQ4)	2016 Q2 (FQ1)	2016 Q3 (FQ2)	2016 Q4 (FQ3)	2017 Q1 (FQ4)	2017 Q2 (FQ1)	2017 Q3 (FQ2)	2017 Q4 (FQ3)	Expected outcomes
1. Collaborative learning (RU i; FCC i)	A1. Facilitate agriculture curriculum expansion to include / integrate rainwater harvesting and conservation	**FCC; RU**								-					Expanded curriculum; Topic specification in course outlines with Amanzi for Food website links; Portfolio of Evidence (evidence into student learning)
	A2. Adapt & adopt exisiting WRC rainwater harvesting materials	**FCC**													WRC rainwater harvesting materials and Navigation tool in FCC library used by students and lecturers; **Teaching notes** on RWH&C (part of tools to implement curriculum) to be **kept in libary every year**; Amanzi for Food website accessed and used for teaching and learning
	A3. Facilitate design seminar for teaching garden (at Rhodes University)	**RU**-Prof Rob O'Donoghue			1				1		-				Plan of a teaching garden at FCC co-developed
0	A4. Establish rainwater harvesting and conservation demonstration site/s (crop)	**FCC**							1						Farm ponds x2 in the farm operational and used for learning; Campus teaching demonstration garden (small) low-tech + medium-tech (tank-proposal); Effective management of biodegradable waste (grass, leaves that can be used for mulching) inputting into policy; Collaboration with extension officers in FCC demonstration sites
	A5. Establish rainwater harvesting and conservation demonstration site/s (pasture)	**FCC** - Dr Moyo (in collaboration with Dohne &		1	1				1	0	-				Pasture demo (rangelands)
	A6. Maintain demonstration sites, with possible expansion	**FCC - Farm Manager**; Academic Dept; RDC							0,25	-					Farmer information sharing day at FCC with inclusion of activity in Annual Farm Plan; Maintenance reports; PoE
	A7. Conduct research feedback seminar/s coming out of conferences, published papers, from completed research and from other projects every quarter and at annual meetings [(see annual meeting activity for timeframe) where multiple stakeholder are invited].	All researchers. **Coordinator: N Makhaga**							0	-	-	-	-	-	New learning avenues; possible research gaps; curriculum innovations on RWH&C and climate-adaptive agriculture; position paper
	A8. Facilitate seminars from internal research proposals (FCC staff & partners), FCC students and from other sites of research e.g. Free State	**FCC & RU; Coordinator: N Makhaga**							0			-	-	-	Draft ideas; proposals; research questions; contextual profiles; emerging findings; **link** to seminars above (A7); building and growing community of learning; position paper
	A8B. School and youth learning activities on RWH & sustainable agriculture														Assessments of learning through competition and awards; link with the 4H project
2. ...expansion of RWH&C to rest of staff	[covered in activity A1]														
3. Mobilise all other staff to participate in integrating rainwater harvesting in the curriculum and/or in their areas of work	A9. Facilitate capacity development and buy-in seminars on RWH&C teaching, learning and integration at FCC with Academic, HR, Finance & Farm Management staff, support staff and students at FCC	**RU-Prof Rob O'Donoghue ; FCC-L Madikiza** (3 core trainers: NM, CM, LM)							0			-		-	A pilot RWH&C teaching garden at FCC (campus); A general buy-in into the vision among all unit areas at FCC; internal exhibition and demonstration days to be organised with involvement of non-academics.
4. Capacity development of FCC staff through Post-graduate research (combines obligations 4 and 5)	A10. Facilitate identification, nomination and registration of two FCC staff as post-graduate students at Rhodes University	**FCC**								1	-				FCC staff completing qualifications and feeding research into curriculum expansion (MEd, PhD)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
16		A11. Submit proposal to WRC to continue with and expand training and research on the introduction of RWH&C practices in colleges	**RU** in consultation with partners							1						Funded project to coninue work started on RWH&C; connect with ISSC project at Rhodes University ELRC (Prof Heila)
17		A12. Facilitate collaborative academic publishing on the curriculum innovation work	**FCC; RU**			1				0.50		.*	*..	*..		Popular and scientific publications; use of published materials in teaching; other possible topics: 'learning competences emerging from rainwater harvesting curriculum innovation work'; 'collaborative learning processes and outcomes for agricultural college curriculum innovation and farmer learning'; 'lessons learnt from civic engagement of farmers as co-educators and co-
19	5. Joint reflection meetings	A14. Hold joint annual reflection meetings back to back with a seminar (with management)	**FCC-LM** & RU						1			.*.			.*.	Implementation and monitoring framework for joint activities; Updates from th staff students; Updates from activity progress.
20	6. Effective communications between the two parties (FCC & Rhodes University)	A15. Communicate with each other monthly (through emails)	**CC-CM**; RU-TP						1	111	11*	***	***	***	***	Regular updates on progress
21		A16. Write detailed activity reports if possible with the the body of evidence (e.g. invitation, agenda, photos, attendance register)	**FCC-Dr Lesoli:** Person/s responsible for the Activities						.0.		0..					
22		A17. Communicate with each other quartely (through joint reports)	**FCC - AR; RU-TP**						1	1	*	*	*	*	*	Regular updates on progress (via Quarterly activity reports (summaries); Use a format (to be developed by AR through Dr Lesoli - to circulate report template by 30 Nov 2016)
23		A18.Produce annual reports	**FCC - AR; RU-TP**									*				
24		A19. Produce completion report	**FCC - AR; RU-TP**												*	
25	7. Participate actively in the Imvotho Bubomi Learning Network in rainwater harvesting	A20. Use demonstration sites as sites of cohesion and expansive learning														
26		A21. Contribute to IBLN schedule of meeet	**FCC**; RU					1	*	1	*	*	*	*	*	Record of developing joint learning activities in the learning network
27		A22. Participate in Amanzi for Food national workshop at RU	FCC; RU						1							Proposal to continue and scale the Training of Trainers to continue the collaboration with funding (see workshop report to WRC); share
28		A23. See publications activity														
29		A24. Engage each other in useful joint-learning activities	FCC; RU													e.g. connect with other WRC projects (FCC), connect with ISSC (RY)
30	9. Research access approval letters	A25. Grant Research access	FCC	1			1									Weaver 2015 MEd thesis; Pesanayi PhD forthcoming
31																
32	10. Curriculum innovation work	A26. Develop Portoflios of evidence for curriculum innovation work done in 2014-2017	FCC (CM; LM; NM; A)					1	1	0	*					PoEs shared between RU and FCC containing assignments, slides for lesson plan/topics deivered including references; PoEs used in teaching and in meetings and workshop; PoEs continuously updated with teaching notes / powerpoints and samples of student work
34		A27. Co-engage key farmer leaders and innovators in curriculum innovation work	**FCC-CM with CM, LM & AR;** RU					1	1			*	*	*	*	Lessons learnt from farmer innovators / leaders regarding inovations and farmer contexts to be documented e.g. in Lecturer's PoEs; and reflected in practical work, teaching and
35																
36																

Appendix 6.8: Transcript of MoU Monitoring and Evaluation Planning Meeting (FCCMESA1) 8 June 2016

Present
QA manager Fort Cox College (Code: ACMSA1)
Tichaona Pesanayi, Rhodes University (Code: TP)
University of Fort Hare Lecturer (UALSA1)
Senior Fort Cox College Lecturer (ACLSA5)

Transcript:
Length of audio = 9 minutes 45 sec

ACMSA1: Colleagues, I saw your email. I don't even know if it was talking about today.
TP: Yes Doc. It was, but of course it was a suggestion of course. And I am also aware that you are very busy these days having… come out of that student protest…
ACMSA1: And we have been in the strategic planning workshop until yesterday. So we are very fresh in the office.
TP: Basically why I am here is just to check with you think you might be available for us to do that planning … for the planning.
ACMSA1: Today is the 8th, Wednesday…
TP: Yes.
ACMSA1: If we do it next week will that be fine?
TP: Next week should be fine with me.
ACMSA1: It won't be Monday, it won't be Tuesday. Can we do it on Wednesday?
TP: Wednesday will be the 15th. That should be fine. I will confirm with you by email. What sort of time would work for you?
ACMSA1: We can do it in the morning.
TP: What kind of preparation are we looking at here? Obviously we need to read the MoU.
ACMSA1: We need to read the MoU. **What I will do is to develop a template that we will use to learn what is in the MoU to action what is there. When we come we will then input information into that template**.
TP: That's beautiful. And you were also talking about making links with the other WRC project that you are doing here wherever it's feasible and also that issue of seminars is also one of the things that we can plan and see what topics, when can they be done and who should be involved.
ACMSA1: And I don't think we can wait on that one. It's very urgent and we have to work on it.
[Spool run: 4min 01 sec]
ACMSA1: We are going to have the meeting on Monday on the WRC project, here. We are doing it with the research team… we have guys from Dohne, the guys from ARC, the guys from Fort Hare Institute of Technology… I will discuss with the team about what we have now been doing with you so that we can link the activities such that in the next meeting we are going to have we are going to invite you so that we can start working together. We have two villages that we are working with. One is called Kwarkwa this side on your way to Hogsback. The other one it is not yet confirmed by WRC, is Qumashe. We were looking for a place without electricity. And it was supposed to be a low rainfall area. So that that issue of water conservation becomes a need, becomes important for them. In high rainfall areas you find that the issue of water is not that really much of a problem. We looked, we were actually driving looking for (laughter) – we could not find one. [Laughter]. The one we found was so difficult to work with. There are those villages that Extension Officers will tell you that we have tried this, we have tried that, we installed this and it was stolen, people are fighting. So you

will understand that villages that are not successful can't be successful. So we decided to look for that one because the communities were willing.
[Spool run = 6 min 38 sec]
TP: Okay.
ACMSA1: Because this one has the biodigestion component that is why the issue of electricity is also important.
TP: This feels a gap…
ACMSA1: Yes so **we were saying we want to see people who are in the energy crisis who want to see an improvement in energy**. So if you take it to people who have got electricity are they going to see any value?
TP: It can be a white elephant is there is no need.
ACMSA1: **But the same community with electricity were very much willing**.
TP: You know there is also the issue of having backup energy or alternative energy…
[brief interruption at 7min 25sec-7,in 50sec]
TP: Doc I think we are done, because we are actually starting to do the meeting for next week.
ACMSA1: Yes, that's fine.
[Laughter]
TP: So thank you so much for your time. What I will also do when you send the template is to also list the issues that are still in my head so that we already start knowing what we are planning for like those seminars and the expansion of the integration of water harvesting beyond the three staff members who have been doing it and so forth.
ACMSA1: Yes.
TP: **And also the inclusion of people in the community. I think this community in Amathole (Matole) basin they are very kin to work with Fort Cox. They have been communicating with some of your lecturers. I have also been there, and I think their rainfall is no longer as predictable, they are also having challenges with water there and they are very kin to start initiatives of water harvesting. In fact some of the farmers have started digging ponds here and there, but we will talk about that**.
ACMSA1: That is fine. Thank you very much colleagues. The workshop was wonderful [referring to Amanzi for Food national workshop held at Rhodes University in May 2016].
TP: We were happy to have you there, thank you. And of course why I came with Mr Moyo is we are working very closely with University of Fort Hare.
[End of transcript.]

Province of the
EASTERN CAPE
RURAL DEVELOPMENT AND
AGRARIAN REFORM
NAME OF EVENT
MIDDLEDRIFT
AGRICULTURAL SHOW
VENUE
XHUKWANE
DATE
23 JULY 2014
TIME
10H00
CONTACT PERSON
0832942197
VISION
Vibrant, equitable, sustainable rural communities and food security for all.
PGDP
125

Appendix 6.9: Nkonkobe Farmer's Association Agricultural Show Programme, June 10, 2015

Province of the
EASTERN CAPE
DEPARTMENT OF RURAL DEVELOPMENT AND AGRARIAN REFORM

Middledrift Agricultural Office.Mkwayi Street. Private Bag X1.Middledrift.5685.REPUBLIC OF SOUTH AFRICA
Tel: +27(0)40 657 3028/6/7.Fax: +27(0)40 657 3550 Website: www.agr.ecprov.gov.za

NKONKOBE FARMER'S AGRIC. SHOW:

DATE: Wednesday, 10 June 2015
VENUE: Cwaru location: Ward 18: Middledrift
TIME: 10H00

PHASE 1
VIEWING OF STALLS & DISPLAYS: Mr Rawana T. & Mr Gede L.

PHASE 2
PROGRAMME DIRECTOR: Mr Tolbat V. & Mrs Quma N.
OPENING PRAYER: Mr Nxoko M.
INTRODUCTION OF GUESTS: Jezile Z.A.
WELCOMING REMARKS: Cllr Xelewa L.
PURPOSE OF THE DAY: Dubasi D.S.
FARMER'S PERSPECTIVE: Venene M.J.
MESSAGES OF SUPPORT:
- SANACO
- Amanzi for Food
- World Vision

COMMENTS FROM JUDGES: ……
KEY NOTE ADDRESS: Mr Ngxeba Z - Deputy Director Extension - Amathole
ANNOUNCEMENT OF WINNERS: Mr Mafu CKK & Nyanga M.R.
VOTE OF THANKS: Mr Zono L.
CLOSURE: Mr Nxoko M.

Email Subject: Our meeting today: formalisation of rainwater harvesting in the Fort Cox College agriculture curriculum

Tichaona Pesanayi <tichpesanayi@yahoo.com>
To
pmasika@fortcox.ac.za
CC
Rob O'Donoghue Heila Lotz-Sisitka
Oct 28 at 9:16 PM

Dear [redacted]

It was great meeting with you today at your (Principal's) office regarding the re-introduction and rolling out of the Amanzi for Food programme and formalisation of rainwater harvesting curriculum development/innovation at Fort Cox College.

I have written the way forward that came out from our meeting below:

1. Rhodes University - Environmental Learning Research Centre (ELRC) was urged to assist the 3 participating lecturers by reviewing how they incorporated rainwater harvesting in the curriculum with the aim of continuous improvement;
2. Cultivate interest among the 3 participating lecturers to pursue PhDs / Masters;
3. Help to recruit other staff who may be interested to participate in integrating rainwater harvesting in the curriculum;
4. Send draft MoU to Fort Cox College: action: Rhodes University will send DRAFT by Friday 30 October 2015
5. Send Amanzi for Food website link: here it is http://www.amanziforfood.co.za/
6. Formalise research access to Fort Cox College to be signed and copy-filed by Principal. Action: Tichaona Pesanayi by Thursday 29 October 2015 and feedback by [redacted].

Please kindly amend as needed.

I have copied in for information Professors Heila Lotz-Sisitka (WRC Water Harvesting Project Leader) and Rob O'Donoghue (Director of Rhodes' ELRC) for information.

Best regards

Tichaona Pesanayi
PhD Scholar
Rhodes University – Environmental Learning Research Centre

COLLABORATIVE *ZENZELE* RAINWATER HARVESTING DEMONSTRATION SITE DEVELOPMENT AGREEMENT

(in short *SISONKE-ZENZELE* GALELA AMANZI ...AGREEMENT)

as a new tool

Background

In 2014 agricultural educators, farmers, extension officers and local economic development facilitators in Nkonkobe Local Municipality and a few farmers from Kleskammahoek (in Amahlathi Local Municipality) decided to engage with each other and with rainwater harvesting and conservation knowledge in a collaborative learning network. This decision came after data was generated which indicated that there are several problems faced by farmers directly and other agricultural actors either directly or indirectly regarding water for food and nutrition security which needed agricultural actors to work and learn together as networked partners.

Objective

The aim is to learn together new self-help solutions and alternatives to agricultural water for and with associated cropping and livestock development.

Process, outcomes and commitments

Participants commit to engage openly and actively in deliberations that build and emerge joint capabilities to;

- work out new solutions that work for the different sites in their specific contexts using a common framework based on the smallest and simplest initial unit of the complex whole of water for food,
    - clarifying and taking responsibility and accountability of the proper functioning of the agricultural water system(s) at all times;
    - understanding, maintaining and managing the basic technical, social, economic and environmental requirements that keep the systems working;
    - adapting what has worked well in other places, based on above;
    - identifying and understanding scalable elements, and scaling those practices that have worked well in other places and in the network members' demonstration sites;

- documenting (photo, drawing, video, artefact), monitoring and reporting processes and results for communicating within (family / group) and without (to the network partners); and
- Understanding that new models are tentative until they are tested and modified through a process in which we are the leading drivers.

Being empathetic to the challenges others are facing and sensitive to the aspirations of others by ensuring that we do our part of ensuring effectiveness and sustainability, and for others' learning.

This agreement is not legally-binding but a social contract based on respect and the spirit of Ubuntu.

Signature:

.....	.....
_____	_____
Name & Designation	Name & Designation

Signature:

.....	.....
_____	_____
Name & Designation	Name & Designation

Appendix 6.10: Curriculum Innovation and Development Outcomes in the Fort Cox Agricultural College

Participant A (NAME AND POSITION: **ACLSA2**

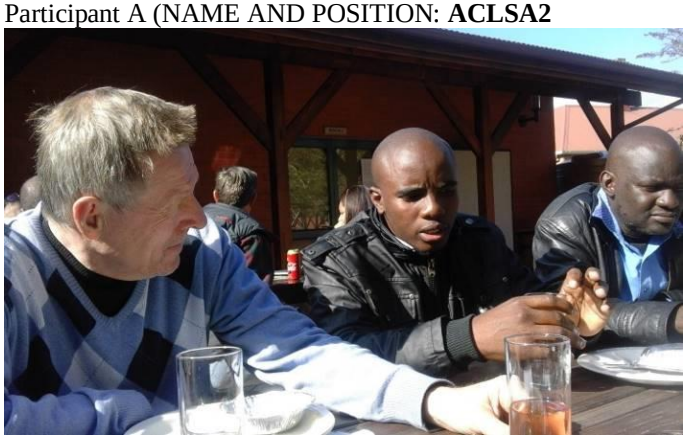
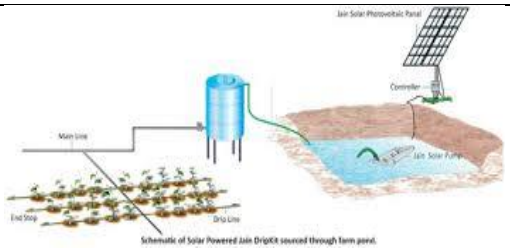


Photo: Agriculture lecturers with Prof Yrjö Engeström from University of Helsinki, International CHAT expert (left) discussing how curriculum review processes on RWH&C can benefit from expansive learning processes (July 2015).

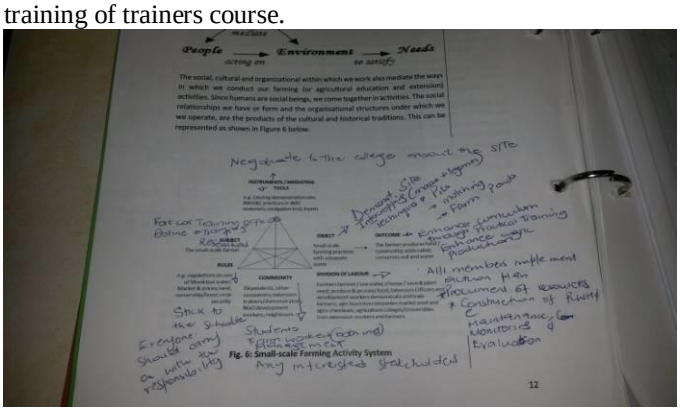
➢ Enhanced knowledge of RWH&C	➢ The lecturer's knowledge of RWH&C was enhanced considerably as he claimed to have known very little at the beginning. His Engineering background contributed to his prior knowledge. ➢ His expanding knowledge of RWH&C is evidenced by how he planned to go about the teaching: • "*The use of photographs and videos is one step towards a true learning experience. These shall be employed for the teaching of farm ponds as a RWH technique to college students. Of utmost importance will be the demonstration site to be erected at Fort Cox College of Agriculture and Forestry. College students, high school students, agricultural professionals, and farmers will all converge at this site for an extra-ordinary learning experience in the construction, observation, guided manipulation and use of the site. The demonstrations shall include all the technicalities involved in the construction of farm ponds as well as the setting up of an irrigation system. College students will be conducting practical and experimental projects from this site which will fall under formal assessments of student achievement of the diploma qualification*" (ACLSA2, Assignment 2, March 22, 2015). ➢ The lecturer successfully integrated irrigation principles and structures (drip irrigation fed by raised reservoir) already in the curriculum, with newly modelled RWH&C practices of farm dam, mulching. He developed these ideas from BCCLWs and in three Amanzi for Food training of trainers' assignments.
➢ Integration of knowledge into development of productive demonstration sites	➢ The lecturer has used knowledge co-developed with colleagues and expanded learning in the Amanzi for Food course to the development of their productive demonstration site as a site for intermediary action. ➢ Below is a diagram of the RWH&C demonstration site design made for the FCC (ACLSA2, assignment 2), using concepts developed with others combined with knowledge from the WRC RWH&C materials of combining RWH&C techniques in this case farm pond, solar panel to power water pump, elevated water tank and gravity conveyance to drip irrigation system:

	 Mulching was also implemented and made a huge impact during the drought of 2015/2016 sustaining a spinach and gooseberry horticulture plot for over two months covering a holiday period where rainfall and watering were absent. ➢ Knowledge developed from boundary-crossing learning was applied in a number of other demonstration plots including a teaching garden developed on Fort Cox College campus near lecturer rooms; in Matole Basin farmers' plots, and other places.
➢ Actual contribution to development of productive demonstration sites for teaching and learning	➢ The lecturer **led** the team made up of colleagues from Dohne Research Institute (2), and a farmer from Perksdale location (FSA3) ➢ ACLSA2 suggested the site for the demonstration site (on lower end of a well – vegetated catchment in the FCC farm). He had observed the flow of water on the proposed site previously during a rainfall event under the shelter of an umbrella. photo: 2 December 2014 – showing natural catchment ➢ and also initiated the construction process by facilitating engagement of a Tractor-Loader Backhoe to dig a farm pond (see photo below). *Photo above: A Tractor-Loader Backhoe (TLB) digging out the farm pond at FCC (C Matambo, Assignment 3).*

	 Irrigation system installed in field adjacent to the RWH&C works ➢ With the winter rains that fell in the last two weeks of July, 2015 the farm pond was filled with water, which he has been monitoring regarding water retention / infiltration (see photo below:). *"Early' (July) rains enter Farm pond whilst waiting for plastic lining* *FCC students installing RWH reservoir infrastructure on 4 September 2015* *Students manual feeding the raised Jojo tank with water from Farm Pond*
➢ Changes made to College Curriculum	➢ ACLSA2 was appointed coordinator of Amanzi for Food processes at Fort Cox College of Agriculture and Forestry.

	➢ The lecturer is working with second year diploma students to do trial experiments on water conservation on grass-covered areas and cleared areas as controls. ➢ "*There lies a good opportunity to engage more students in experimental projects that are RWH&C related. The fact that the experimental projects and the Soil and water conservation course are done in the second semester (which culminates into the rainy season) is an advantage that can be manipulated in the teaching of the RWH&C since practical engagement can most conveniently be carried out during this period*" (ACLSA2, Amanzi for Food Assignment 1) ➢ The lecturer has been liaising with the Head of the Department of Agriculture to ensure that the 5-year curriculum review process (which was taking place in 2015 and continued into 2016) at Fort Cox College of Agriculture and Forestry will capture rainwater harvesting more explicitly. ➢ The course notes developed by the lecturer now contain detailed diverse RH&C practices. ➢ The lecturer is leading a process of incorporating curriculum innovation changes into the wider and stronger college curriculum review process.
➢ Expanded community interaction	➢ The lecturer is now (since August 2014) operating in an expanded community of practice where the lecturer interacts with University of Fort Hare on curriculum development matters, and also with farmers, and extension workers. Farmers have questioned the curriculum's absences of RWH&C resulting in curriculum innovation actions of teaching RWH&C. ➢ He was elected chairperson of IBLN in 2015 till to date. ➢ In 2016 this expanded community grew to include a farmer innovator in Matole Basin with whom the college has shared leaf litter for mulch, advice on RWH&C designs and construction of a tunnel garden. ➢ Together with three other lecturers, he is jointly responsible for bringing on board lecturers in the pasture section to expansive learning on RWH&C that the pasture section had mistakenly considered irrelevant to their work. ➢ Participated actively in national water symposia, national and international conferences and workshops sharing agricultural water learning. ➢ Participated actively in Mpumalanga agricultural water learning network development. ➢ Initiated *ilima* approaches to the IBLN that have expanded agricultural water learning to several farmers and extension workers through at least two meetings, and these are ongoing.
➢ Links with universities and other knowledge partners	➢ He has made contact with a Water Engineer Mr Jonathan Denison (who is a member of the WRC Reference Group on the Amanzi for Food project) during the training of trainers course field follow ups, who provided him with ideas for a rainwater harvesting demonstration site which he has since implemented. ➢ A lecturer at University of Fort Hare facilitates a session on collaborative RWH&C learning with a community garden group at Lloyd Village (see photo below), who were represented at the Amanzi for Food Training of Trainers course. The University works closely with Fort Cox College of Agriculture and Forestry, and chairs their Academic Board. ➢ As part of his Masters in Agricultural Engineering Course, ACLSA2 has embarked on a thesis combining RWH&C with irrigation. The idea is an off-shoot of the expansive learning, transformative agency and new culture of boundary-crossing learning emanating from the change laboratory workshops and the Amanzi for Food Training of Trainers Course. The Masters has also led to him doing assignments which have linked him more closely with colleagues in the

	Amanzi for Food course, such as FSA7 of Keiskammahoek Dairy (part of the Amadlelo Agricultural projects) thus enhancing collaborative learning on rainwater harvesting.
➢ How RWH&C materials were used	The lecturer engaged with the WRC materials to look for combinations of RWH&C techniques that would suit the demonstration site that has since been established at Fort Cox College of Agriculture and Forestry, and also to analyse his existing curriculum. Copies of materials have been deposited in the college library.

Participant B (INDEX CODE : **ACLSA3, Lecturer**	
➢ Enhanced knowledge of RWH&C	➢ The lecturer's knowledge and appreciation of the significance of RWH&C was enhanced as shown by her progress in the assignments and also by her quick engagement with facilitating the development of a productive RWH&C demonstration site with team mates in Keiskammahoek. ➢ Co-engaged learning among people on the ground has progressed with college lecturers, farmers and extension officers sharing knowledge. ➢ Gained new RWH&C indigenous knowledge of *gelesha*. ➢ Students have learnt through lecturers, practicals at college and at farmers' plots
➢ Integration of knowledge into development of productive demonstration sites	➢ There is evidence of integration of her knowledge of RWH&C into the development of productive RWH&C demonstration sites as shown by her engagement with others and with course texts (see photo below) during the training of trainers course.  Fig. 6: Small-scale Farming Activity System ➢ *"My role in this collaborative team was to organize the meetings for planning and implementation of the demonstration plot plan. I also became responsible with procurement of seedlings and transportation thereof and supervising the completion of the whole demonstration plot project. I was fully involved in the construction of the RWH technique and the planting at the site"* (ACLSA3, Assignment 3). ➢ *"Being a skilled person in agriculture, I was then given an overall role of leading the technical implementation of the infield rain water harvesting technique" (ibid.)*
➢ Actual contribution to development and sustainability of productive demonstration sites for teaching and learning	➢ Led the development of a homestead productive demonstration site meant for collaborative learning by farmers at Keiskammahoek in the Amahlathi *Local Municipality. She was successful in planning together with the farmer whose plot was used (FSA7), and also in encouraging mobilisation of the local Extension officer (see photos below):*

	 Demonstration site assessment and selection: ACLSA3 *with Extension Officer in overalls, and FSA7, and other farmers* *Construction of the In-Field RWH&C technique (10 March 2015)* The garden was observed towards the end of April 2015 already productive with crops and functional RWH&C structures (see photo below shared via IBLN WhatsApp group). ➢ Colleagues in her team for RWH&C demonstration site in Keiskammahoek made her the secretary. From 2015 through to 2017 lecturer continued to use the demonstration plot as a teaching site for diploma students, with farmer as co-facilitator. There are plans to continue beyond 2018.
➢ Changes made to College Curriculum	➢ The lecturer has been documenting the RWH&C works so that she can use the photos and videos in her teaching: "*In the course offering, I will create a facilitative method of learning where in after transferring the knowledge of RWH&C techniques students will be given an opportunity to select and try out the technique they prefer. Therefore, the students will have to plan and implement the technique. The productive demonstration plots in the farmers' plots will also be used as a reference; hence they will be documented thoroughly to ensure that there is material available for future trainings*" (ACLSA3, Assignment 3, 2015).

	➢ The participant has started working with the college's curriculum review committee on "*integration in the existing curriculum i.e., fitting it in the courses that implicitly covers RWH& C, courses such as soil and water conservation (SS 221 and SWC 211) and Irrigation principles (Fort cox prospectus, 2015). I believe that the above mentioned courses must cover RWH&C in depth rather than the way it appears in the curriculum now. An example is that in SS 221 and SWC 211, RWH&C is covered only as the examples or introduction that the application. In some courses (e.g. SWC 211) the component of RWH&C is thought of being under soil conservation technique, which might not even be proved. In irrigation we only see rainfall as a source of irrigation water which is doubtful that the RWH&C techniques are addressed. At the wing of informal training (Rural Development Centre) RWH&C can be integrated as a short course which will enhance the knowledge and the skills of the farmers, extension officers and the educators" (ACLSA3, Assignment 4, 2015).*
➢ Expanded community interaction	➢ The lecturer is collaborating with farmers in Keiskammahoek (ACLSA7, Dairy Farmer from Seven Stars Dairy Project in Keiskammahoek and Individual garden farmers in the local village), and extensions officers helping them with technical knowledge and rainwater harvesting skills, and also with sourcing of seedlings for their garden. ➢ Coordination of IBLN Communications. ➢ She is also reaching out to Agriculture students at University of Fort Hare and University lecturers. ➢ BCCLW support in Mpumalanga and Eastern Cape Provinces (2017)
➢ Links with universities and other knowledge partners	➢ The lecturer is linked with the University of Fort Hare regarding RWH&C networking through involving students and lecturers from the University in her demonstration site as detailed in other sections of this profile. ➢ Lecturer also linked with University of Fort Hare through a PhD study.
➢ How WRC RWH&C materials were used	➢ The participant used the WRC RWH&C materials to compare different methods and practices, and for learning new knowledge: "*The information on the construction of furrows was taken from the technical manual and farmer hand-outs* called 'Water harvesting and conservation volume 2 part 1', *page 143 on the Water Research Commission materials.* The other information was from the internet. *As we read through the books we did the comparisons between all the techniques listed and infield caught our interest. The handbook provided us with relevant in-depth information that covers different types of the RWH&C techniques. The WRC materials also include the advantages and disadvantages of all the techniques covered and it provides the step-to-step details of constructing such RWH&C techniques. I found the WRC hand books very useful, it has enhanced my knowledge on the RWH&C techniques and it made my practicals very easy*." (ACLSA3, Assignment 3) ➢ Compiled notes for students and PowerPoint lesson guides for lecturing using the WRC materials ➢ Placed several WRC textbooks in the college library, giving students assignments requiring them to use the books ➢ "After your visit we were told that there are books at the library that are available for the students who want to read more about water harvesting and then we went to the library" (Fort Cox College Student).
➢ Boundary crossing transformative agency	➢ '*Transformation: new boundary practice*': Follow through of co-engaged transformative learning and agency with farmers and extension officers for curriculum innovation: Observed absence of farmer input in college curriculum, to which a research technician agreed, lamenting similar absence in agricultural research culture. "I am trying to think **that most of our curriculums, if we do them inside Fort Cox it is a Fort Cox thinking, not farmer-based** you know. It's **more academic than the practicality that the farmer could**… What I am trying to say is **it's not customer-**

	based, it's house-based." (BCCLW#1 at IBLN meeting #1, August 12, 2014). This legitimated coexistence of distributed cognition between college lecturers and farmers. Lecturer also reflected on the possibilities of co-engagement with extension officers. EOSA1: The learning network will assist to accelerate those programmes … ACLSA3: *Anisi supporti nina casenza* ioutreach [You can assist us with outreach]. *Sizazoboyela kuwe*… EOSA1: What kind of support do you want? ↓ *Reflecting* on the quality of the formal college curriculum offerings with respect to *taking farmers' perspectives*. "College graduates become either farmers, trainers and/or advisors. Therefore *it is crucial that the college programmes address the crucial issues that pertain to farming*, e.g. water as the source of farming." (Assignment #1). This process of *identifying with* farmers gradually shifted farmers' positions to the centre of knowledge flow. The lecturer further reflected on the absences of RWH&C training in the informal short courses for farmer training through FCC RDC, again taking perspectives of the smallholder farmer, i.e. looking at oneself through farmers' world. "Fort Cox College offers formal and non-formal trainings (short courses), *the informal training concentrate in primary agriculture, but RWH&C are never offered in such trainings*. Therefore *integrating RWH&C in such courses will increase the knowledge of farmers on water issues*." (ACLSA3, Assignment #1). ↓ Grouping with Keiskammahoek farmers in IBLN BCCCL workshops #3 and consolidating in CL workshop #4. ↓ Relating farmers' ideas at the centre of knowledge flow to the curriculum (Assignment #2, Assignment #3, IBLN BCCL workshop #5) ↓ Co-engaged learning with KKH farmers on planning & developing their RWH&C demonstration site. Lecturer demonstrated mature empathetic agency / '*identifying with'* farmers in recognising othering and negotiating power, mediating reframing of $power_2$ to $power_1$ relations. ↓ Bringing in lessons from KKH co-engagement into the FCC knotworking, demonstration plot development & own teaching. ↓ Taking students regularly to KKH demonstration plot to learn from and with farmers (2015, 2016 & 2017). Farmers as co-trainers ("She was excellent in her teaching", see excerpt 6.19), and at centre of knowledge flow. "*Continuous joint work at the boundary*" (Akkerman & Bakker, 2011).

Participant C (NAME **: ACLSA4**	
➢ Enhanced knowledge of RWH&C	➢ The assignments done by the candidate during the Amanzi for Food course indicate that she has enhanced her knowledge of alternative agricultural water specifically RWH&C practices in context, and its role in enhancing her curriculum and teaching effectiveness. ➢ Research by students in the WRC project has revealed that there is continuous engagement with RWH&C knowledge practices and co-engaged learning among people on the ground during teaching and learning processes.
➢ Integration of knowledge into development of productive demonstration sites	➢ She has contributed ideas on harvesting run-off in a restricted area, and the possible recycling and quality treatment of sewerage water which is available in a plant situated by the proposed rainwater harvesting site at Middledrift (by Keiskamma river)that she is involved with other stakeholders in the Amanzi for Food Learning network.
➢ Actual contribution to development and sustainability of	➢ The lecturer was involved from the beginning in joint planning of the demonstration site at Middledrift with team-mates from Nkonkobe Economic Development Agency (NEDA) and the Middledrift Extension office.

productive demonstration sites for teaching and learning	➢ She has made joint visits to the demonstration site with her team mates and other members of the learning network. ➢ She also forms part of the team developing a demonstration site at the Fort Cox College of Agriculture and Forestry.
➢ Changes made to College Curriculum	➢ "*There are two options that have been suggested as vehicles for the integration of the RWH&C practices into the curriculum. Firstly, the RWH&C practices will be incorporated into the current curriculum of academic programmes through courses such as Soil & Water Conservation. This course will teach students the whole range of RWH&C practices that are commonly practiced in South Africa while the other related courses such as irrigation principles and production courses (field crops, fruits and vegetables) will only infuse related RWH&C practices. Integrating the RWH&C techniques into the current course offerings augers well with the new line of thought in the curriculum development arena which emphasizes on horizontal and vertical integration of concepts rather than treating the courses individually. In addition, the college is focusing on improving the practical aspect of the program as such there is a proposal for streamlining the 35 courses to fewer courses so that there is more room for the practicals. The short courses on RWH&C at the Fort Cox Rural Development Centre will be offered as a standalone course and as a topic in production courses that will be offered targeting farmers, educators and the extension officers"* (ACLSA4, Assignment 4) ➢ *"… various methods will be used to teach the content such as … group discussions, videos, posters, photos as well as guest lectures from specialists and practicing farmers on RWH&C. In addition, students will be given opportunities for field excursions to sites where RWH&C is practiced as well as be hands-on RWH&C techniques through practicals and research projects and demonstration sites development"* (*ibid.*).
➢ Expanded community interaction	➢ The lecturer has linked with the Nkonkobe Economic development Agency (NEDA) and the Middledrift Extension Services to work together on a demonstration site at Middledrift which is planned for commercial tomato production in liaison with a farming conglomerate ZZ2 in Limpopo. A group of farmers is planned to initially work on the project and eventually be weaned to take over business operations.
➢ Links with universities and other knowledge partners	➢ By virtue of association of Fort Cox College with the University of Fort Hare, the lecturer is collaborating with colleagues at University of Fort Hare's Agriculture School in developing RWH&C; ➢ *"The collaboration will continue after the RWH&C learning network workshops have ceased. The collaboration will help to pool resources such as expertise in various aspects of the RWH&C, vegetable production, and group dynamics, financial…. Other organizations in the community will be identified during the social facilitation who could also be possible partners in providing expertise and tangible materials required in the project".* (ACLSA4, Assignment 4)
➢ How RWH&C materials were used	➢ The participant used WRC materials as a knowledge resource to enhance understanding of the whole range of RWH&C practices (see quote below) and to make selections of what could be used in improving RWH&C content and teaching in the curriculum, developing the rainwater harvesting demonstration site and how. ➢ "*The learning content for the RWH&C practices will include the whole range of practices that are recommended by the Water Research Commission, as represented in Denison et al (2011) and Stimie et al. (2010). For example Denison et al. (2011) provides a summary on pages 13 to 18 covering the description of thirteen practices, their main purpose and the type of water harvesting system involved. The same practices are further described in detail in Water Harvesting Conservation manual, part 1 on pages 129 to 170. The recommended RWH&C*

techniques are diversion furrows, trench beds, mulching, stone bunds, tied ridges, swales, terraces, fertility pits, greywater harvesting, ploegvore, dome water harvesting and saaidam. In addition, there are other useful practices such as conservation tillage, small earth dams and sand dams which although not explained in the manual are deemed useful techniques for rain water harvesting. What is seen as also useful and which could be added to the RWH&C content is the topic highlighted from pages 21 to 39 which is dealing with the global water crisis, water in South Africa and how the water crisis is being addressed globally and in South Africa. This topic would form as an introductory chapter on RWH&C as it addresses the underlying issue of water distribution and availability, the climate change, pollution etc. which would form a basis for the need for rainwater harvesting.

All the above RWH&C practices would be covered in Soil & Water Conservation course which would be the backbone for the RWH&C in the college curriculum. Teaching the students all the common RWH&C practices is necessary because the students come from different areas of the province and beyond therefore particular techniques may not be applicable to all situations. Secondly, different types of RWH&C practices are suited for different scales of farming for example homestead gardening (small scale), medium scale and large scale. Since the students work with farmers at all levels of farming, it is reasonable option to expose the students to a wide knowledge of RWH&C practices to enable them to choose what would be feasible for the particular farmer's situation. Beside, many RWH&C practices do not work in isolation, they complement each other, for example, diversion furrows work with storage structures, deep trenches and other topics such as knowledge on contouring. Therefore dealing with these together provides a complete package. The table below summarises the proposed content" (ACLSA4, Assignment 4, June 2015).

Table 2: A summary of proposed RWH&C content

Content	Source /Materials	Comments
Water in the world	Denison et al. (2011, pgs. 21-40).	To be infused in Soil and water conservation
RWH&C methods	Denison et al. (2011, pgs. 13-18; 129-170 & handouts (presented after page 185) & Stimie et al. (2010, pgs.58-108).	Partially covered under soil and water conservation course
Soils	Denison et al. (2011, pgs.79-104	Topic already covered under two courses under the current curriculum: Soil Classification and Soil fertility and Plant Nutrition
Water harvesting and conservation planning	Denison et al. (2011, pgs. 109-126)	To be infused in vegetable production course especially practicals

Appendix 6.11: Matrix for the Empirical Analysis of Boundary-Crossing Expansive Learning

(adapted from Engeström, 2001, p. 138)

	Activity systems as a unit of analysis	**Multi-voicedness**	**Historicity**	**Contradictions**	**Expansive cycles**
Who are learning? (definition & location of subjects)	Smallholder farmers, college and university agricultural educators and trainers, extension workers, youths.	All participants from each other	All participants connecting contemporary problems to historical roots	All participants	All participants
Why do they learn? (what makes them make the effort)	Possible realisation of aspirations through pursuit of joint motive as object of collective activity	Desire to seek solutions from each other's work	Needs and curiosities	Problems reflect back to participants and stimulate learning	Interest in co-creating value and new nodels
What do they learn? (contents and outcomes)	in Matole Basin engaged in agro-ecological and conventional farming	Importance of sharing problems, knowledge practices and co-creating an atmosphere of respect and sharing.	The germ cell properties provided by *gelesha* and seed saving knowledge practices among few farmers connecting with college agricultural water knowledge needs.	The ambivalence of working in silos; Absenting absences of sustainable agricultural water in farming, extension and curricula through co-engaged learning.	Emergence of model water, seed, curriculum and extension solutions from dialogue, analysis and examining them before implementation.
How do they learn? (key actions and processes of learning)	They learn together pursuing a common object. They share knowledge practices and interrogate them to come up with new knowledge practices. • Negotiating joint object; • Farmer innovator shared her farming and garden plots as sites of intermediary action and engagement • Agricultural college lecturers shared their RWH&C and micro-irrigation knowledge practices • Permaculture 'motivator' share her knowledge practices	From dialogical interactions	Linking policy with actions and absenses	Relating reciprocal problems	Joint modelling

Appendix 6.12: Summary Of Boundary Crossing Issues, Mechanisms and Agentive Trails in the IBLN (incorporating and expanding Tables 6.3 and 6.8)

Boundary crossing mechanisms experienced (*)	**Nature of boundary issues concerned**	**Agentive trails**
'**Identifying with**' and '**transformation: continuous joint work at the boundary'**	**Agricultural extension starting to identify with and direct extension advice relevant to farmers' contexts**. The IBLN helped the agricultural advisors (extension officers) to see beyond their scripts and support farmers' household food security through new collective extension with others in the IBLN mediated by change projects and productive demonstration plots, in line with their mandates.	***Resisting*** the change, new suggestions or initiatives. Directed at management, co-workers or the interventionist →mediated BCCLW co-engagements→ ***Resisting*** the new suggestions or initiatives for incorporating Agroecology farmers in extension support: directed at farmers and IBLN: ("there is no other way I can take you, except for the cropping programme that is in the plan" EOSA1, excerpt 4.16)→***criticizing*** new farmers practices as justification for extension script: "*farmers these days are no longer prepared to work hard in the fields*. ...The *GMOs do not need much labour*" EOSA4, excerpt 6.14→Realization of extension absences in agricultural water and locally adaptive seed from extension officers' deliberative interactions with agentive agro ecological farmers, with WRC RWH&C knowledge materials in IBLN and co-engagement with IBLN members→***Explicating* new possibilities or potentials** in the activity. Relating to past positive experiences or former well tried practices (e.g. EOSA1 supporting efficacy of locally adaptive seed and EOSA4 agreeing to OPV trials in IBLN) →***Commitment to action and implementation*** (FSA10: "We used *manual weeding* with tractor and "skoffel", followed by *Ilima* where men from the village came to assist, we cooked for them and had to buy a case of Black label beer for quenching thirst. The only challenge is pest control for the maize in the fields". R1: "Wow great to see Ilima in action. Please invite some us to ilima next time. ...". (see DIBSAW, IBLN WhatsApp line 322-323-appendix 3B, March 17, 2017). Extension officers participating in most *ilima* and ILBN meetings as collective extension support. (see DIBSAW, line 332, March 21, 2017 – EOSA1: "I am in support of the 30/03 date". Line 400: March 30, 2017, EOSA1: "It was a day well spent keep it up team IBL")
Transformation of curriculum practices through placing farmers at the centre, curriculum innovation and continuous joint work at the boundary	Diversification of knowledges to **incorporate farmers' contexts in agricultural college curricula**, reframing of power and working together (DIBSAF3, November 2016); Excerpt 6.22 (ALCAWSA1, September 24, 2014)	Mediation of inter-sectorial deliberations in a learning network→Immanent critique of business as ususal in curriculum practice by agricultural college educators and farmers→ Understanding farmers' contexts by agricultural college educators through interaction and critique→Lecturers developing empathetic agency→Basing curriculum practice on farmers' rain-fed contexts→Integrating RWH&C in pedagogy →Expansion of curriculum practice through MoU backed by agricultural college management→Including farmers in teaching around farmers' productive RWH&C demonstration plots
Coordination: information or knowledge structure	**Learning Network as a critical knowledge exchange and information structure**	Water needs of farmers emerging as contradictions in farming work foregrounded in IBLN initially as an "un-reflected, situationally given 'raw material' to other

provides communicative connection between diverse practices, efforts of translation. **Cooperation:** actors focus on a shared problem, trying to find mutually acceptable ways to conceptualize and solve it. Participants go beyond the confines of the given script, yet they do this without explicitly questioning or reconceptualizing the script. (Engeström, 2008a)	**enabling cooperation** and centering of farmers with relevance to extension and curriculum practices.	agricultural learning system actors→ RWH&C practices endorsed by IBLN while Agroecology practices of locally-adaptive seed are welcomed by extension for trials as collectively meaningful boundary objects→Agricultural college lecturers, farmers and extension workers collaborate and cooperate on planning and developing emergent and contextually relevant agricultural water and locally-adaptive seed solutions and implementation plans embraced as jointly constructed objects→development of demonstration plots, new curricula with RWH&C practicals and collective extension (see first row on extension above)
Integration and **communication** (Engeström, 2008a)	**Co-engaging youths** in farming and agricultural water through Co-engaged reflexive communication, collective planning and action (see excerpt 6.45). Role of retired professionals in mentoring youths in community.	Youths individual agency in seeking seeds locally, attending a farmers' meeting and doing farming (excerpt 6.45)→**Relational interaction** between members of IBLN (EOSA1, NESDA2, R1) with empathetic farmer innovator FSA10 and Youths via formative intervention→Farmer FSA10 reaches out to mentor youths→ →seed sharing in IBLN→**mutual conceptualization and formation of cooperative** organization 'ZAMBS'→development of productive garden plot→production of first OPV crop by youths→participation of FSA10 and youths in IBLN WhatsApp group and community radio shows.

*Coding for Boundary learning and crossing (based on Akkerman & Bakker, 2011 and Engeström et al., 1995) and Types of Agency expression (based on Engeström 2011 and Haapasaari 2012)

Appendix 7.1: List of Agricultural Colleges and Selected Vocational Training Colleges in Zimbabwe

Name of Agricultural College	Location	Management	Relevant Offerings and known encounters with RWH&C and locally-adaptive seed	Some relevant changes
Chibero Agricultural College	Mashonaland West Province	Department of Agricultural Education and Farmer Training	Certificate in Agriculture; Diploma in Agriculture; Higher National Diploma in Animal Production; Introduced to RWH&C through Principals Councils meetings	Introduced environmental education and conservation courses in 2009 in liaison with DAEFT and Faculty of Agriculture, University of Zimbabwe
Gwebi Agricultural College	Harare Province	Department of Agricultural Education and Farmer Training	Diploma in Agriculture; Conventional Diploma in Agriculture; Block Release Diploma in Agriculture; Higher National Diploma in Horticulture; Farmer Training and Outreach Programmes; Introduced to RWH&C through Principals Councils meetings	Introduced environmental education and conservation courses in 2009 in liaison with DAEFT and Faculty of Agriculture, University of Zimbabwe
Mlezu Agricultural College	Midlands Province	Department of Agricultural Education and Farmer Training	Certificate in Agriculture; Diploma in Agriculture; Farmer Training (one day to four months) tailor made to suit the farmer; Introduced to RWH&C through one-one encounters, Principals Councils meetings, BCCLWs and visits to RWH&C and seed saving innovators.	Introduced environmental education and conservation courses in 2009 in liaison with DAEFT and Faculty of Agriculture, University of Zimbabwe
Esigodini Agricultural College	Matabeleland South Province	Department of Agricultural Education and Farmer Training	Certificate in Agriculture; Diploma in Agriculture; Introduced to RWH&C through Principals Councils meetings	Introduced environmental education and conservation courses in 2009 in liaison with DAEFT and

				Faculty of Agriculture, University of Zimbabwe
Rio Tinto Agricultural College	Mashonaland West Province	Department of Agricultural Education and Farmer Training	Certificate in Agriculture; Diploma in Agriculture; Introduced to RWH&C through one-one encounters, Principals Councils meetings, BCCLWs and visits to RWH&C and seed saving innovators.	Introduced environmental education and conservation courses in 2009 in liaison with DAEFT and Faculty of Agriculture, University of Zimbabwe
Shamva Agricultural College	Mashonaland Central province	Department of Agricultural Education and Farmer Training	Certificate in Agriculture; Diploma in Agriculture; Introduced to RWH&C through Principals Councils meetings	Brought in environmental education and conservation courses into the curriculum as it took off
Mazoe Veterinary College	Mashonaland Central province	Department of Agricultural Education and Farmer Training	3 year Diploma in Animal Health and Production; 1 year Higher Diploma in Animal Health and Production; Introduced to RWH&C through Principals Councils meetings	
Kushinga Phikelela National Farmer Training College	Mashonaland East Province	Department of Agricultural Education and Farmer Training	Diploma in Commercial Farming (3 years full time) ; Introduced to RWH&C through Principals Councils meetings	

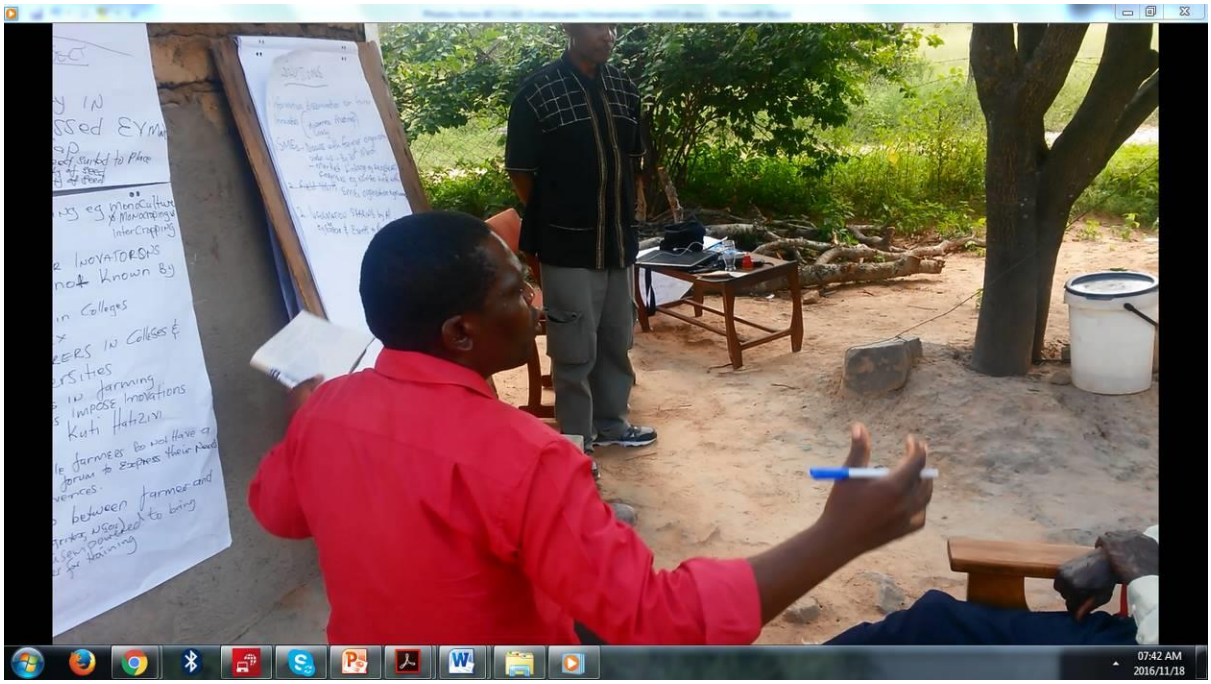
The Department of Agricultural Education and Farmer Training (DAEFT) in Zimbabwe is the umbrella body overseeing all state agricultural colleges. It has been concerned with the impact of climate change on agricultural production, education and training and has thus incorporated key stakeholders to address these issues in its curriculum development meetings and management workshops.

Appendix 7.2: Data Sources for Boundary-Crossing Expansive Learning Zimbabwean Case Study

Data source	Code	Comments
Documents		
National Diploma in Agriculture: Chibero, Gwebi, Mlezu, Esigodini, Rio Tinto, and shamva, Syllabus for Agricultural Engineering	DAEZAES1	Agricultural Engineering Syllabus (2012-2016; 2016-)
National Diploma in Agriculture: Crop Production Syllabus	DAEZCPS1	Syllabus for Agricultural Engineering (2012-2016; 2016-)
Documented transcripts and reports		
Transcript of Zimbabwe RWH&C learning network BCCLW 1	DLNZ1, January 15, 2015	
Transcript of Zimbabwe RWH&C learning network post BCCLW 1 visit to a farmer #1	DLNZF1a, January 15, 2015	
Transcript of Zimbabwe RWH&C learning network post BCCLW 1 visit to a farmer #2	DLNZF1b, January 15, 2015	
Record (Research Journal entry) of meeting with Community Liaison Officer Murowa Mine (Rio Tinto Pvt Ltd).	ZM1a, January 7, 2015;	
Email communications with Community Liaison Officer Murowa Mine (Rio Tinto Pvt Ltd).	ZM1b, January 12-13, 2015)	
Transcript of Zimbabwe RWH&C learning network BCCLW 1 focussing on Mlezu Agricultural College network	DLNZM1, April 22, 2016	
Report of Zimbabwe RWH&C learning network BCCLW 1 focussing on Mlezu Agricultural College network	DLNZM1b, April 22, 2016	
Transcript of Zimbabwe RWH&C learning network focussing on Rio Tinto Agricultural College network BCCLW 1	DLNZR1, 18-19 February 2016	
Transcript of Zimbabwe RWH&C learning network focussing on Rio Tinto Agricultural College network BCCLW 2	DLNZR2, August 6, 2016	
Transcript of Zimbabwe RWH&C learning network focussing on Rio Tinto Agricultural College network BCCLW 3	DLNZR3, 11 to 12 August 2016	

Appendix 7.3: Sample Transcript of Zimbabwean Learning Network Boundary Crossing Workshops

Transcript of plenary and Photos from BCCLW2 Zvishavane-Mazvihwa
File name: 20150212_141659 Marketing problm & soln College demo plot.mp4
File type: Video mp4
Length of video: 33min 25s long
Date: 12 February 2015
Venue: Zepheniah and Constance Phiri homestead

1. *Spool run 14min 52 sec*
2. ACLZ1: Ini ndanga ndichida kuti se College zvatiri kufunga kuti tinogona kuitawo since tiri college yakatarisana nenyaya dzeku trainer vanhu vacha zoti batsirawo kana tave kuma communities atinogara kuti problem idii, ipere ye object yedu, ye common object. Tinofungidzira kuti tinogona kunotangawo ma demo plots sort of on how to conserve moisture at college level ne water harvesting. So that vatinenge tichidzidzisawo vakamboonawo iri a demo maybe pavanobudawo vachiinda kunotaurawo ne vavanenge vachigara navo kuda zvingaita kuti zvibatsire kuti problem yedu igadzirike.
3. Translation: *My contribution is that* ***as a college what we are thinking of doing since we are in the business of training people who will help us when we are in the communities where we stay to help us solve our problems regarding our common object****. We think we can start some demo plots sort of on how to conserve moisture at college level and water harvesting. So that those we are training can be able to see the demonstration plots so that when they go out to talk with those communities they live with it may help to address and solve our problem.*
4. 

5. *Spool run 15min 44 sec*
6. TP: Munoinzwa seivo iyo?
7. Translation: *How do we see this point?*
8. FZ4 and others: Iri right.
9. Translation: *This is good.*

10. TP: Muri kufunga kuti ma college edu arikuinda in the right direction haere kana kuti ari kurashika kana kuti vari kudokera shure?
11. FZ2: Ini ndaifunga kuti munogona kuita demo asi demo yoga pasina history, imi moga munonyatsozviona, nokuti zvinoda history kuti zvinomboitigweyi, zvakamboitigweyi. Chinyi chakaitika zvaitiwa izvozvo. Ndofunga panoda kuti pave ne background, pave ne history.
12. Translation: ***My thinking is that you can do a demonstration plot, but a demo plot on its own without history, you may also see what I mean, because it needs history of why is it being done, why was it done****. What happened when this was done. I think there is need to have a background, to have a history.*
13. *Spool run 16min 26sec*
14. TP: Inenge ichiitiwa seyi iyoyo history yacho? Point yenyu yakanaka zvikuru va X. Nokuti pataitaura nyaya iya yokuti activity system [referring to workshop 1] taiti zvirikubva mune yataiti cultural-historical activity iya iyi. Saka nyaya ye history iripi, iripo. Saka ngativape more ideas kuti vanozvifambisa seyi.
15. Translation: *How do you go about this history? Your point is very important Mr X. You may also recall that when we were talking about activity systems* [referring to workshop 1] *we said that it emanates from the cultural-historical activity ideas. So the issue of history is very much part and parcel of this process. So let us give them (Mlezu college) more ideas on how they can go about it.*
16. *Spool run 16min 48sec*
17. FZ2: History unoi capture nokuinda kwazvinoitwa, kundovona kwazvinoitwa. Kuti zvakaitwa kwe period yakadini, zvikapeyi, kana zvakapa goho rakadini? Hanzvina here ma harms, ma effects azvakaita.
18. Translation: ***History can be captured by going to the places where these things are being done, to see where it is done. To learn about how long it was done, what results came out, or what yields did they produce****. Did they have any harm or effects they caused?*
19. *Spool run: 19min51sec of 33min 25sec*
20. Commitment to help Mlezu with demo plot: show of hands by FZ1 - small-scale farmer innovator, FZ2 - small-scale farmer innovator, FZ8 – local Marketing coordinator, FZ3 – small-scale farmer innovator
21. *Spool run: 19min53sec*
22.
23. Commitment to help Mlezu with demo plot: show of hands by FZ2, FZ4, NGOFOZ1 – Muonde RWH NGO

End of abridged transcript.

Appendix 7.4: Curriculum Analysis Tool used in BCCLWs and applied in Curriculum Documents with Analytical Content

Name of curriculum document/practice and year	General and topic/s overview, level of implementation	RWH&C content or issues (explicit / implied)	Locally-adaptive seed content (explicit / implied)	Comments
Syllabus For Agricultural Engineering (National Diploma In Agriculture: Chibero, Gwebi, Mlezu, Esigodini, Rio Tinto, And Shamva) There is large devotion of time and detail to ***irrigation theory and practicals***, including a project.	There is a strong commodification value: "The trainers must be well prepared to give the hands on training necessary **to move agriculture from subsistence to commercial**." (p. 1)	Water conservation is explicit but RWH&C is absent: "**6.6 Conservation: principles, methods, scheduling, applications and limitations"**. Water conservation also featured but in the context of dams for irrigation.	Nil	
Crop Production Syllabus Revised: June 2012 (Diploma In Agriculture Course)	1.Among food crops **Maize allocated** far much more ***teaching time*** (24 hours, p. 28) as a topic on its own, covering many dimensions of production, compared to other crops e.g. 2.**Maize** also appears together with other crops (Cotton, Winter Cereals and Oil Seeds) as a sub-topic under the topic ***practicals*** in the final year (p. 47). Tobacco is a full-subtopic on its own under practicals showing its economic importance, and so are oil seeds, fruit growing (pomology), and flower growing (floriculture). Small grains and OPVs also feature but minimally as discussed in the next columns.	RWH&C is not explicit in the syllabus.	**1.Sorghum, Millets, Bambara nut, Cowpeas** together with 5 other crops under the general topic of 'Crop Production 1' (19 hours all together, p. 17), implying an average of about 2 hours per crop, covering fewer dimensions. It is noteworthy that **key small grains and pulses** are included in the crop production syllabus, although as minor crops.	The small grains and pulses do not feature under practicals meaning **they do not have to be taught practically, hence showing their low rank of importance in the curriculum**. 2.4.2 Open pollinated varieties (OPVs) Featured in syllabus **just as one of the varieties, with no special mention of special attributes such as climate adaptability, accessibility, or market value**.

Fort Cox prospectus 2013	ACLSA3: Horticulture (vegetable &fruit production) (P.87); and ACLSA4: Horticulture 1 (Vegetable production – role of *organic matter; temperature, wind, rain, drought; cover crops, manure, compost*), Horticulture II (macro and micro *climate* and fruit production, irrigation)	ACLSA3: No		ACLSA3: Part of water conservation could be best
Fort Cox prospectus 2013	ACLSA3: Farm Structures (P.87)	-	ACLSA3: RWH&C works could be one of the farm structures?	ACLSA3: Construction of the RWH catchment areas and diversion should be entertained
Fort Cox prospectus 2013	ACLSA2: Introduction to agricultural engineering- P63.	ACLSA2: Tillage operations; Conservation agriculture Crop residue as mulch	ACLSA2: Ripping as a practice that breaks plough pan and allows water infiltration to higher depths	ACLSA2: Concepts covered in depth
Fort Cox prospectus 2013	ACLSA2: Introduction to soil science- P65		ACLSA2: Soil moisture	ACLSA2: Reflects the importance of soil moisture to plant growth and hence the need for RWH where/when rapid moisture loss is a high risk
Fort Cox prospectus 2013	ACLSA2: Experimental project- P72	ACLSA2: RWH&C projects	ACLSA2: Other experimental projects	ACLSA2: Projects can be tailor-made to relate to specific research areas

Appendix 7.5: Curriculum Innovation and Development Outcomes in the Mlezu and Rio Tinto Agricultural Colleges

College A: **MLEZU COLLEGE OF AGRICULTURE**	
➢ Enhanced knowledge of RWH&C	➢ RWH&C knowledge has been enhanced among college staff, principal and block release students (in-service extension workers) through BCCLWs and linkages with RWH&C and OPV seed innovators.
➢ Integration of knowledge into development of productive demonstration sites	➢ The college team has used knowledge co-developed with farmer innovators and local colleagues and expanded learning to the development of their productive demonstration site as a site for intermediary action. ➢ Knowledge developed from boundary-crossing learning was planned for application other demonstration plots in the community whereby willing farmers had already been identified.
➢ Actual contribution to development of productive demonstration sites for teaching and learning	➢ At least 8 lecturers and a farmer trainer, and the College Principal were involved in BCCLWs and in the implementation of deep contour demonstration plots in the college farm. While agricultural extension officers and farmers were part of the BCCLWs they were not involved in the initial development of the RWH&C demonstration plot. This omission was to be corrected via the farmer trainer. ➢ Plans were put in place to plant small-grains adaptable to climate variability and change.
➢ Changes made to College Curriculum	➢ The development of demonstration plots involved students. Teaching strategies were not evident at time of exit.
➢ Expanded community interaction	➢ Mlezu Agricultural College is well connected with the local extension and farming community, within whom the seed has been sown for demonstration plots to be established. The college is also connected with RWH&C innovators in Zvishavane and Mazvihwa.
➢ Links with universities and other knowledge partners	➢ The agricultural college is linked to Midlands State University and plans to include RWH&C innovations in curriculum reviews with the University.
➢ How RWH&C materials were used	➢ The college was given copies of WRC RWH&C materials for the library for use as reference materials for lecturers and students, and a copy was deposited with the principal. Electronic versions were also provided.

College B: **RIO TINTO COLLEGE OF AGRICULTURE**	
➢ Enhanced knowledge of RWH&C	➢ RWH&C knowledge has been enhanced among college staff, principal and block release students (in-service extension workers) through BCCLWs and linkages with RWH&C and OPV seed innovators.
➢ Integration of knowledge into development of productive demonstration sites	At least 3 lecturers, a farm manager and the College Principal were involved in BCCLWs and in the implementation of a deep contour demonstration plot in the college farm.
➢ Actual contribution to development of productive demonstration	➢ At least 4 lecturers, a farmer manager, and the College Principal were involved in BCCLWs and in the implementation of deep contour demonstration plots in the college farm. While agricultural extension officers and farmers were part of the

sites for teaching and learning	BCCLWs they were not involved in the initial development of the RWH&C demonstration plot. This omission was to be corrected. ➢ Plans were put in place to plant small-grains adaptable to climate variability and change. The principal was keen to lead this initiative together with an interested lecturer.
➢ Changes made to College Curriculum	➢ The development of demonstration plots involved students. Teaching strategies were not evident at time of exit.
➢ Expanded community interaction	➢ Inclusion of at least 4 extension workers already started during BCCLWs and is set to continue with the detailed plans made for OPV and small grain seed fairs and RWH&C filed days. Connections with farmer innovators in Zvishavane and Mazvihwa have been established and the college has initiated further interactions with them on its own.
➢ Links with universities and other knowledge partners	➢ The agricultural college is linked to Midlands State University and plans to include RWH&C innovations in curriculum reviews with the University.
➢ How RWH&C materials were used	➢ The college was given copies of WRC RWH&C materials for the library for use as reference materials for lecturers and students, and a copy was deposited with the principal. Electronic versions were also provided.

Appendix 8.1: Proposed Curriculum Analysis tool for Sustainable Agricultural Water and Locally Adaptive Seed - based on Tested Tools (see Appendix 6.6)

I. Institutional profile

1. Name of Agricultural Training Institution: _____

2. Type of ATI: (tick most appropriate)

A)University	B)Agricultural College / TI	C)FET College	D)Other (please specify)

3. Responsible authority: A) Government _____; B. Private _____(Name: _____); C. Other: _____ (Name:_____)

II. Stakeholder Analysis Profile

4. Who is consulted and how are they involved in curriculum revirew and development? (tick in appropriate fields)

	A)Agricultural industry	**B)Department/ Ministry of Agriculture**	**C)Large-scale commercial farmers**	**D)Smallholder farmers**	**E)Accrediting body**	**F) Other (please specify)**
Tick in this row and in the appropriate shaded boxes						
Regular long-term engagement						
Process involvement in workshops / meetings						
Sometimes consulted						
NOT consulted						
5. Level of Importance to curriculum review and development (tick one box in each column)						
High to very high						
Medium						
Very low, if at all						

6. Would you say smallholder farmers' rain-fed contexts are seriously considered in extension education?

A. YES	B. NO

7. Explain your answer: _____

8. Would you say smallholder farmers' rain-fed contexts are seriously considered in farmers training programmes?

C. YES	D. NO

9. Explain your answer: _____

III. Agricultural water, Environmental water and Potable water Assessment Profile

10. What is the main source of supply for potable water (drinking and sanitation):

_____

11. What are the sources of supply for agricultural water (in order of importance):

A)Dam (name:)	B)Agricultural College / TI	C)FET College	D)Other (please specify)
.....	.....	.....	.....
.....	.....	.....	.....

IV. Agricultural water knowledge practices and skills assessment

12. Have you been trained in RWH&C?
13. Which (diversity of) RWH&C practices are you familiar with?
14. Which of these RWH&C practices have you experienced practically at professional level or otherwise?

V. Locally adaptive seed knowledge practices and skills assessment

15. Have you been trained in locally / climate adaptive seed practices?
16. Which (diversity of) locally / climate adaptive seed practices are you familiar with?
17. Which of these locally / climate adaptive seed practices have you experienced practically at professional level or otherwise?

VI. Agricultural Curriculum Assessment Profile: agricultural water

Name of curriculum document/practice and year	**General and topic/s overview, level of implementation**	**RWH&C content or issues(explicit)**	**RWH&C content (implied)**	**Comments**
	Provide a qualitative and quantitative assessment. In the quantitative, score between 1 to 5 the level of content (0-nil; 1-implied; 2-mentioned with no detail; 3-mentioned with little detail; 4-included with some relevant content but no direction for			

	teaching and practicals; 5-included with depth of how to teach it (hours of lectures and practicals) – for graphical analysis e.g. spider graph			

VII. Agricultural Curriculum Assessment Profile: seed

Name of curriculum document/practice and year	**General and topic/s overview, level of implementation**	**Seed inputs content or issues (GMO)**	**Seed inputs content or issues (Hybrid)**	**Seed inputs content or issues (OPV / traditional)**	**Seed inputs content or issues (climate adaptation)**	**comments**
	Provide a qualitative and quantitative assessment. In the quantitative, score between 1 to 5 the level of content (0-nil; 1-implied; 2-mentioned with no detail; 3-mentioned with little detail; 4-included with some relevant content but no direction for teaching and practicals; 5-included with depth of how to teach it (hours of lectures and practicals) – for graphical analysis e.g. spider graph					