

**A review of Climate-Smart system innovations
in two Agricultural Colleges in the North West Province
of South Africa**

A thesis submitted in fulfilment of the requirements for the degree of

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ABSTRACT

This study was centred on the Agricultural Innovation System in the North West Province, South Africa as a response to climate change. The study developed during a time when Climate-Smart Agriculture emerged in policy and was developed as a strategic agricultural innovation process in response to changes in climate that increased food insecurity. The Agricultural Colleges embedded in the agricultural system realised that they were teaching students without a clear provision for climate change and therefore needed to initiate climate responsive innovations to comply with the Climate-Smart strategy that had been proposed by the provincial authorities. This provided the context for the study to track and support the innovation process of transitioning towards Climate-Smart responsive curriculum and learning practices within the system.

A theoretical framework for the study was developed using a Cultural Historical Activity Theory perspective. This allowed the researcher to approach the research process as two case studies of innovation within the Agricultural Innovation System of the North West Province. The study developed as an iterative process of innovation support and tracking. At the early stages of the research process, data were generated through document analysis and a survey completed by the research participants at the preliminary consultative workshop. The contextual data allowed the researcher to begin to develop a clear contextual profile for both case studies.

The consultative workshops were held to orientate the research around the central problems and challenges related to curriculum alignment with provincial Climate-Smart Agricultural policies. The methodology thereafter was developed as an iterative process of successive intervention-innovation workshops where the participating staff in each college reviewed their curriculum with the support of a Climate-Smart Innovation Tool. This tool was developed as a mediating resource for participants to undertake intervention work towards curriculum innovation in their context.

The historical analysis from the two consultative workshops and the data derived from the initial use of the Climate-Smart Innovation Tool was used to model the activity systems in the respective colleges and the provincial system. This analysis enabled the researcher to scope how the system was currently functioning and how it had changed over time. During the workshops, curriculum innovations were reviewed and a fuller picture of the challenges of system innovation emerged, especially from a curriculum innovation vantage point. This

system analysis was used to analyse emergent tensions and contradictions within the system and to build a picture of the complexities of participating staff initiating innovations towards Climate-Smart responsiveness in the colleges and within the Agricultural Innovation System.

During the review and tracking of the supported innovation process the Climate-Smart Innovation Tool was developed into online sub-tools where either Departments or individual lecturers could review and track their own Climate-Smart responsiveness. The tool was shown to be a useful tool for surfacing contradictions, and identifying absences, and thus for charting out the start of reflexive learning and change processes needed for introducing climate responsive knowledge into the system.

The study reveals that catalysing of curriculum and learning system innovation aligned with wider innovations in the agricultural innovation system requires specific tools, time and the understanding of the importance of micro-level innovation. The innovations within the system revealed the significance of allowing for time and processes that facilitate 'ascending' from the abstract concept of Climate-Smart Agriculture into more concrete curriculum processes. The curriculum review tool developed for this study served as an important double stimulation tool, along with activity system mapping, and ongoing refinement and clarification of the object of Climate-Smart Agriculture and associated contradictions and action plans for climate smart responsiveness in the college context. The tools and processes that were developed during this study, assisting in the emergence of micro-level innovation of the curriculum and learning system. The barriers and processes hampering curriculum and learning innovation within the system were identified. The study concludes with the recommendations on how a Climate-Smart innovation process might best be supported with reflexive tools within a curriculum and learning system during a time of institutional flux.

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LIST OF ACRONYMS

AgriSETA	Agriculture Sector Education and Training Authority
AISHE	Auditing Instrument for Sustainability in Higher Education
AOS	Action Oriented Strategy
ARC	Agricultural Research Council
ATI	Agricultural Training Institute
CHAT	Cultural Historical Activity Theory
DACERD	Department of Agriculture, Conservation, Environment and Rural Development
DAFF	Department of Agriculture, Forestry and Fisheries
DHET	Department of Higher Education & Training
DoA	Department of Agriculture
DoE	Department of Education
DRDLR	Department of Rural Development and Land Reform
ELRC	Environmental Learning Research Centre
EU SCAR	European Commission & Standing Committee on Agricultural Research
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food & Agriculture Organisation
FET	Further Education and Training
GASU	Graphical Assessment of Sustainability
GET	General Education and Training
HET	Higher Education and Training
IPCC	Intergovernmental Panel on Climate Change
LTAS	Long-Term Adaptation Scenarios
NCCRP	National Climate Change Response Policy
NDA	National Department of Agriculture
NEPAD	New Partnership for Africa's Development

NQF	National Qualifications Framework
OECD	Organisation for Economic Co-operation and Development
PCA	Potchefstroom College of Agriculture
READ	Department of Rural, Environmental and Agricultural Development
RSA	Republic of South Africa
SANBI	South African Biodiversity Institute
SAQ	Sustainability Assessment Questionnaire
SAQA	South African Qualification Authority
SARUA	Southern African Regional Universities Association
SETA	Sector, Education and Training Authority
TAC	Taung Agricultural College
UDA	Union Department of Agriculture
ULSF	University Leaders for a Sustainable Future
USAT	Unit-Based Sustainability Assessment Tool

CHAPTER 1

BACKGROUND TO AND OVERVIEW OF THE STUDY

1.1 INTRODUCTION

This study is embedded in the Agricultural Innovation System of the North West Province, South Africa. Agricultural Innovation Systems have developed as systemic processes of change including the way that the production of knowledge is viewed and supported. These systems are increasingly subject to rapid and unpredictable agro-ecological, institutional, policy and curriculum fluctuation. As the need for responses to the changing climatic and seasonal cycles has become more urgent, the Climate-Smart Agriculture approach has emerged as a climate responsive tool. Climate-Smart Agriculture as a response tool was used in this study of supported curriculum innovation in two Agricultural Colleges within a Provincial Agricultural Innovation System in South Africa.

The current Agricultural National Diploma curricula in the North West Province, South Africa, as a key part of a provincial Agricultural Innovation System, does not adequately include climate responsive topics such as climate change, food security, adaptation, mitigation and resilience. The situation puts the Provincial Agricultural Innovation System that encompasses education practices, farmer training through extension and the system of agriculture productivity, at risk. This study is developed as a supported process of Climate-Smart innovation that examines curriculum and learning system responses to climate change and food insecurity within the Provincial Agricultural Innovation System. The inclusion of Climate-Smart concepts into the agriculture curriculum is a way to prepare future farmers to ensure food security and regional climate responsiveness. Post-schooling education is a critical contributor to this goal as many of the students who graduate from the Agricultural Colleges ultimately work as agriculture extension workers or become farmers themselves (Southern African Regional Universities Association [SARUA], 2014).

The North West Province realised that these issues and challenges of Climate-Smart innovation needed to be addressed to ensure food security, rural development, and sustainable agriculture production within the province. The North West Department of Rural, Environmental and Agricultural Development (READ) stated in its 2014/2015 Annual Report

that Climate-Smart Agricultural systems need to be promoted within the province (Department of Rural, Environmental and Agricultural Development [READ], 2015a). At the beginning of 2015 READ held a meeting where the lack of knowledge relating to climate change within the agricultural sector was discussed (D. Serage, personal communication, 26 May 2015). This meeting made the Director of Structured Agricultural Training and Empowerment of READ realise that to address these challenges, the agriculture curriculum needed to realign and become Climate-Smart and function within the wider Agricultural Innovation System fostering responsive change. The study emerged during a time when the Agricultural Colleges, also known as Agricultural Training Institutes, of the North West Province were striving towards new solutions in response to climate change and inclusion of Climate-Smart Agriculture within the agricultural strategic plan of the province (READ, 2015b). This was to be undertaken through curriculum innovation and alignment of the teaching and learning practices within the wider Agricultural Innovation System. The concern for change and alignment was an opportunity for formative intervention research to support the college staff during the curriculum and learning innovation process.

Chapter One places the two case studies that are the focus of this study as curriculum and learning systems within the provincial and ecological setting embedded in the wider Agricultural Innovation System. The chapter presents an introduction to and an overview of the study. It discusses the goals, the motivation behind the study, its objectives, and the research focus before providing an outline of the chapters of the developing study.

1.2 THE AGRICULTURAL INNOVATION SYSTEM OF NORTH WEST PROVINCE, SOUTH AFRICA

An innovation system is a system structured by the actors involved in the process of innovation. The behaviours, practices and values of these actor are shaped through their engagements and actions within the system's socio-economic environment (Spielman, Ekboir & Davis, 2009). An innovation system is defined by the generating of new knowledge, interactive learning and the sharing of knowledge. Innovation and learning have always been part of agricultural practices. The Agricultural Innovation Systems framework was developed to facilitate these processes, joining various sub-systems within the agricultural sector together as actors participating in the larger organisational learning processes (Spielman et al., 2009). This framework focusses on behaviours and practices that influence institutional innovation (Sumberg, 2005). The theory of innovation systems has received a significant

amount of attention, however the emergence and functioning of innovation systems in the agricultural sector in southern Africa is largely under researched (Spielman et al., 2009; Nordwig, 2015). To understand the challenges and complexities of an innovation system, it is necessary to identify the stakeholders and role players, to understand their interests and interactions and to identify barriers and contradictions in the long-term transitioning process towards a more sustainable agricultural sector and food system (Nordwig, 2015). The research reported in this study draws upon Cultural Historical Activity Theory to support a system analysis and expansive learning innovation process within this study. Figure 1.1 illustrates the Agricultural Innovation System of the North West Province indicating the system drivers, stakeholders and the sub-systems. This study focussed on the curriculum and learning sub-systems.

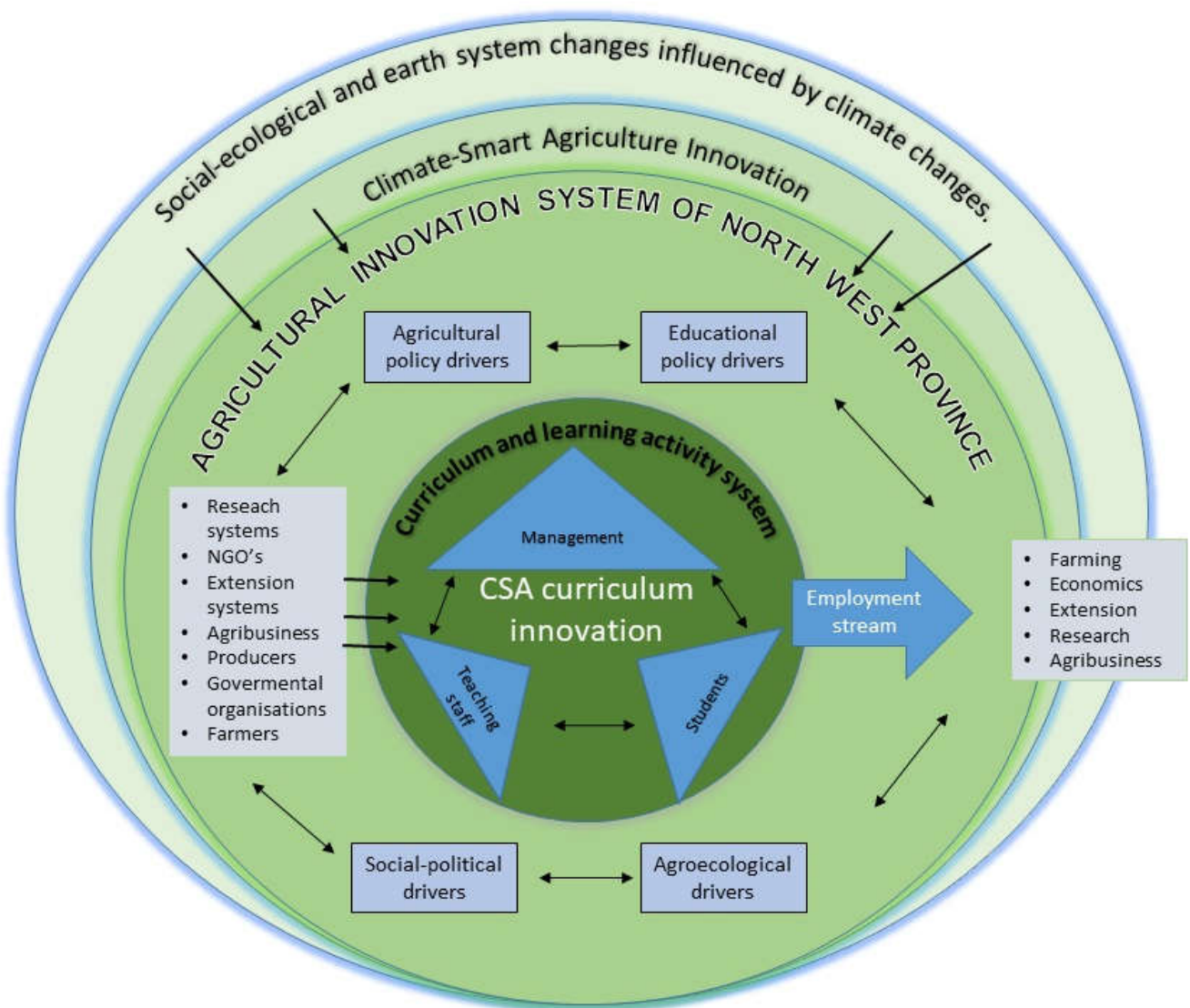


Figure 1.1: The Agricultural Innovation System of the North West Province, South Africa (Adapted for this study from Aerni, Nichterlein, Rudgard & Sannino, 2015, p. 834)

The North West Province covers 118 710 km² (9.7%) of South Africa's surface area (Vershoor, 2005). It has typical warm to hot summers and cool, sunny winters. The average midsummer temperature ranges between minimum of 15°C to maximum of high twenties to low thirties degree Celsius. Frost occurs during winter with below freezing minimum temperatures to maximum temperatures around 20°C. The province has different climatic regions. The eastern part of the province is wetter and suitable for mixed-crop farming. The semi-arid region comprises of the central and western part of the province with lower rainfall. The semi-arid region is suitable for livestock and wildlife farming. Seasonal droughts occur, but agriculture is aided by the many irrigation projects found along the Crocodile, Vaal and Harts River that supports the major production of vegetables and fruits within the province (Department of Agriculture, Forestry & Fisheries [DAFF], 2014).

The province produces 33% of the country's ground nuts, 23% of the maize, 36% of the sunflowers and 13% of the country's dry beans. Many other crops are produced including soy beans, grain sorghum, tobacco, paprika, peppers, cotton and wheat (DAFF, 2014). It has the highest number of poultry boilers (24%) and 17% of the country's pig farms. Other livestock include 13% of the country's cattle and 12% of its goats (DAFF, 2014). This indicates that the North West Province is an agriculturally productive area and plays a key role in establishing national food security. The province's primary agriculture contributes approximately 3% of South Africa's gross domestic product (GDP) and 7% of formal employment (Goldblatt, 2011).

1.2.1 COMPONENTS OF NORTH WEST PROVINCE PROVINCE'S AGRICULTURAL INNOVATION SYSTEM

The Agricultural Innovation System of North West Province comprises the agricultural producers (the farmers) and the extension, education, research and other supporting sub-systems (Aerni, Nichterlein, Rudgard & Sannino, 2015). The various provincial sub-systems include the Agricultural Research Systems such as Agricultural Research Council's Grain Crops Institute in Potchefstroom, curriculum and learning systems such as the two Agricultural Colleges and the two campuses of North West University situated in Potchefstroom and Mahikeng (see Figure 2.1). The province is situated in the north-western part of South Africa bordering Botswana, Limpopo, Gauteng, Free State and Northern Cape (Vershoor, 2005). The sub-farming systems within the Agricultural Innovation System include commercial farmers, organic commercial farmers, small-scale commercial farmers, small-

scale organic farmers, organised agriculture and for this study, the household food production farmers are also included (Nordwig, 2015).

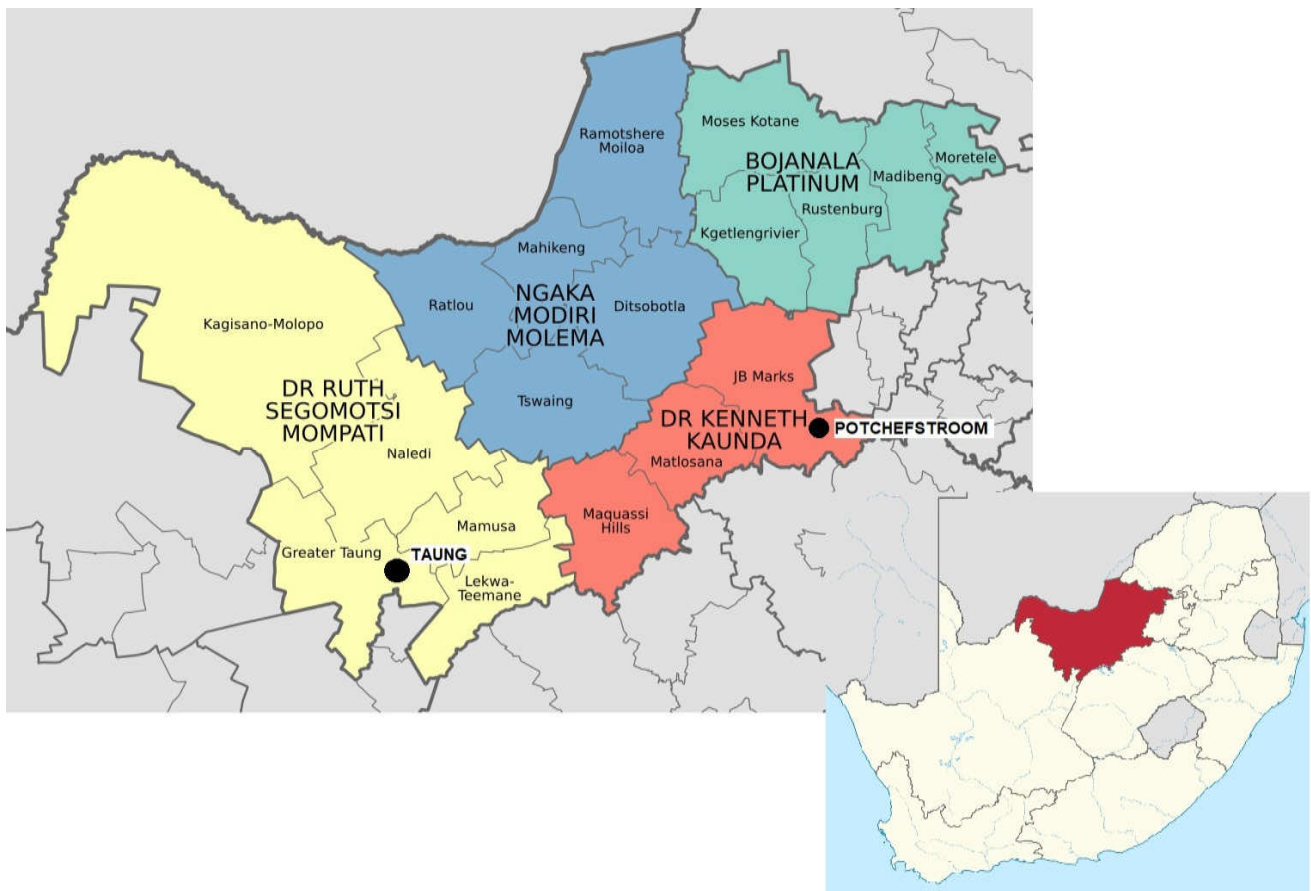


Figure 1.2: A map of the north West Province indicating the municipality districts within the province (https://en.wikipedia.org/wiki/List_of_municipalities_in_the_North_West and [https://en.wikipedia.org/wiki/North_West_\(South_African_province\)](https://en.wikipedia.org/wiki/North_West_(South_African_province)))

1.2.2 INNOVATION DRIVERS OF THE AGRICULTURAL SYSTEM

Political, seasonal and climatic external systems affect the functioning of the Agricultural Innovation System. The system is also driven by agricultural policies, educational policies, agro-ecological drivers, social-political drivers, and the needs of the actors within the system. Figure 1.1 (see above) illustrates the role and interaction between the drivers and other components of the system.

1.2.2.1 SOCIAL AND POLITICAL DRIVERS

The North West Province has undergone many changes in agriculture. The former Bophuthatswana¹ was incorporated into South Africa in 1994 as part of North West Province merging with the former Western Transvaal. Figure 1.3 illustrates the provinces and homelands within South Africa under the apartheid state before 1994. Until the late 20th century, crop farming was the domain of women in the former Bophuthatswana region and men mainly worked with the large animals and hunted. Cattle featured prominently in local culture. They were kept at cattle posts and primarily used for milk and slaughtered for occasions. The men also became migrant mine workers and labourers on white-owned farms within the former Transvaal Province. Even after the formal establishment of Bophuthatswana under the separatist policies of the apartheid state, the tenurial patterns and communal arrangements persisted in many areas. The introduction of commercial agricultural development projects and leasing of land mitigated this arrangement (Acha, 2014). Share cropping became the way to utilise land and small-scale farmer production gave way to a form of commercial agriculture (Stacey et al., 1994 cited in Vershoor, 2005). In 1989 tribal land consisted of 11.2% of the total agricultural land in former Bophuthatswana. The government owned 19.2% of the land, trust land comprised of 63% (2.5 million hectares) and 6.8% (273 000 hectares) was privately owned (Agricor, 1989). In 1976 projects were established within this region aimed at food production. These food production projects involved farmers linked to a co-operative that focused on commercial production with mechanisation and modern cultivation practises. These farmers received financial support, training, technical assistance and management from the South African government, while also receiving access to production inputs and markets (Bembridge, Graven, Hough & van Rooyen, 1982). To assist these farmers, the Taung Irrigation Scheme and the Sheila Dryland Cropping scheme were developed within these projects by the South African government in the 1970s (Acha, 2014).

¹ A former homeland under the apartheid state that was incorporated into the post-apartheid state after 1994 as part of the North West Province.

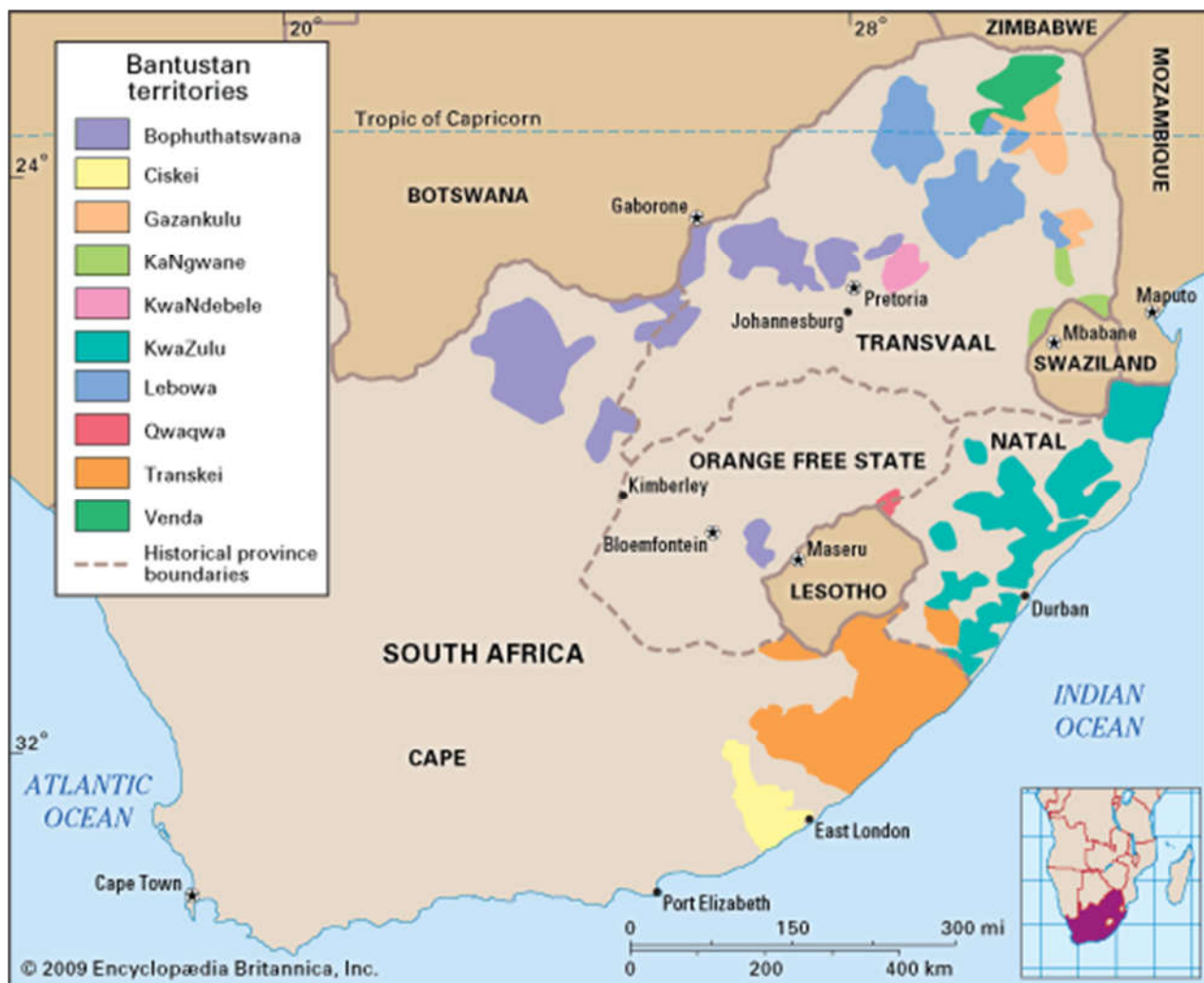


Figure 1.3: Map of the homeland territories within South Africa during the apartheid era. [Available at: <https://southcoastherald.co.za/70623/kzn-scores-low-in-national-assessment/> Accessed 8 January 2018]

1.2.2.2. AGRO-ECOLOGICAL DRIVERS

There are various agro-ecological drivers and innovation challenges that affect the curriculum and learning practices within the system. The North West Province is situated in the Highveld region.² Seasonal and climatic variations are drivers that affect the functioning of the Agricultural Innovation System. Water availability is an important driver of the system as this region has various irrigation projects. More than 10.83 million hectares are cultivated by rain-fed crops within the North West Province.

² The Highveld is the portion of the South African inland plateau which has an altitude above 1500m but below 2100m. It comprises of the Free State, Gauteng and portions of the Eastern Cape, Northern Cape, North West, Limpopo and Mpumalanga Provinces of South Africa (Cowling, Richardson & Pierce, 2004).

The Irrigation scheme is the heart of most agricultural crop activities within the Taung area. Due to climate changes, water quality and quantity has become a serious issue. READ (2015b) acknowledged that climate changes have multiple consequences, but the vulnerability of the North West Province to restricted water availability is a critical consequence. The plans for further expansion of agriculture by developing the irrigation schemes are still being implemented. However, water scarcity can severely constrain these expansions; no additional water will be available for irrigation and this can potentially impact the food security status as the North West's population continues to grow. There are various challenges that the province is facing due to climate changes. The decline of the water quality of the Vaal River that feeds the Vaalharts Irrigation system has been a concern for the last decade. As the salinity of the water that feeds the irrigation system has increased, it has shown that these solvents do not return to the water system but drain into the groundwater system that affects the ground and drinking water's quality of the whole region (Verwey and Vermeulen, 2011).

A pest increase has also become a problem in the last seven years. In 2010 the false armyworm (*Leucania loreyi*) was responsible for the loss of up to 50% of barley harvests in the Vaalharts Irrigation system (Coleman, 2010). However, this pest was brought under control as there were pesticides registered against *Leucania loreyi*. Towards the end of 2016 an outbreak of the Fall Armyworm (*Spodoptera frugiperda*) occurred in the North West. The species prefers maize crops, but once its food sources are depleted the entire army of worms moves to the next available food source. The crisis was intensified by the fact that no pesticides that could kill the Fall Armyworm were registered for use in South Africa. The farmers were almost helpless as this pest originated from North and South America and only in 2016 was the first recorded appearance in mid-Africa. The Fall Armyworm is transported in the irrigation water, thus it is a continuous threat and serious concern to the agricultural production of the area (Goergen, Kumar, Sankung, Togola & Tamo, 2016). Farmers started using bio-pesticides that contain diatom frustules against the Fall armyworm in the Vaalharts Irrigation system in 2017. These agro-ecological concerns are drivers of the Agricultural Innovation System as these are issues that need to be addressed to ensure food security and agricultural production within the system.

1.2.3 THE CURRICULUM AND LEARNING SYSTEMS EMBEDDED WITHIN THE SOUTH AFRICAN AGRICULTURAL INNOVATION SYSTEM

This study focusses on the embedded curriculum and learning sub-systems that play a crucial role in the functioning of the Agricultural Innovation System (see Figure 1.1). The specific inputs, drivers and outputs of the system are discussed in Chapter Four. Rapid changes in contemporary agriculture highlight the urgency for the curriculum and learning systems to instil the knowledge and competencies that can support more effective agricultural innovation (Rajalahti, Janssen & Pehu, 2008).

South Africa originally had twelve Agricultural Colleges (AgriSETA, 2014; DAFF, 2010), however the twelfth college was incorporated into the University of Mpumalanga in 2015 (Department of Higher Education & Training [DHET], 2014). Some Agricultural Colleges have changed to Agricultural Training Institutes as stipulated by Norms and Standards (DoA, 2005a). However, other colleges are either engaged in the transitioning process or no transitioning has taken place. The Agricultural Colleges, also known as Agricultural Training Institutes, are located in six of the nine provinces. These include Potchefstroom and Taung Agricultural Colleges in the North West Province, Cedara and Owen Sithole Colleges in KwaZulu-Natal, Elsenberg (Cape Institute of Agricultural Training) in the Western Cape, Glen College in the Free State, Fort Cox Agricultural Training Institute, Tsolo College, and Grootfontein Agricultural Development Institute in the Eastern Cape and lastly, Madzivhandila and Tompi Seleka Colleges in Limpopo. All the Agricultural Colleges and Training Institutes are managed by the respective Provincial Department of Agriculture, Forestry and Fisheries (DAFF) except for Grootfontein Agricultural Development Institute which is managed directly by DAFF (Lotz-Sisitka, Pesanayi, Lupele, Sisitka, Denison & van Staden, 2016).

These eleven Agricultural Colleges and Training Institutes provide both Higher Education, Further Education and Training qualifications in agriculture (AgriSETA, 2014; DAFF, 2010). The qualifications include national certificates, higher certificates, diplomas and degrees (Cedara and Elsenburg) in a range of disciplinary areas that include animal production, plant production, agribusiness, irrigation, consumer studies and mixed agriculture (AgriSETA, 2014; DAFF, 2010; Potchefstroom College of Agriculture [PCA], 2014; Taung Agricultural College [TAC], 2014a). The Agricultural Colleges and Training Institutes offer a three-year

Diploma in Agriculture at NQF³ level six. Vocational skills training programmes are also offered at these training institutes to the farming community and youth. These qualifications are offered in partnership with the relevant Sector, Education and Training Authorities (SETAs) including Umalusi⁴ or AgriSETA⁵ that accredit these programmes (AgriSETA, 2014; DAFF, 2010; PCA, 2014; TAC, 2014a).

The Agricultural Colleges and Training Institutes' role is to develop educational programmes and curricula that are responsive to the need of socio-economic development by providing the knowledge and skills required to meet the needs of the community, industry and the environment (DAFF, 2008; Department of Agriculture [DoA], 2010). These institutes focus on the practical aspects of curriculum and learning practices. They aim to train agricultural practitioners and academic graduates, to provide skills training to farmers, to provide short practical courses for farmers and their employees and to enhance production in farming practices. While the national qualifications frame all Agricultural College and Training Institute's programmes, they are fundamentally flexible to contextualisation as the institutes orientate their courses towards supporting the agricultural activities practiced in their respective regions (Department of Agriculture and Fisheries [DAF]⁶, 2008; PCA, 2014).

Cedara, Grootfontein, Elsenburg, Glen and Potchefstroom Colleges are the five oldest Agricultural Colleges and are all formerly white Agricultural Colleges established under colonial and apartheid governance regimes (Union Department of Education [UDA], 1915). Before 2005 the South African agriculture curricula were mostly based on teaching commercial agriculture and production as this addressed the needs of the dominant agricultural sector at that time (AgriSETA, 2014; DAF, 2008; DoA, 2005b). The curricula were reconceptualised with the introduction of Agricultural Education and Training Strategy in 2005 to incorporate a stronger transformation focus and to include smallholder farmers, who had largely been excluded from formal agricultural training in the past (DoA, 2005b). Since 2005 there has also been a reorientation towards conservation of natural resources (DoA, 2005b) and in 2014 the AgriSETA noted the need to incorporate sustainability and green economy

³ NQF stands for the National Qualification Framework used to arrange levels of achievement by the South African Qualification Authority. NQF Level 4 is equivalent to a National Certificate. NQF 5 is equivalent to a Higher Certificate. NQF level 6 is equivalent to a Diploma or Advanced Certificate. NQF 7 is equivalent to a Degree or Advanced Diploma.

⁴ Umalusi is the South African Quality Council for General and Further Education and Training.

⁵ Agriculture Sector Education and Training Authority.

⁶ DAF became DAFF when Forestry was added after 2008.

dimensions into the Agricultural Education and Training programme (AgriSETA, 2014). However, the focus of the agriculture curricula was mostly on competence development for conventional methods of agriculture, which exclude an engagement with climate change responsiveness, adaptation and water conservation farming (DAF, 2008; PCA, 2014; TAC, 2014a). After an evaluation of the Agricultural Education and Training curricula of South Africa in 2008 it was recommended that the curricula should be adjusted and upgraded to be more responsive in addressing the critical challenges of the South African agricultural sector (DAF, 2008). Since 2005 there has been an expansion within the agriculture curricula to include these key challenges that also include topics which address climate change responses (DAF, 2008; DAFF, 2010). The departmental policy on Extension and Advisory Services also reported on the importance of alignment of real needs and national priorities while creating linkages within the Agricultural Innovation System (DAFF, 2013a, 2015).

The two case studies that are included in this study are Taung Agricultural College (Case Study One) and Potchefstroom College of Agriculture (Case Study Two) in the North West Province. These colleges are managed by the Department of Rural, Environmental and Agriculture Development of the North West Provincial Government (READ, 2015b). The colleges are responsive to the current needs of the provincial agricultural systems and governmental policies including the Strategic Plan for the North West Province (READ, 2015b). Both curricula are aligned with the specific agricultural region and biomes which they are situated in. During the study, the two case studies are defined as curriculum and learning systems that jointly function within the larger Provincial Agricultural Innovation System (Figure 1.1).

1.2.4 TERTIARY AGRICULTURAL EDUCATION RESPONSIVENESS TO CLIMATE CHANGE WITHIN THE SYSTEM

In theory, education is part of the solution to development challenges such as climate change responsiveness and food security. As mentioned, levels of education and economic development have a strong correlation (Chakeredza, Temu, Sak, Munthali, Muir-Leresche, Akinnifesi & Sileshi, 2008.). The curriculum and learning system is a foundation of society's competencies, knowledge and contributes to an ability of society to cope with future social and environmental challenges. Societal needs and challenges channel directly through our educational system as a process for dealing with expected challenges that might arise. South

Africa's needs and challenges in the agricultural sector ought therefore to be reflected in agricultural curricula (Department of Education [DoE], 2008).

Higher Education Institutes can contribute to knowledge distribution of expected climate change and this can potentially lead to institutional innovation. A climate responsive curriculum can potentially ensure that graduates produced from the agricultural institutes are educated in climate change issues such as mitigation, adaptation strategies, food security and water conservation farming (Chakeredza et al., 2008). The mechanisms of climate change integration into the Agricultural Innovation System and sub-systems are of utmost importance. Yet little is known of how this occurs, hence this study aimed to shed some light on this process and to understand the innovation mechanisms better. The curriculum content, teaching materials and methods of delivery need to be designed so that they strive towards climate responsive objectives. To be able to release agricultural graduates into the system equipped with the necessary knowledge and competencies to tackle challenges related to climate change and apply their knowledge to a local situation systems innovation is crucial. The curriculum content, teaching materials and methods of delivery need to be designed in such a way to achieve this objective (Chakeredza et al., 2008.). However, there are many obstacles and challenges that the tertiary educational system faces and that hinder the innovation of the system to become more responsive to climate change and food insecurity (DAF, 2008; DAFF 2010).

1.3 A CLIMATE-SMART AGRICULTURE APPROACH TO CURRICULUM INNOVATION

Beddington, Asaduzzaman, Fernandez, Clark, Guillou, Jahn & Wakhungu (2011) noted how Agricultural Colleges and Training Institutes are primarily set up to train students and to run extension services within agricultural communities. Their activities thus ought to include adaptation to a changing climate by transitioning to a climate responsive approach. Climate-Smart Agriculture is such an approach that addresses the challenges of food insecurity and climate change within the Agricultural Innovation System and sub-systems. It is a strategy for long term innovation that considers national and local priorities and challenges (Food & Agriculture Organisation [FAO], 2013). Looking at Figure 1.1 the whole North West Province's Agricultural System is undergoing Climate-Smart innovation. The system drivers and responses affect the functioning of the curriculum and learning system. In this context,

Chakeredza, Temu, Yaye, Mukingwa, & Saka (2009) argued that the educational system is the foundation of society's responsive knowledge, competencies and the future ability to cope with social and environmental challenges. The curriculum and learning system thus play a key role in responding to the complex web of issues surrounding climate change responsiveness.

In the North West Province of South Africa, the Department of Agricultural, Forestry and Fisheries (DAFF) developed the Agricultural Education and Training (AET) strategy in 2005. This strategy focuses on the improvement of agricultural production through developing agricultural education and training services to realign with and cater more for current agricultural demands (DAF, 2008). The inclusion of Climate-Smart Agriculture in the agriculture curricula is an important contributing factor to sustainable development of agricultural systems (FAO, 2013). Chakeredza et al. (2008) emphasised that graduates in agriculture should be competent to analyse and solve climate change related problems, to anticipate and prepare for future climatic challenges, as well as to create and seize opportunities to apply their knowledge to a specific individual localised situation. In line with this, Competency-Based Education has emerged in agricultural education in South Africa (AgriSETA, 2014; DoE, 2008; PCA, 2014).

Climate-Smart Agriculture is a responsive concept for strategic implementation. However, the innovation towards a climate responsive orientated agricultural college curriculum is only in the early stages of transitioning towards this goal. None of the Agricultural Colleges or Training Institutes offer a specialised qualification in Climate-Smart Agriculture, or associated comprehensive curriculum, responses to changes in climate or sustainable agriculture (AgriSETA, 2014; DAF, 2008; DAFF, 2010; PCA, 2014; TAC, 2014b). A need for a research-based curriculum that emphasises a systems approach to problem-solving in relation to climate change and food security and its implications to future agriculture in southern African regions has arisen. Seen within this systems perspective, Climate-Smart Agriculture can provide the foundation to develop a review tool for curriculum transitioning to plot the direction for curriculum innovation (seen as part of the wider system of agricultural innovation) within the curriculum and learning systems. This is the focus of this study.

1.4 RESEARCH OBJECTIVES AND RESEARCH QUESTIONS

This study aimed, through a situated analysis and a formative intervention process, to support and review the alignment of the curriculum and learning system with the Agricultural Innovation System's objectives and to identify what drives innovation within these systems towards more Climate-Smart responsiveness (see also Section 1.5 and Chapter Three). The research supported the incorporation of Climate-Smart Agriculture as an innovative response tool in the case studies to address key challenges relating to climate change and food insecurity. The objectives and research question that guided the research²² process are listed in Table 1.1

Table 1.1: The research objectives and research question which inform the four phases of the study

Phase of the study	Objective	Research question
1	To review the current National Diploma of Agriculture curricula in the context of Climate-Smart Agriculture in the two colleges of agriculture in the North West Province	1.1 How are the current National Diploma of Agriculture curricula constituted? 1.2 How can a reflexive tool be developed for review, support and tracking of curriculum innovation towards Climate-Smart responsiveness? 1.3 Are there examples of curriculum innovation tools for sustainability that can be adapted for climate smart responsiveness? If so, how can this be done?
2	To engage college staff involved in the offering of the National Diploma of Agriculture to explore practical options for curriculum innovation within a Provincial Agricultural System undergoing Climate-Smart innovation through an iterative process of expansive learning	2.1 What Climate-Smart Agriculture elements (context, content, competencies, knowledge dynamics) are incorporated into the current National Diploma agricultural curricula content and practices, if any, at the start of the curriculum innovation formative intervention process? 2.2 How can college staff involved in the offering of the National Diploma in Agriculture be engaged through formative intervention explore practical options for curriculum innovation utilising Climate-Smart Agriculture?

Phase of the study	Objective	Research question
3	To work with the outcomes of the curriculum innovation process as mirror data to reflect on the systemic formative intervention to determine the barriers hampering the innovation process towards a Climate-Smart system	3.1. How do the Climate-Smart Agriculture elements change through the process of the curriculum innovation formative intervention? 3.2. Can significant absences within the National Diploma curricula be identified if viewed from a Climate-Smart Agriculture innovation perspective? 3.3. What contradictions are evident and what resolutions of these might inform the National Diploma curricula innovation process? 3.4. Can the outcomes of the curriculum innovation process be used as mirror data to reflect on the systemic formative intervention to determine the barriers hampering innovation towards a Climate-Smart Agriculture system?
4	To determine the use and potential of the Climate-Smart Innovation Tool as a reflexive tool that lecturers can use to support and track the processes of curriculum review and innovation	4.1. Can the Climate-Smart Innovation Tool be used as a reflexive tool to support and track the processes of curriculum review and innovation?
Concluding Research Question		
How can an Agricultural Innovation System functionally foster the necessary knowledge and competencies for transitioning to a climate responsive system of curriculum and learning innovation within a system of flux?		

1.5 OVERVIEW OF THE CONTEXT, METHODOLOGY AND APPROACH TO THE STUDY

This study was centred on some of the complexities of innovation in the Agricultural System in response to climate change in the North West Province of South Africa. It developed within the Amanzi [Water] For Food Project (WRC Project No. K5/2271) supported by the Environmental Learning Research Centre (ELRC) of Rhodes University and the Water Research Commission. The Amanzi For Food Project concentrated on knowledge dissemination of sustainable water use and Food Security through a course activated social learning network approach within the agricultural learning system (Lotz-Sisitka et al., 2016). Amanzi For Food worked closely with smallholder farmers, extension officers, farming communities and Agricultural Colleges and Training Institutes to develop a social learning

network capacity building approach. During the development of the course activated social learning network, each participant focused on their own situation with a change project being developed using Water Research Commission (WRC) materials on Rain Water Harvesting and Conservation as innovation tools for knowledge dissemination on water conservation farming.

The study was divided into four sub-objectives (Section 1.4), namely 1) the development of curriculum innovation tools, 2) system analysis, 3) the iterative process of expansive learning to support and track innovation, and 4) the potential use of the tool as a reflexive double stimulus tool which informed the four phases of this study. The study, as indicated previously, employed a systems approach to track an iterative process of supported innovation two Agricultural Colleges⁷ functioning within the North West Provincial integration of Climate-Smart Agriculture.

Throughout the study, the principles of Climate-Smart Agriculture, as reflected in the emerging provincial policy responses to climate change, were used to guide and to build a picture of the future pathways of innovation towards a Climate-Smart responsive curriculum. However, even though the colleges have broad objectives, this research was confined to the Climate-Smart curriculum and learning innovation within the colleges of the North West Province. The iterative process of supported expansive learning was centred on curriculum and learning innovation and uncovering some of the current challenges in systems innovation.

The methodology that was developed for this study was based on an iterative process of supported innovation using a systems approach. Therefore, the research design had to align with this. Cultural Historical Activity Theory (CHAT) was used to define and analyse the system and innovation processes using an adapted expansive learning process (Engeström, 1987). Expansive learning is an open process and a reflexive design methodology that can also be seen as a type of action (participatory) research. It aims to support collective engagement and learning change in the object of activity. This study, focused on systems innovation from an Agricultural System perspective with the emphasis on Agricultural College

⁷ The Agricultural Colleges within the North West Province have not yet officially transformed to Agricultural Training Institutes at the time this research was conducted and thus these institutes are referred to as Agricultural Colleges.

curriculum innovation. The expansive learning process consisted of several collective learning actions that developed as an expansive cycle of engagement over time (Engeström & Sannino, 2010). As the study developed, it became clearer that a lens to study innovation as transformative change was needed. The study therefore drew upon Margaret Archer's morphogenic approach (Archer, 1995). The theoretical foundation enabled the study to lift out the activity system work while also analysing the agency-led change. The study is divided into four phases and consisted of two research streams (see Chapter Three, Section 3.4.1). Stream One consisted of the development of a reflexive tool that stimulated and supported the innovation process towards a Climate-Smart responsive system. The second stream consisted of the iterative process of innovation workshops to support and track innovation within the system.

The research was based on collaborative work with college staff, mainly lecturers from two colleges in the North West Province (Taung, Case Study One, and Potchefstroom Colleges of Agriculture, Case Study Two) focussing on the core activity of support, innovation tracking and curriculum development. A formative intervention methodology was adapted for this study. This method is useful when an activity system requires transformation and development of the activity, but the subjects within the system are not sure how to proceed (Lemos, Pereiro-Querol & Almeida, 2013). In the case of the North West Province Agricultural Colleges' context, the management of the colleges expressed their uncertainty on how to proceed with climate change response integration in the college curriculum (D. Serage, personal communication, 26 May 2015). To analyse the data, and to progressively develop and focus the study within its formative interventionist case study design, four phases of analysis were used:

Phase One consisted of developing a contextual profile. An ethnographic and historical analysis of the current system were included. During phase one, data were generated through document analysis and interviews. Two consultative workshops were held with workshop participants of both case studies during **Phase Two** of the study. The aim of the consultative workshops was to orientate the research around the central problems and challenges surrounding curriculum alignment with the provincial policies and the integration of Climate-Smart Agriculture within the provincial system. During Phase Two, the concept of a Climate-Smart Innovation Tool that could be used as a reflexive tool to support the college lecturers, was discussed. Phase Two of the study also consisted of the development of the Climate-

Smart Innovation Tool to review the way the Agricultural Colleges respond to climate change and implementation of Climate-Smart responsive policies.

During **Phase Three**, the data derived from the tool were reflected to the workshop participants as mirror data. Through the adapted expansive learning process, the staff in the respective colleges then used the Climate-Smart Innovation Tool to assist in strengthening their understanding of the curriculum as part of the Agricultural Innovation System using Climate-Smart responsive perspective. During Phase Three problematic situations within the agriculture curriculum and learning activity system were surfaced and analysed. The systemic and historical causes of the problems were identified and thereafter, the inner contradictions of the systemic structure of the system and interacting activity systems surfaced. Phase Three consisted of the surfacing of the contradictions within the system and the development of strategies to support innovation within a system of institutional flux. **Phase Four** consisted of examining the proposed innovation barriers and the dynamics, potentials and limitations of these barriers and making recommendations for the way forward. Further details on the methodology are provided in Chapter Three.

1.6 KEY CONCEPTS OF THE STUDY

1.6.1 CLIMATE CHANGE

Climate change can be described as a change of the average weather caused directly or indirectly by human activities combined with natural events that changed the composition of the Earth's atmosphere and which is in addition to natural climate variability observed over decades or longer (Ikehi, Ifeanyieze & Ugwuoke, 2014; Intergovernmental Panel on Climate Change [IPCC], 2014). Climate change causes increases in temperatures, rainfall variation, changes in ocean currents and wind patterns. These environmental changes and the frequency of extreme weather events add to the pressure on the agricultural system. Climate change contributes to resource problems such as water scarcity, pollution and soil degradation that affects food security (Organisation for Economic Co-operation and Development [OECD], 2015; Chakeredza et al., 2008). Increasing water shortages can put strain on agricultural practices thus resulting in society becoming more vulnerable to environmental hazards. SARUA (2014, p. 69) described southern Africa's climate vulnerability as follows:

Globally southern Africa is one of the most vulnerable regions to the impacts of climate change. Current climate variability and vulnerability to extreme events such as floods and droughts is high, and a range of existing stressors, including water availability, land degradation, desertification and loss of biodiversity constrain food security and development.

1.6.2 CLIMATE-SMART AGRICULTURE

The concept potentially offers a way forward for conceptualising how to enhance food security in a rapidly changing environment characterised by increased climate variability and longer-term climate change within a southern African context (FAO, 2013). The approach was designed to identify and operationalise sustainable agricultural development within the explicit parameters of climate change. It promotes strategies to increase food security such as using agricultural resources efficiently by using less water, land and inputs to produce food more sustainably, while increasing the agriculture systems' resilience to change and shock (FAO, 2013). Climate-Smart Agriculture aims to address the main issues concerning food security namely:

- the availability and access to food,
- the utilisation of food for adequate nutrition, and
- the security of food supply.

Climate-Smart Agriculture integrates the economic, social and environmental components of sustainable development by jointly addressing food security and climate challenges through three pillars of sustainable development. The concept is structured under three pillars or three goals:

- sustainably increase agricultural productivity and income,
- adaptation and strengthen resilience to climate change and variability, and
- reduce agriculture's contribution to climate change by reducing greenhouse gas emissions and Carbon storage on farmlands. (FAO, 2013, p. ix).

The Food and Agricultural Organisation (FAO) of the United Nations elaborated further on the three pillars through identifying specific practices that underpin Climate-Smart Agriculture. Some of these practices include agroforestry, an ecosystem approach on fisheries and aquaculture, the restoration and reclaiming of degraded soil, conservation of local biodiversity, improved management of livestock waste and water conservation (FAO, 2013). Climate-Smart Agriculture promotes sustainable farming practices that include mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management,

improved and rotating grazing and enhanced soil and water management. The aim is to use these practices and technologies through a systems approach to increase productivity and food security while increasing resilience and decreasing emission levels within in the Agricultural System (FAO, 2013). Climate-Smart Agriculture is a responsive concept for strategic implementation and is currently used to inform curricula and to enhance the realisation of national food security and development goals. This approach is discussed in detail in Chapter Two.

1.6.3 INNOVATION

Innovation can be defined as the process of forming new knowledge and utilising existing knowledge into a combined knowledge applicable for social and economic use (European Commission & Standing Committee on Agricultural Research [EU SCAR], 2012). Drucker (1998) describes innovation as ‘purposeful focused change’. Innovation is also described as a process that involves the creation of knowledge and the successful application and use of the knowledge while undergoing fundamental change (EU SCAR, 2012). Innovation is also described as “the successful exploitation of creative ideas” (Knickel, Brunori, Rand & Proost, 2009, p.883). Leeuwis (2004) regarded climate change adaptation as a process of innovation. Sustainable systems innovation focuses on sustainability through an analysis of the system and the identification of transformation requirements within the system to create sustainability (Togo, 2009). The system analysis conducted during this study is described in Chapter Four. The identification of the innovation barriers and drivers are discussed in Chapter Seven.

1.6.4 A SYSTEMS PERSPECTIVE INFORMING CURRICULUM INNOVATION RESEARCH

There have been various agriculture systems approaches, including National Agricultural Research System, National Agricultural Extension System, the National Agricultural Education and Training System (Ponniah, Puskur, Worhneh & Hoekstra, 2008). The trend of applying systems approaches continues to evolve towards the inclusion of Agriculture Research and Education Institutes, which are integral to wider Agricultural Innovation Systems as depicted in Figure 1.1. This has resulted in systems frameworks such as Agricultural Knowledge and Innovation Systems, Agriculture Knowledge System, the Technology Development and Transfer System and the Agriculture Innovation System which are inclusive of the above diverse systemic elements (EU SCAR, 2013). Bean and Radford (2002) explained a system as a collection of interacting elements that function together to

achieve a desired outcome. Two key conclusions that emerge from systems thinking are that interrelated parts drive the system and that the feedback loops make the process recursive rather than linear (Bean & Radford, 2002). A systemic model is favourable for research on the design, administration and analysis of a system's innovation capabilities (Ponniah et al., 2008), including those situated within the agricultural curriculum and its actors.

1.6.5 COMPETENCIES

Mulder (2012, p. 3) defined competence as:

A set of integrated capabilities which consist of content-related clusters of knowledge, skills, and attitudes, which are conditional for sustainable effective performance in a certain context.

Applied to Climate-Smart Agriculture, competencies can be described as complexes of knowledge, skills, and attitudes which enable successful task performance and problem solving with respect to real-world Climate-Smart application (Rowe, 2007; FAO, 2013). Defining the key competencies, the challenges and conversion factors that aid in the development of a profile for Climate-Smart Agriculture innovation within the academic field and curricula is an essential step to track innovation of the agriculture curricula. Key competencies support the development of a reference scheme for evaluating the curricula from the viewpoint of knowledge content and flow between the student, educator and other components within the curriculum and learning system (Rowe, 2007; FAO, 2013). SARUA (2014) established a broad framework for curriculum innovation in the context of climate compatible development (see Figure 1.4), which provided useful guidance on how to structure thinking around Climate-Smart Agriculture curriculum innovations. The framework for Climate-Smart curriculum innovation adapted from SARUA (2014, p.190) is illustrated in Figure 3.1.

SARUA (2014) recommended the following, which is relevant to the inclusion of Climate Compatible Development in agricultural curriculum innovation:

- All Climate Compatible Development curriculum needs to be guided by Climate Compatible Development concerns, policy and research. Research-informed curriculum development is therefore recommended.
- Curriculum concerns to include in Climate Compatible Development curriculum innovations across disciplines and levels include new paradigm thinking i.e. systems

thinking, integrative thinking, critical and creative thinking;

- The integration of different types and forms of knowledge relevant to Climate Compatible Development, including giving attention to indigenous knowledge where relevant; core competencies for Climate Compatible Development,
- Values and ethics, including for example inclusivity and democracy; respect for people and all life forms; relational understanding; aesthetic appreciation; equity and social justice; futures oriented; quality of life; care and concern; sustainability.
- New teaching methods and approaches also need to be considered, including service learning and Web2.0 approaches. (SARUA, 2014, p. 191, emphasis original)

SARUA (2014) further recommended processes of staff capacity development for climate change related curriculum innovations, which was also a focus of this study.

1.7 THESIS OUTLINE

CHAPTER 1: BACKGROUND TO AND OVERVIEW OF THE STUDY

This first chapter began by outlining the setting of the study focussing on the South African Agricultural Innovation System in the North West Province. The agriculture and farming practices within the province were discussed to frame the Agricultural System. The chapter went on to discuss the setting of the Agricultural Colleges as curriculum and learning sub-systems within the broader provincial Agricultural Innovation System included as case studies. The chapter also described the motivation behind the study, its objectives and the research focus before providing an orientating summary of the study and an outline of the thesis chapters.

CHAPTER 2: CLIMATE-SMART AGRICULTURE: RESEARCH, PRACTICE, POLICY AND EDUCATION

This chapter examines the effects of climate change and the climate responsive strategies of the North West region. The emergence of Climate-Smart Agriculture within the North West Province as an agricultural strategic response to climate change and food insecurity is examined. Local South African climate response programmes and research are briefly discussed outlining Climate-Smart Agriculture and the possible challenges. In doing so, it examines the emergence of Climate-Smart Agriculture and its relation to the agriculture curriculum and learning system. Insight into the agriculture curriculum and policies also

provide a clearer picture of the articulation between Climate-Smart responsiveness, education and policies.

CHAPTER 3: THEORY AND METHODOLOGY

The third chapter focusses on the theory framing of curriculum and learning within the Agricultural System in the context of innovation. The application of a systems thinking approach is elaborated. Cultural Historical Activity Theory is discussed as a framework for guiding the formative intervention and tracking innovation of the curriculum and learning sub-system towards the development of knowledge and competencies through expansive learning. This is followed by further details of the methodological framework comprising of the research design, the methods of collecting and analysis of data, the engagement process of the researcher and research participants, how the data aided in the development of the Climate-Smart Innovation Tool and finally, the ethical and validity aspects of how these were addressed during the research process.

CHAPTER 4: CONTEXTUAL PROFILE AND PRELIMINARY WORKSHOPS

Chapter Four summarises Phases One and Two of the study. It begins with a brief contextual profile and historical background of each of the case studies. It then continues to discuss the two preliminary consultative workshops and the development of the tool during Phase Two.

CHAPTER 5: INNOVATION TOOL FOR MOBILISING REFLEXIVITY ON CLIMATE-SMART AGRICULTURE WITHIN THE AGRICULTURAL CURRICULUM AND LEARNING ACTIVITY SYSTEM

Chapter five describes the Climate-Smart responsive picture of the two case studies through presenting indicative data of the Innovation Tool reviews which the study participants completed before the first intervention-innovation workshops.

CHAPTER 6: THE ITERATIVE PROCESS OF INNOVATION SUPPORT AND TRACKING IN CASE STUDY ONE

Chapter Six focusses on the intervention-innovation workshops held during Phase Three of the study and the refinement of the Climate-Smart Innovation Tool. The tool was used as a double stimulus to examine the curriculum and learning systems in Case Study One. The

chapter discusses the expansive learning process which led to the identification of contradictions through mirror data. The chapter concludes with a review on the innovation process that emerged through the three expansive learning cycles.

CHAPTER 7: THE ITERATIVE PROCESS OF INNOVATION SUPPORT AND TRACKING IN CASE STUDY TWO

Chapter Seven continues to use the insights derived from the tool-based data generated in Phase Two as mirror data in the subsequent intervention-innovation workshops held at Case Study Two. This chapter is an account of the three intervention-innovation workshops held as part of Case Study Two. It outlines the support and tracking of innovation within the system during the processes of expansive cycles. An in-depth look into the system allowed the research participants to develop a picture of the innovation challenges that were being encountered during the transitioning towards Climate-Smart responsiveness. Chapter Seven continues to explore the agricultural curriculum and learning activity system by focussing on the surfacing of contradictions. The evident contradictions were identified and solutions to these contradictions that might inform the curriculum innovation process were discussed during the intervention-innovation workshops.

CHAPTER 8: TOOLS, TIME AND LEARNING WITHIN A STATE OF INSTITUTIONAL FLUX

Chapter Eight discusses the innovations within the system and the institutional flux experienced. The significant processes associated with the development of the abstract Climate-Smart Agriculture concept into a concrete curriculum incorporated approach and the double stimulation tools developed during this study that assisted in the micro-level innovation of the curriculum and learning system are also discussed. The barriers and processes hampering the curriculum and learning innovation within the Agricultural Innovation System towards Climate-Smart responsiveness are reported on. innovations within the two separate streams of research are considered and micro and macro innovations are analysed. Chapter Eight continues to report on the iterative process of innovation and the role of expansive learning during this process within a system of flux. The study indicated that the catalysing of curriculum and learning systems require specific tools, time and the understanding of the importance of micro-level innovation. The study concludes with recommendations. It reports on how to better support the Climate-Smart innovation process

within the curriculum and learning system and more broadly within components of the Agricultural Innovation System during a time of flux supported by reflexive tools.

1.8 CONTRIBUTION OF THE STUDY TO NEW KNOWLEDGE

An understanding of the innovation processes of the Agricultural Innovation System is crucial for transitioning towards a Climate-Smart system. The ability to steer innovation towards better alignment with the needs of the agricultural sector and climate responsiveness might be better realised once barriers of innovation are identified and addressed. Through an iterative process of innovation support and tracking in this study (See Chapters Four to Seven) these associated innovation challenges could be identified. The findings and recommendations of this study may inform the actors within the system how to better support the Climate-Smart innovation process so that reflexive change can be more effective. Such functioning of an innovation system can then promote the ability to adapt to climate change and potentially contribute to climate resilient development in future. The study focused on the challenges that influenced innovation within the existing curricula to initiate and improve the climate response approach in agricultural teaching and learning practices.

1.9 CONCLUSION

In Chapter One the setting, background and overview of the research context and process were discussed. The importance of the study, the research questions and objectives were outlined. The chapter also clarified concepts and key terms, before providing a summary of the remaining chapters. Chapter One was concerned with the setting which the case studies are situated in. The next chapter focusses on developing a deeper understanding of Climate-Smart Agriculture. Chapter Two also discusses the environmental and educational policies that presently drive innovation within the Agricultural System.

CHAPTER 2

CLIMATE-SMART AGRICULTURE: RESEARCH, PRACTICE, POLICY AND EDUCATION

2.1 INTRODUCTION

Climate change and food insecurity is an international concern that has emerged on regional and provincial levels. In Chapter One the engagement with agricultural colleges to support curriculum and learning innovation towards Climate-Smart responsiveness was introduced. Chapter Two begins to examine the climate responsive strategies in the region and the emergence of Climate-Smart Agriculture within the system. The chapter then discusses the agricultural strategic responses to climate change, food insecurity and rural development within the North West Province, South Africa. The essence of Climate-Smart Agriculture is outlined and the local South African Climate-Smart Innovation programmes and research are briefly discussed with possible challenges experienced. In doing so the emergence of Climate-Smart Agriculture is examined with its relation to the agriculture curricula and how it became a conversation within the colleges. An agriculture curricula and policies review provides a clear picture of the articulation between climate responsiveness, education and policy.

Chapter Two describes the climate responsiveness of South Africa and the agriculture curricula, while also discussing the historical outline of the policies and agricultural systems. It provides a clear picture of the Climate-Smart Agriculture approach as an innovation driver for the Agricultural System. Figure 2.1 outlines the topics of discussion within each section of the chapter within the context of Climate-Smart Agriculture innovation at policy level within the Agricultural Innovation System (see Figure 1.1).

seasonal climatic conditions during 2015 that affected the province's summer grain production and general water availability (Bureau for Food and Agricultural Policy [BFAP], 2015). The province's agricultural and farming systems' vulnerability to climate change depend on the systems level of response, adaptive and resilience capacity. The Long-Term Adaptation Scenarios (LTAS) projects estimated a temperature increase of 2.5°C by 2035 in the province (DEA, 2013). A climate vulnerability assessment of the North West revealed that the high-risk sectors affected by climate change are the agricultural systems, ecosystem and rural livelihoods (DEA, 2015). The mining sector is also affected indirectly (READ, 2015c). This climate vulnerability is of great concern as the North West's agricultural practices are known to be highly sensitive to rainfall changes. Maize production and cattle ranging are affected and can in turn affect the food security (Blignaut, Ueckermann & Aronson, 2009). A decrease in agricultural revenue is expected with rainfall decreases (Benhin & Hassan, 2006). Smallholder farmers' crop success can also be affected and this in turn affects the rural livelihoods based on crop production and livestock.

As efforts to understand the nature and extent of the current and future impacts of climate change response strategies were developed. Climate-Smart Agriculture was identified and integrated by the North West Province as a climate responsive strategy (DAFF, 2013b; READ, 2015b). The implementation of a climate responsive strategy is of utmost importance as a Bureau for Food and Agricultural Policy case study confirmed. The study reported that 55% of the commercial farmers in North West's farming input cost consisted of fuel and fertiliser. When seeds were added, this increased to 69% (BFAP, 2015). The implementation of Climate-Smart Agriculture could lessen the input cost: using alternative fuel, natural fertilisation and seed saving techniques would decrease costs for the farmers of the North West Province. Another reason for the implementation of Climate-Smart Agriculture practices within the provincial system is water scarcity and quality deterioration. Thirty-four percent of the provincial agricultural land is potentially arable and currently approximately 4% of the arable land is under irrigation within the commercial and developing agricultural systems (READ, 2015b).

The Strategic Plan of the North West Province focuses on protecting water resources and maintaining water resources with close monitoring. However, the province is also developing new irrigation projects and other agriculture facilities that require a tremendous amount of water such as the abattoir and feedlot facilities at Mahikeng. The current irrigation projects in

progress within the province include Taung Irrigation Scheme (expansion), Molatedi Irrigation Scheme (resuscitation), Disaneng Irrigation Scheme (resuscitation) and Tsholofelo Irrigation Scheme (resuscitation). The plan is that 552 additional hectares' irrigation infrastructure will be developed and used by smallholder producers in the province by 2019/2020. This is in contradiction with the acknowledgement of the water crisis and climate change adaptation issues also addressed in the Strategic Policy (READ, 2015b).

These strategic policy plans for more land to be irrigated will boost the agricultural production and food security, but this is not a long-term solution as water scarcity is the North West's main climate vulnerability. The continued pressure on the Agricultural System to increase output per unit of land amidst climate change poses a challenge. Innovation towards responses to climate change requires the involvement of all actors including the agriculture curriculum and learning system to be able to stabilise the province's vulnerability to climate change (FAO, 2013).

2.3 CLIMATE-SMART AGRICULTURE

The challenges of food security and climate change are intertwined within the agricultural system. About 20% of South African households have inadequate or severely inadequate access to sufficient food (Du Toit, Ramonyai, Lube & Ntushelo, 2011). This situation becomes more critical as an international population increase of approximately 33% is expected to occur before 2050. These additional two billion people will mostly be living in the third world regions (FAO, 2013).

Climate-Smart Agriculture is a holistic concept that seeks to unite numerous issues concerned and related to the development of agricultural food systems efficiency and resilience to climate change (FAO, 2013). The concept is defined in Section 1.6.2. It is an international concept developed by the Food and Agriculture Organisation of the United Nations (FAO) in response to a growing need for a clear and coherent approach to manage agriculture and food systems alongside climate change in a local, national and international context. It forms part of a wider discourse of climate resilient development put forward by the Intergovernmental Panel on Climate Change (IPCC) that includes, but is not reducible to, sustainable development (SARUA, 2014).

During the global conference on Food Security and Climate Change at The Hague, Netherlands in 2010, the Food and Agricultural Organisation of the United Nations proposed for the first time the concept of Climate-Smart Agriculture. The publication *Climate-Smart Agriculture: Policies, Practices and Financing of Food Security, Adaptation and Mitigation* was prepared for this conference (FAO, 2010). A Global Science Conference on Climate-Smart Agriculture was held in 2011 organised by Wageningen University and Research Centre and Netherlands Ministry of Economic Affairs, Agriculture and Innovation and the World Bank (Synnevag & Lambrou, 2012). In 2013 the *Climate-Smart Agriculture Sourcebook* was published (FAO, 2013). This approach is backed worldwide by scientists, agricultural experts, policy makers and other stakeholders in the agricultural sector as a strategy to establish food security through sustainable agriculture and climate responsive actions for the international agricultural sector (FAO, 2010; FAO, 2013; World Bank, 2014; Food, Agriculture and Natural Resources Policy Analysis Network [FANRPAN], 2012).

2.3.1 CLIMATE-SMART AGRICULTURE IN SOUTH AFRICA

The future of South Africa's food security, poverty reduction, employment and overall socio-economic upliftment lies in the agriculture sector's ability to respond and adapt to climatic and seasonal variations (IPCC, 2007). Farmers, especially smallholder farmers, are facing many challenges due to the variations in the weather system. Land degradation, soil erosion, declining of water quality and water shortages are the main threats to food security (Goldblatt, 2011). Climate-Smart Agriculture practices can assist the improvement of soil quality, the use of indigenous knowledge, rain water harvesting and conservation to develop sustainable practices within Agricultural Innovation System. Smallholder farmers and farming communities can benefit greatly.

2.3.1.1 CLIMATE-SMART AGRICULTURE AWARENESS

International institutes and organisations including World Bank, the New Partnership for Africa's Development (NEPAD) and the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) have prompted this approach within African countries including South Africa (Nciizah & Wakindiki, 2015; Mnkeni & Mutengwa, 2014). To tackle the current food security and climate change challenges, the South African Agricultural System has been orientating itself towards Climate-Smart innovation. The approach is promoted on a national level by the Agricultural Research Council (ARC), Department of Agriculture,

Forestry and Fisheries (DAFF), the Department of Rural Development and Land Reform (DRDLR) and non-governmental organisations. It is promoted on a provincial level by READ within the North West Province (READ, 2015b).

Since its introduction, many initiatives including Climate-Smart related conferences, projects and programmes have been hosted in South Africa. In 2013 the third Global Conference on *Agriculture, Food and Nutrition Security and Climate Change* was hosted by the Governments of South Africa and The Netherlands in partnership with the Food and Agricultural Organisation of the United Nations and the World Bank in Johannesburg. One of the main topics of discussion was “Understanding the link between agriculture-related investments, policies and measures with Climate-Smart Agriculture” (AFC Conference, 2013). The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) hosted a Climate-Smart Agriculture conference in Boksburg, South Africa during 2016. Attendees included National Agricultural Marketing Council, the FANRPAN Regional Secretariat and the Centre for Coordination of Agricultural Research and Development for Southern Africa. The aim of the conference was to contribute and share information on the best Climate-Smart practices to adopt to develop climate resilient practices and innovation among the agriculture extension team and other stakeholders within the region (FANRPAN, 2016). The fourth Global Science Conference were held November 2017 in Johannesburg. The conference theme was “Catalysing local innovations and action to accelerate scaling up of Climate-Smart Agriculture” (New Partnership for Africa’s Development [NEPAD], 2017).

2.3.1.2 CLIMATE-SMART AGRICULTURE RESEARCH AND OUTREACH PROGRAMMES

Various Climate-Smart discipline-based research programmes and projects are currently running in South Africa. The FANRPAN programme focused on conducting an analysis of the policies, programmes and institutional implementation within South Africa. Mnkeni and Mutengwa (2014) published a comprehensive scope of these policies within South Africa. FANRPAN’s Climate-Smart Agriculture programme’s main objectives are policy orientated, but the programme also aims to improve and support integrated water management and the uptake of Climate-Smart practices as the best practice in Africa (Mnkeni & Mutengwa, 2014).

The New Partnership for Africa’s Development equipped 300 agriculture extension agents in KwaZulu-Natal and the Free State Province with skills for training farmers in the application

of weather, climate and agro-meteorological information as part of a Climate-Smart Agriculture project. After the initial training, identified adaptive measures to climate change were used to train 400 farmers in water harvesting, land use planning, change in farming systems, crop breeding, improved climate forecasting and information and improved insurance schemes. The Agriculture Research Council's commitment to Climate-Smart Agriculture is noted through their research focus on Climate-Smart and sustainable agriculture for South. The Agriculture Research Council and Grain Crop Institute has several projects investigating aspects such as insect and weed dynamics within a Conservation Agriculture System and the effects of these practices on crop yield (Agricultural Research Council [ARC], 2016). The South African Biodiversity Institute (SANBI) has also implemented a project *Building resilience in the greater uMngeni catchment* in 2015. The project aimed to increase resilience of vulnerable communities by implementing Climate-Smart Agriculture strategies, early warning systems and climate proofing settlements, through interventions. (SANBI, 2014).

Within the North West, a Maize Trust funded research project under the banner of Grain South Africa investigated commercial Conservation Agriculture practices under semi-arid, sandy soil conditions (Mnkeni & Mutengwa, 2014). The same project is also running in KwaZulu-Natal and the Eastern Cape where the project focus shifted to the challenges facing smallholder farmers in the adoption of Conservation Agriculture. These Conservation Agriculture projects, run by the Grain SA and Maize Trust's new strategy on Conservation Agriculture, follow a strictly on-farm, farmer-led approach, whereby farmers conduct their own experiments, which are properly designed and well supported by researchers, input suppliers and manufacturers. These projects are aligned with Climate-Smart Agriculture. The objectives of the projects include to empower farmers and create awareness of sustainable farming practices that all farmers can benefit from (Mnkeni & Mutengwa, 2014). The African Conservation Trust also promotes Conservation Agriculture in the smallholder farming sector in South Africa (Nciizah & Wakindiki 2015). This programme trained and implemented ecological micro-farms at 40 schools and 250 individual gardens which produce fresh vegetables and fruit for 27 000 people (ACT, 2013 cited in Nciizah & Wakindiki, 2015). The African Conservation Trust focusses on replanting indigenous forest and assisting communities to harvest rainwater for homestead gardens and reducing erosion.

2.3.1.3 CLIMATE-SMART AGRICULTURE RESEARCH

South Africa's Climate-Smart Agriculture research covers social case studies that study the social aspects including food security, agriculture communities and job creation, scientific research such as crop resilience to early climate warning systems and policy-oriented research. Climate-Smart Agriculture research in South Africa covers not only the social aspects of climate change including case study, training programmes and food security programmes. It also covers scientific research relating to crop resilience and production and livestock resilience to early climate warning system developments. This is aligned with the Climate-Smart systems approach. There are also specific scoping studies for the review and assessment of policies and policy implementation within South Africa (Mnkeni & Mutengwa, 2014).

2.3.2 CLIMATE-SMART AGRICULTURE POLICIES IN SOUTH AFRICA

South Africa recognises the challenges of climate change and food insecurity and is actively involved in responding to climate change challenges on a governmental, educational and community level (DEA, 2011). South Africa has responded by developing the South African National Climate Change Response White Paper (NCCRP) (Republic of South Africa [RSA], 2011). The Long-term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa developed a national and sub-national adaptation scenario for South Africa to inform key decisions to build South Africa's climate resilience (DEA, 2013). The Programme (LTAS) identified important adaptation interventions for the agriculture sector. These adaptation interventions include:

- Sustainable use and management of water resources (DEA, 2013, p. 43),
- Maintenance and climate-resilient restoration of ecosystem services (DEA, 2013, p. 41),
- Sustainable farming systems including integrated crop and livestock management (DEA, 2013, p. 45),
- Community-based forestry and diversification of livelihood skills (DEA, 2013),
- Climate resilient forestry options (DEA, 2013, p. 48),
- Climate advisory services and early warning systems for extreme weather events (DEA, 2013, p. 50),
- Fire mitigation including burning fire breaks and reactive firefighting (DEA, 2013, p. 48),

- *Climate change integrated into agricultural curriculum* (DEA, 2013, p. 48),
- Integrated water use planning (DEA, 2013, p. 44),
- Integrated, simplified and unambiguous policy and effective governance systems (DEA, 2013, p. 51),
- Sustainable urban expansion including, where possible, ecosystem-based solutions (DEA, 2013, p. 51), and
- Awareness, knowledge and communication on climate change and adaptation (DEA, 2013, p. 52).

The Long Term Adaptation Scenario recommends the integration of climate change into the agricultural curriculum and it suggests research on improved education and awareness programmes in rural areas (DEA, 2013). Currently South Africa is struggling to implement the Climate-Smart Agriculture approach through policy as well as practice. Challenges that effects the implementation were identified by Mnkeni and Mutengwa (2014) through interviews with various stakeholders in South Africa. These challenges included:

- Shortage of arable land and infrastructure,
- *Lack of education in Climate-Smart Agriculture*,
- Lack of involvement and commitment by leaders in the community, and
- Limited research and case studies on the implementation of Climate-Smart Agriculture in South Africa.

(Mnkeni & Mutengwa, 2014)

Most of the provinces, including North West, are involved in projects and activities that are aligned with the principles of Climate-Smart Agriculture (Mnkeni & Mytenqwa, 2014; READ, 2015b; DAFF, 2015a). These projects include research, outreach and capacity building programmes. Many of these projects are in cooperation with the Agriculture Research Council, DAFF and universities (Mnkeni & Mutengwa, 2014; Lotz-Sisitka et al., 2016).

2.3.3 CRITICAL REVIEW OF CLIMATE-SMART AGRICULTURE APPROACH

Climate-Smart Agriculture is criticised by many sceptic Civil Society Organisations such as Biowatch. Mainly these organisations are concerned about the framing of the approach in South Africa. Biowatch stated that the approach is framed in too general and wide terms that can accommodate almost any “new” technology and institutional structure, thus leaving the

door open for misinterpretation. This misinterpretation can lead to organisations adjusting this approach for industrial and personal gain instead of Climate-Smart responsiveness (Biowatch, 2015). This organisation is also concerned that the current climate change crisis can be used by profit making opportunistic companies who use 'loop-holes' to create a new commercial marketplace. Biowatch also questioned the priorities of Climate-Smart Agriculture and if it is actually climate change responsive as the approach prioritises sustainable productivity through intensification over mitigation (FAO, 2013; Biowatch, 2015).

Many websites also list their concerns. The *Climate-Smart Agriculture concerns* website supported by Action Aid International (<http://www.climatesmartagconcerns.info/>) has warned against this approach and expressed their concerns about the influence and agenda of the approach.

The Global Alliance for Climate-Smart Agriculture's website urges the decision-makers to reject the "dangerous rhetoric of Climate-Smart Agriculture" as a politically-motivated term that has no criteria that defines what is and what isn't 'Climate-Smart'. The website also raises concerns that many agribusiness corporations, not named on the website, promote synthetic fertilisers, industrial meat production and large-scale industrial agriculture and call themselves "Climate Smart". The website raised similar concerns to Biowatch relating to the framing of the approach within a commercial framework. The website also mentioned the fact that the approach does not question the basic structural imbalances and development paradigm that created these challenges relating to climate change. It noted that there is a lack of definitions, criteria, standards, safeguards or exclusions. Concern is expressed as the Global Alliance for Climate-Smart Agriculture is not accountable to the United Nations that drives the international food security, climate or agriculture agenda (Action Aid International, 2017; FAO, 2013).

2.3.4 CLIMATE-SMART AGRICULTURE POLICIES DRIVING INNOVATION WITHIN THE AGRICULTURAL SYSTEM

Climate-Smart Agriculture is an approach initiated as a response to the climate change effects on a national and provincial policy level in South Africa. Even though the problem has been prioritised, policies, institutional arrangements and funding channels for climate change, food security and sustainable rural development are generally poorly coordinated (Mnkeni &

Mutengwa, 2014, p. 4). The North West's climate response strategy has adopted Climate-Smart Agriculture approach as a response to the effects of climate change on the agriculture system including the agricultural educational system (READ, 2013). There are various stakeholders associated with this approach within South Africa. These stakeholders consist of the National Committee on Climate Change and the Intergovernmental Committee on Climate Change that is chaired by the Department of Environmental Affairs. DAFF is actively part of both committees (Mnkeni & Mutengwa, 2014, p. 27). South Africa's climate change responses are articulated in the form of a National Climate Change Response Policy - White Paper (NCCRP) published in 2011 (DEA, 2011). The National Climate Change Response Policy - White Paper describes various climate change response strategies including:

...financing models to promote the development of Climate-Smart Agriculture that lowers agricultural emissions, is transitioning towards a low carbon sector, is more resilient to climate change, and boost agriculture production. (DEA, 2011, p. 19).

The published Gazette Notice 7 of 2013 entitled *Climate Change response plan for Agriculture, Forestry and Fishery* includes Climate-Smart Agriculture as a strategic approach for the agriculture sector plan and promotes its development and implementation.

The basic approach of the sector plan is Climate-Smart Agriculture, which entails the integration of land suitability, land use planning, agriculture, forestry and fisheries to ensure that synergies are properly captured and that these synergies will enhance resilience, adaptive capacity and mitigation potential. (DAFF, 2013c, p. 6)

The Climate-Smart Agriculture Policy Framework in South Africa falls under the National Climate Change Response Paper and the Climate Change Sector Plan for Agriculture, Forestry and Fisheries. The South African National Climate Change Response Policy - White Paper describes climate response strategies for different sectors of the South African economy including the agriculture sector (RSA, 2011). The South African National Climate Change Response Policy - White Paper reports on the need for integration of climate change responses into the agricultural curriculum and Climate-Smart related research projects. According to Mnkeni and Mutengwa (2014), the specific institutional arrangements for the approach is expected to be put in place when a Climate-Smart Agriculture policy for South Africa is formulated.

The National Sector plan covers the national policy on food and nutrition security developed by Department of Social Development and the Department of Agriculture, Forestry and

Fisheries. It outlines strategies and focus on the improvement food security. The policy is based on seven key pillars (DAFF, 2013c) summarised below as goals.

- Improvement in the availability of nutritional safety nets, developing feeding programmes as well as providing emergency food relief;
- Broadening and strengthening nutrition education;
- Articulating the local economic developing needs between the needs focusing on rural development and agricultural investment;
- Providing provision and subsidisation of agricultural inputs and services while developing better food storage and distribution networks around the country;
- Improving the participation of emerging farmers by implementation of a government food purchase programme where the agro-processing industries use smallholder farmers as suppliers;
- Protect agricultural land from development by mining, game farming and property development that can have a negative impact on food production; and
- Expanding research and technology to understand food production vulnerabilities related to climate change and bioenergy demands. (DAFF, 2013c)

Climate-Smart Agriculture is also included in DAFF's 2015/2016 to 2019/20 National Strategic Plan (DAFF, 2015a, p.12), as cited below:

the key is to promote a shift from conventional agriculture to "Climate-Smart Agriculture" such as Conservation Agriculture. Whereas Climate-Smart Agriculture has long been argued on grounds of environmental sustainability and reducing production risk, another advantage is that is can achieve the same or greater productivity, but with greatly reduced production inputs.

Various other policies and strategies, not mentioned above, related to climate change responses remain influential drivers of the system and framing of the agriculture curriculum (Mnkeni & Mutengwa, 2014). Here follows a summative list of some of these influential policies:

- White Paper on Agriculture (DoA, 1995, p. 5)
The mission of this policy was to ensure equitable access to agriculture and promote the contribution of agriculture to all communities, society at large and national economy in order to enhance income, food security, employment and quality of life in a sustainable manner.
- Agricultural Policy of South Africa (National Department of Agriculture [NDA], 1998a)

This policy's objective is “economic growth reducing income inequalities especially along racial lines eliminating poverty”. The strategic objectives of this policy include components that focus on enhancing food security in rural households through agricultural development support to small-scale and medium-scale farmers. The policy also facilitates the contribution of agriculture to the national economic development as part of the Rural Development Programme and Growth, Employment, and Redistribution plan.

- The Comprehensive Rural Development Programme framework (RDLR, 2009)
This programme focusses on successful land reform, employment creation and environmental safeguards (Mnkeni & Mutengwa, 2014, p.17).
- Policy on Agriculture and Sustainable Development (NDA, 1998b).
This policy focusses on the alignment of the three pillars of sustainable development namely social, environment and economic with the aim to ensure responsible economic development for future generations. The policy has identified tools that the agricultural sector can utilise to achieve sustainable development. These tools include agrarian reform, participation, income diversification, land conservation and improved management of inputs.
- National Agriculture Research and Development Strategy (DoA, 2008).
This research strategy guides and direct the adaptation and application of knowledge and the innovation towards sustainable agriculture that can benefit the community. It aims to improve agricultural research to attain economic growth through sustainable agricultural productivity, sustained competitiveness to ensure food security and eradication of poverty in South Africa. This strategy is implemented through universities and other research institutes such as the Agricultural Research Council (ARC), Water Research Commission (WRC), Council of Scientific and Industrial Research (CSIR) and the National Research Foundation (NRF).

2.3.5 POLICIES AND STRATEGIES RELATED TO CLIMATE CHANGE AND CLIMATE-SMART AGRICULTURE WITHIN THE NORTH WEST, SOUTH AFRICA

The Climate Change and Disaster Management Department within DAFF aims to facilitate risk and disaster management in agriculture. It functions to implement climate change programmes in support of risk and disaster management as well as to ensure compliance to the National Climate Change Response Strategy – White Paper. The Department of Rural,

Environment and Agricultural Development's (READ) position on climate change towards the adaptation and resilience of the North West's Agriculture sector has described the challenge as follows:

The challenge for the province is then the one of preparing the impact of climate change and developing and implementing interventions that will mitigate the impact of climate change rather than climate change itself. (READ, 2015b, p.17)

READ's slogan is "Together moving the North West Province forward" and its mission is to "work together with partners to provide sustainable agricultural, environmental management and comprehensive integrated rural development" (READ, 2015b, p. 3). READ has various legislative mandates that reflect the national legislation required to be implemented that reflects the province's climate response position (READ, 2015b, p. 11). A few of these Acts are listed below

- Atmospheric Pollution Prevention Act, No. 45 of 1965
- Conservation of Agricultural Resources Act, No. 43 of 1983
- Environment Conservation Amendment Act, No. 50 of 2003 as amended
- National Environmental Management Act, No.107 of 1998
- National Environmental Management Air Quality Act, No. 39 of 2004
- National Environmental Management Biodiversity Act, No. 10 of 2004
- National Forests Act, (No. 84 Of 1998)
- National Water Act (No. 36 of 1998)

Policy mandates to be implemented by the North West Province and READ department are listed in the North West Provincial Government Strategic Plan 2015-2020 (READ, 2015b, p.13). The North West Province is also obliged to comply with the international environmental treaties that South Africa has signed in the past (READ, 2015b). In compliance with the above mentioned constitutional and policy mandates READ has developed a Strategic Plan for 2015 to 2020 that supports the National Development Plan (NDP). READ's Strategic Plan aims to incorporate the National Development Plan vision of "spatially, socially and economically well integrated rural areas as well as environmental sustainability and resilience" (READ, 2015b, p. 3). During the development of the Strategic Plan, twelve policies were identified and became the focus of the Provincial Strategic Plan related to climate change and agriculture. These policy imperatives focused on agricultural transformation by sustainable agriculture, developing smallholder farmers, improving food security, education, implementing climate change adaptations and mitigations (READ, 2015b, p. 2).

These policies' imperatives were developed to align priorities of Environmental Management Frameworks for Districts and Local Municipalities, Climate Change Response Strategy for the North West Province and the Environmental Implementation Plan (3rd Edition), 2014-2019 between READ, the Traditional Authorities Development of the Provincial Integrated Development Plans (Programme of Action) with the Department of Rural Development and Land Reform, DAFF, District Municipalities and other provincial sector partners (READ, 2015b). The following projects that contribute to the development of the North West Agricultural Strategic Goals were implemented:

- Crop Massification Programme including Tshimo Ya Kgosi Programme (Also contradicting as it focusses on GMO seed distribution),
- Taung Irrigation Scheme (expansion),
- Molatedi Irrigation Scheme (resuscitation),
- Disaneng Irrigation Scheme (resuscitation),
- Tsholofelo Irrigation Scheme (resuscitation),
- Livestock breeding material,
- Animal feed manufacturing plant in Taung,
- Feedlot in Mahikeng,
- Meat processing plant including abattoir and packaging facilities in Mahikeng,
- Rehabilitation of Springbokpan, Vryhof and Kraaipan grain silo,
- Establishment of Grain milling,
- Taung Skull World Heritage Site, and
- Mahikeng Buy-Back centre to recycle waste (READ, 2015b, p. 53).

In the Strategic Plan for 2015-2020 the North West acknowledged the challenges that the province faces in the shadow of climate change. READ specified that the biggest challenge for the province was to prepare for the impact of climate change and to develop and implement interventions that would mitigate its impacts in the agricultural sector. The Strategic Plan emphasised the importance of mitigating greenhouse gas emissions, but also stressed the need to accept and prepare for the indefinable climate change occurrence. The policy imperatives that articulate with Climate-Smart Agriculture focus on food security, small holder development and climate change adaptation and mitigation (READ, 2015b).

2.3.6 CLIMATE-SMART AGRICULTURE IN AGRICULTURE EDUCATION

South Africa faces many challenges to align the agriculture curriculum and learning practices with Climate-Smart responsiveness. In general, the current agriculture National Diploma curricula do not formally address issues of climate change, adaptation, mitigation and climate

responsiveness adequately. This leaves the country's agricultural education, extension training and agriculture productivity at risk. The Agricultural College and Training Institute graduates entering the agricultural sector lack climate responsive knowledge and competencies to respond to climate challenges by implementing practices and strategies that will ensure future food security and climate resilience. The Department of Environmental Affairs (2013) noted the significance of agricultural education and extension activities as important focus points for future research into climate change responsiveness in the agricultural sector in South Africa. Transitioning towards a Climate-Smart responsive curriculum will increase the quality delivery of training that prepare graduates to deal with climate change. In this way, the future extension workers, agriculture entrepreneurs and smallholder farmers will be better equipped to increase productivity and incomes, build resilience to climate change and reduce or remove greenhouse gases where possible.

Presently, there is little evidence of any formal integration of Climate-Smart Agriculture into the Agricultural Training Institutes or Agricultural Colleges' curricula (DAF, 2008; DAFF, 2010; PCA, 2009; TAC, 2014c). However, some of the recommended Climate-Smart responsive topics are included as part of a subject or as informal practical component within the National Diploma (see Chapter Four, Section 4.6). Climate-Smart Agriculture topics that are recommended for integration into the agriculture curricula include:

- Climate Change,
- Principles of Climate-Smart Agriculture,
- Rural health creation,
- Food security,
- Sustainable agricultural practices,
- Renewable energy and energy management,
- Agro-forestry,
- Soil and water management,
- Sustainable irrigation systems,
- Sustainable crop and livestock production, and
- Rain water harvesting and conservation (DAF, 2008; DAFF, 2010; FAO, 2013; Ikehi et al., 2014).

2.4 LEGISLATION AND POLICIES THAT FRAME THE AGRICULTURAL COLLEGE CURRICULA

The nine provincial educational systems are managed and organised by a single National Education System. The National Department of Education is responsible for educational matters and matters that need to be coordinated and aligned with specific policies, norms and standards at a national level (AgriSETA, 2014). The National Department of Education develops strategies and sets policies for Higher Education and Training colleges and skills development for post-school education and training to ensure educational and training alignment for the country as a whole. The Agricultural Education and Training programmes are planned and implemented within this framework.

Before the establishment of the democratic government in 1994, the Agriculture Educational and Training were informed by the Bantu Education Act No. 47 of 1953. The enforced separated curricula for different racial groups consequently combined Agriculture with non-scientific subjects in most of the schools under this Act. There was no emphasis on a scientific approach in teaching Agricultural Science within these schools (DoA, 2005a). Since 1994 agricultural education and training has expanded in policies and programmes as well as strategies for agricultural education, and training in revised governance structures (Didiza, 2005 cited by DAFF, 2010, p. 29). The development strategy for agricultural education and training is now supported by national legislation (DoA, 2005b, DAF, 2008, DAFF, 2010).

The South African National Qualification Framework (NQF) distinguishes between General Education and Training (GET), Further Education and Training (FET) and Higher Education and Training (HET). All tertiary learning institutions including Agricultural Colleges and Agricultural Training Institutes (ATIs) are incorporated within the Higher Education and Training band, but may also offer qualification at other levels. The most widely offered qualifications offered by the Agricultural Colleges and Training Institutes are the Diploma in Agriculture (see Section 1.2.3), which is also the focus of the curriculum innovation in this study. Prospective farmers, extension officers, animal health and engineering technicians are trained at these Agricultural Training Institutes and colleges (DAFF, 2010).

During 2005 the Department of Agriculture developed the Agricultural Education and Training Strategy which focused on the improvement of agricultural production through providing

quality agricultural education and training services that were aligned with and were relevant to the current agricultural challenges (DoA, 2005b; DAF, 2008). The Department of Agriculture identified the key challenges for the agriculture sector, namely sustainable agriculture development, land care, household food security, water harvesting and rural wealth creation (DAF, 2008; DoA, 2005b). A National Agricultural Education and Training Forum was established to support the implementation of the Agriculture Education and Training strategy. The National Agricultural Education and Training Forum strives to develop and recommend a systematic plan to identify, prioritise and remove access barriers to Agriculture Education and Training (DAFF, 2010). It also aims to improve and promote the image of Agriculture as a career and livelihood choice by encouraging post-graduate studies in Agricultural Sciences. The National Agricultural Education and Training Forum ensures that Agricultural Institutes are accredited at all levels with qualified and capacitated educators and trainers (DAFF, 2010). DAFF collaborated with the Agriculture Sector Education and Training Authority (AgriSETA), the South African Qualifications Authority (SAQA) and other relevant Quality Assurance Bodies to produce relevant qualifications and skills programmes that promote the implementation of Agriculture Education and Training (AgriSETA, 2014). However, the evaluation of the agricultural education and training curriculum of South Africa during 2008 indicated that the curriculum of the Agricultural Colleges addressed none of the key challenges related to climate change within their formal education programmes and struggled to implement the Agriculture Education and Training Strategy within the curriculum (DAF, 2008). Recommendations of the adjustment and upgrading of the agriculture curriculum to be more responsive in addressing the critical challenges of the agricultural sector were made (DAF 2008; DAFF 2010). In response to the curriculum alignment challenges, DAFF developed the norms and standards as guidelines to implement the Agriculture Education and Training Strategy within the agriculture colleges to create alignment between agricultural training programmes offered and challenges that the agriculture sector faces (DoA, 2005b, 2010). The norms and standards were developed as “a framework for ensuring consistent quality of Agriculture Education and Training, the sound management of public funds, and establishing and maintaining equity among the Agricultural Training Institutes” (cited by AgriSETA, 2014, p. 69)

The Agricultural Education and Training Access Barriers Report published in 2010 assessed the level of compliance of the 11 Agriculture Colleges and Training Institutes with the proposed Norms and Standards. None of the institutes complied fully (DAFF, 2010). The

Norms and Standards were developed as the main drivers to ensure alignment between the educational programmes of the Agricultural Colleges and strategic development of the agricultural sector. The Norms and Standards aimed to create consistency between the Agriculture Training Institutes to ensure quality education, sound management of public funds and establishing and maintaining equity between Agriculture Training Institutes (DAFF, 2011). A Revitalisation Plan for the colleges of agriculture was developed based on the approved Norms and Standards (DAFF, 2017) and the Governance and Financing Framework for Agriculture Training Institutes, and findings of the compliance study (DAFF, 2015b). The Colleges Revitalisation Plan (CRP) was founded on the following critical pillars:

- Improvement of Infrastructure and equipment;
- Curriculum review with emphasis on value addition;
- Accreditation and registration of Colleges, Leadership development and change management; and
- Strengthening of Information and Communication Technology including Colleges Governance (DAFF, 2017, p. 2).

The strengthening of Information and Communication Technology were also addressed by the Transformation of colleges of agriculture into Agricultural Training Institutes Training project running since 2013. The project introduced the Community Learning of Agriculture system and Competence-based learning (DAFF, 2015a; Chaminuka et al., 2016). In 2013 a cabinet memorandum was passed that suggested the restructuring of the Agricultural Colleges by the National Department of Higher Education and Training (DHET) to include the colleges in the National education system (AgriSETA, 2014). The 2013 White Paper on post-school education and training is the leading policy framework that guides the development of Agricultural Colleges. The incorporation of the colleges into the DHET system aims to result in greater coordination, integration and articulation between all stakeholders involved in the success of the Agricultural Training Institutes (DAFF, 2013a; AgriSETA, 2014). When the transfer occurs, it is likely to bring about change to the agricultural curriculum and learning system (AgriSETA, 2014). This, will in turn affect the functioning of the Agricultural Innovation System as one of the embedded systems will then be transferred to the Education System.

The norms and standards focused on approaching the operational issues of the Agriculture Educational Training Strategy. Areas for development and challenges identified included

academic and other programme development and delivery; the need for applied research in agriculture; integration of Agriculture Training Institutes into the Human Research Development programmes of the Provincial Departments of Agriculture; the development of collaboration with stakeholders within the Agriculture System and the development of skills and competencies within Agriculture Training Institutes to contribute to the process of rural development thus developing food security. It also focuses on developing centres of excellence in its agro-ecological zone and covers management, staff, infrastructure and equipment requirements of agriculture training facilities.

AgriSETA seeks to address the issue of scarce skills and key challenges by offering bursaries for qualifying candidates prioritising learning programmes that address scarce and critical skills in the sector. It invested R28.3 million over three years (2016/2017) in the development and support of Agricultural Colleges. The organisation does not only focus on skills development strategies of new entrants in the agriculture sector, but also individuals employed in the agriculture sector as well (AgriSETA, 2014).

There have been countless discussions about the possibility of integrating the Agricultural Colleges into the wider post-school education and training system, but at present the North West colleges of agriculture remain the provincial departments' responsibility (AgriSETA, 2014; DAFF, 2010; F. Klink, personal communication, May 13, 2015). A task team was developed in 2000 to investigate the integration of the colleges. An agreement to transfer the Agricultural Colleges to the Further Education and Training sector was reached in 2005 between the National Department of Agriculture and National Department of Education (AgriSETA, 2014, DAFF, 2010). However, only in 2007 was a proposal developed on how to transform South Africa's colleges of agriculture. The 2007 proposal sets guidelines for the transformation of the Agricultural Colleges to ensure that the colleges contribute meaningfully towards the development of human resources within the agriculture sector in South Africa (DoA, 2007). The proposal aimed to provide a framework to align all actors involved in the curriculum and learning process within the Agricultural System. It also addressed the articulation between the structures and offerings with the aims and objectives of the Agricultural Strategy Plan while ensuring the implementation of the Agricultural Education and Training Strategy (DoA, 2007). It proposed that the colleges should be known as Agricultural Training Institutes (ATI) and that a National Council of South African Agricultural Training Institutes (NCSAATI) should be established to govern the Agricultural Training

Institutes. These institutes are proposed to be independent institutes but coordinated and managed by the National Minister of Agriculture and Land Affairs guided by a proposed Agricultural Training Institutes Act. Each Agricultural Training Institute should then be managed by a principal who reports to the Governing Body established at the Agricultural Training Institute which then report to the National Council. The Agricultural Training Institutes offer qualifications to NQF level six and can offer higher qualifications under a franchise system in partnership with a recognised South African University or University of Technology. These recommendations are in alignment with the systems approach wherein the transitioning of the Agricultural Colleges towards an agriculture innovation system that creates and shares knowledge.

Despite these policies being in place there is no clarity or consensus on exactly what the future holds for the Agricultural Colleges. A green paper release by DAFF in 2015 proposed the establishment of a new entity that would effectively change the nature of the colleges, but keep them under DAFF control. The DHET and DAFF held meetings to develop a plan for the transitioning process from colleges to Agricultural Training Institutes. However, the process has not been finalised (Academy of Science of South Africa [ASSAf], 2017).

2.5 CONCLUSION

It is clear that to successfully implement Climate-Smart innovation through a systems approach, all the challenges hampering food security and adaptation to climate change need to be identified and addressed. Climate-Smart Agriculture is evident within institutional policies and strategies from an international level to a national level and provincial level (see Figure 2.1). The Agriculture Education and Training Strategy guides the agricultural curriculum and learning systems. This strategy aims to overcome the key climate change challenges by incorporating food security, rural development, rain water harvesting and conservation into the agricultural curriculum. The Agricultural Colleges are on the brink of transitioning towards innovation as Agriculture Training Institutes that aim to bring more communication and coordination within the broader agriculture educational and training system. Climate-Smart Agriculture principles are articulated within the system through the Agricultural Education and Training Strategy and the Norms and Standard policy. This strategy and the norms and standards also align the colleges with the agriculture sector's needs and challenges. The agricultural college curriculum is outcome-based moving to a

competency-based framework. The curriculum has room for adjustment to ensure that the course content stays relevant and aligned with the agriculture sector's needs. As yet, the Agricultural Colleges and Training Institutes (ATIs) are not including Climate-Smart Agriculture principles or approaches systemically. A Climate-Smart Agriculture curriculum innovation framework allow the colleges to integrate Climate-Smart responsiveness into the curriculum and develop graduates with knowledge and competencies that will enable them to adapt and be responsive towards specific climate change impacts and challenges. Chapter Two has provided a clearer picture of Climate-Smart Agriculture. The chapter also provided insight into the agricultural and educational policies that drive the system towards innovation. Chapter Three discusses the theoretical framework and the research methodology that frames and supports the study.

CHAPTER 3

THEORY AND METHODOLOGY OF THE STUDY

3.1 INTRODUCTION

Chapter Three discusses the theory and methodology that enabled the support and tracking of the colleges that initiated curriculum innovation. The narrative opens with an overview of systems thinking and the concept of an Agricultural Innovation System. This is followed by a section on the innovation systems framework used during the study. The chapter continues to outline the collaborative research methods used in the collection and analysis of data by the researcher and the study participants. It describes the iterative process of supported innovation and tracking through expansive learning cycles. The development of the reflexive tool, the Climate-Smart Innovation Tool, is also discussed. The chapter closes by looking at questions of ethical research practices and validity and describes how these questions were addressed during the research process.

3.2 THEORETICAL FRAMEWORK

Section 3.2 discusses the theory that was used to contemplate and track innovation within the agricultural curriculum and learning system. The theoretical framework, founded on systems thinking, was developed to support the study's research on systems innovation and the process of implementing the climate responsive policies to initiate Climate-Smart innovations in the curriculum and learning practices. The application of systems thinking approach is elaborated as Cultural Historical Activity Theory (CHAT) is applied as the method to tracking systems innovation within the provincial Agricultural Innovation System towards the development of knowledge and competencies through expansive learning. The morphogenic approach provided a lens, to study innovation from a transformative change perspective. The theory orientated the study to the central problems and challenges surrounding curriculum alignment within the provincial system and the integration of Climate-Smart Agriculture.

3.2.1 SYSTEMS THINKING FRAMEWORK

To research the Agricultural System's innovations in response to climate change and food insecurity challenges within the South African context, the researcher drew upon a systems

thinking approach. This approach allowed the researcher to view the agriculture curriculum and learning system as interrelated with its social-economic and ecological environment (Francis et al., 2011). As previously discussed, the Climate-Smart Agriculture approach was identified as a responsive systemic tool to support innovations in response to climate change and food insecurity challenges within the North West Province. A systems thinking perspective enabled the use of Climate-Smart Agriculture as a responsive tool to inform curriculum and learning innovation. A systems vantage point enabled the researcher and study participants to build a picture of the complexities in a system driven by responses to policy, climate change and the demands of the agricultural sector as an embedded system (see Figure 1.1). Through a system thinking approach, the researcher was able to work with the college participants in the system to provide tools for a review of current practices and the implementation of responsive change. This co-engaged and developing analysis enabled the researcher and study participants to get a better grasp on some of the current barriers to change and the complexities obstructing the process of transitioning towards a Climate-Smart System (Geels, 2004).

The use of an innovation systems framework enabled the researcher through the research process to develop an understanding of how the evolutionary change noted was responsive to climate variations and food insecurity. For the Agricultural System to successfully respond to climate change and food insecurity challenges, it needs to be harmonised with the agricultural curriculum and learning systems within. The Agricultural Innovation System framework provides a system where these components can interact and respond to each other. As the study is embedded in the North West Agricultural Innovation System, the concept is briefly discussed below (also see Figure 1.1). Nordwig (2015) has also provided a detailed picture of the provincial system, its stakeholders, structures and processes. An Agricultural Innovation System (shown in Figure 1.1) aims to create knowledge, provide access to knowledge and manage the sharing and co-production of knowledge between all the components within the system. It is an outcome-based system that is driven by agro-ecological and policy drivers and is intended to address emerging challenges through innovation in the agricultural sector. This innovation is focused on building competencies (EU SCAR, 2013, Ponniah, 2011). While all the system elements outlined in Figure 1.1 of the North West Province were considered in this study, the study mainly focused on the central activity system of the college lecturers and management involved with the offering of the National Diploma in Agriculture within the province.

Through the Innovation Systems framework developed for this study, the innovation process was perceived as the outcome of collaboration between actors, or agents, within the Agricultural System. Actors exchange information and learning processes alongside the Climate-Smart Agriculture knowledge engagement. The systems innovation design was used to approach the study to enable participants in the system to enhance the curriculum and learning practices embedded in the system. Through the Innovation Systems framework, the researcher and participants in the iterative research process could support and track the innovation process and the emerging complexities of systems innovation

In this way, the research process enabled the supporting and tracking of the college initiated innovation towards a responsive and informed Climate-Smart system. Here the focus was to support research participants to develop the capacity to deal with the complexity, change and multi-actor engagement processes within the Climate-Smart innovation framework. SARUA (2014, p. 59) described the innovation process as a knowledge co-producing process that requires “new partnerships between researchers and a wider range of societal actors” as a requirement for responsive climate resilient development in the agricultural sector. To achieve this, the innovation process needs to focus on network building, social learning and negotiations between the actors within the system (Leeuwis, 2004). An adapted formative intervention approach and the Systems innovation framework supported by Climate-Smart Agriculture tools enabled the workshop participants to respond to contradictions surfaced in the study and to initiate innovations with support from the researcher. Working with the participants and tracking innovations enabled the researcher and participants to review the college agriculture curriculum and learning system within the Provincial Agricultural Innovation System. This allowed the researcher to establish what processes were required to arrive at innovation. The college curricula were approached as an integral part of an emerging Agricultural Innovation System undergoing innovation as a response to climate change and using Climate-Smart Agriculture as a responsive tool (Figure 1.1). This enabled the researcher to support and track innovation of the system as knowledge flow was translated within the curriculum and learning component to better relate to other areas of the Agricultural System. The innovation process towards Climate-Smart responsive knowledge uptake was used as a driver to encourage transformation within the system. By analysing the link between the historical and current curriculum and learning practices the opportunity for

innovation and the areas where innovation was plausible were identified (Dockés, Tisenkofs & Bock, 2011).

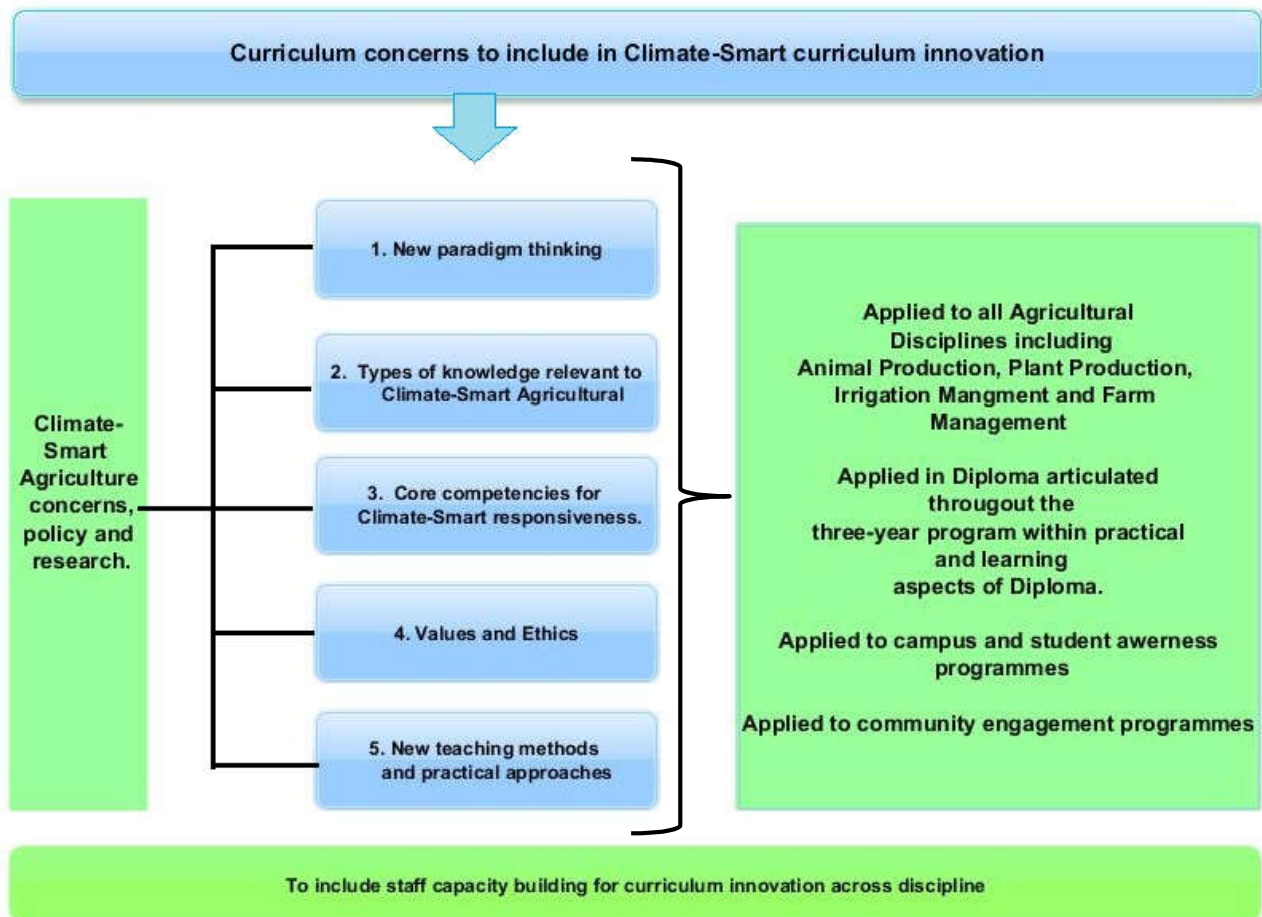


Figure 3.1: The framework for Climate-Smart curriculum innovation adapted from SARUA (2014, p.190)

The framework for Climate-Smart Innovation as seen in Figure 3.1 was used to identify the knowledge and competencies that agricultural graduates should attain from a Climate-Smart responsive curriculum. This framework was adapted from the Climate Compatible Framework for curriculum innovation developed by SARUA (2014, p.190) discussed in Section 1.6.5. The framework was guided by SARUA (2014, pp.141-142) and Wiek, Withycombe and Redman (2011) to identify the Climate-Smart responsive competencies necessary for systems innovation. These competencies were also included in the Climate-Smart Innovation Tool (see Appendix 5). The competencies can be outlined as follows:

- *System thinking competence*

Competencies to understand complex problems relating to climate change from an integrated social-ecological systems perspective, and to understand such problem arrangements in the current situation, and their history and relations to other contexts or situations.

- *Anticipatory competencies*

Competencies to assess and understand risk and vulnerability, and to anticipate possible scenarios and consequences.

- *Strategic planning competencies*

Competencies to engage with future planning and strategy development to conceptualise appropriate alternatives and responses that are sustainable and viable i.e. to engage with transitioning processes.

- *Normative competence*

Competencies to consider the implications of decisions and how they affect current and future agriculture, ecology, social, economic stability.

- *Socially engaged practical competence*

Competencies to engage in adaptive management and to participate in social innovations that generate innovative curriculum and learning practices.

(derived from SARUA, 2014, pp.141-142, adapted from Wiek et al., 2011)

The diagram depicted in Figure 3.1 illustrates the framework developed for Climate-Smart driven curriculum innovation. The diagram guided the development of Climate-Smart Agriculture as a responsive tool that could capacitate staff and innovate the curriculum through integration of new paradigm thinking, integration of Climate-Smart Agriculture knowledge, relevant core competencies and values and ethics incorporated within this approach. The researcher drew upon SARUA recommendations for curriculum innovations at a broader level, which was used to guide engagement in the post-schooling agricultural college context. The reflexive tools for supporting innovation were founded within the Innovation System framework informed by the Climate-Smart Agriculture approach. The Climate-Smart Innovation Tool was used reflexively to develop a clear picture of the agriculture curriculum as a whole while also allowing the researcher and research participants to track the system's innovation towards Climate-Smart responsiveness.

3.2.2 TRACKING INNOVATION WITHIN THE CURRICULUM AND LEARNING SYSTEM THROUGH CULTURAL HISTORICAL ACTIVITY THEORY

Cultural Historical Activity Theory enabled the researcher to support and track curriculum and learning innovations within the system through an iterative formative intervention process. The theory provided the epistemological foundation of the study. It enabled the researcher to approach the research process as two case studies of innovation within the system. Cultural Historical Activity Theory is based on Vygotsky's theory of learning and development (Vygotsky, 1978) which the researcher drew on to understand knowledge building and innovation developing around contradictions. This provided a perspective for examining and discussing opposing ideas so as to find a solution while studying the relationships between cause and effect within the system (Engeström, 1987). Within the methodology of formative intervention, the activity system becomes a unit of analysis. (Davydov, 1999; Engeström, 1987). Engeström (1987) noted that within this model of process a variety of things such as the community, rules, tools, and division of labour can have an impact on the object of activity and the outcome of activity. As the activity system becomes fragmented by its inner contradictions the initial object of the activity can get blurred or lost. By means of formative intervention methodology, the object of the activity can be rediscovered and aligned (Engeström, 2016). Engeström stated that the internal tensions and contradictions within and among the components of a human activity lead to the transition and transformation of knowledge (Engeström, 1987).

The Cultural Historical Activity Theory perspective developed for the study allowed the review and analysis of each case study as an activity system with a social-historical context embedded in the collective Agricultural Innovation System (see Figure 1.1). This approach required a shared understanding of the functioning and history of the system, in this case the curriculum and learning practices of each case study. A clear picture of the object, in this case Climate-Smart innovation, the system attempted to enact, the characteristics of the surrounding community, and the tools required to reach the system objectives were developed (Bodker, 1991).

The first generation of Cultural Historical Activity Theory was based on Vygotsky's concept of mediated action as the unit of analysis and focused on individual or singular activity systems (Zinchenkon, 1985 cited in Engeström, 2016). Figure 3.2 represents the way in

which Vygotsky brought together cultural artefacts with human actions to dispense with the individual or social dualism. In the second generation of Cultural Historical Activity Theory, the original Vygotskian triangle is expanded to represent the social and collective elements in the activity system. Through the addition of these elements of community, rules and division of labour analysis focus did not only occur at a micro level, but the interactions between the actors could also be analysed in a social context (Figure 3.3; Engeström, 1999a).

The study focused on the third generation activity system approach that is illustrated in Figure 3.4. This approach is centred around social transformation. It incorporates the system structure within a wider range of system interactions analysis, considering the conflicting nature of social practice. Through Engeström's approach, the researcher and participants could identify the complexities, tensions and contradictions outlined through mirror data within the case studies, but also between their activity system and other activity systems located within the wider Agricultural Innovation System in which they were embedded (Engeström, 1999b). The third generation of Cultural Historical Activity Theory intends to develop conceptual tools to understand dialogues, multiple perspectives and networks of interacting activity systems with emphasis on resolving contradictions associated with a shared objective of activity. During the study the Climate-Smart Innovation Tool and online sub-tools were developed to support innovation within the colleges focussing on the shared objective of Climate-Smart Agriculture innovation in the curriculum and learning system in the North West Province. Engeström (1999a) suggested that activity theory may be simplified with the help of five principles namely, seeing the object-oriented activity system as the prime unit of analysis, keeping in mind the multi-voicedness and historicity of the system, seeing contradictions as sources of change and development and lastly, the possibility of expansive transformations.

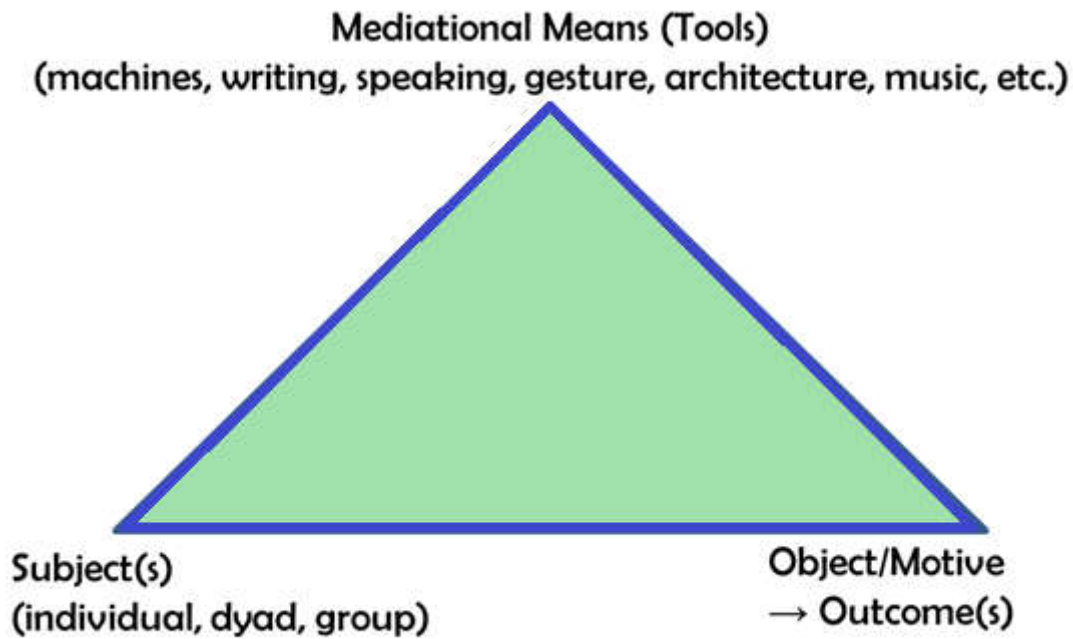


Figure 3.2: Vygotsky's model of the mediated act represented as its common reformulation (Engeström, 1999a, pp. 25, 30)

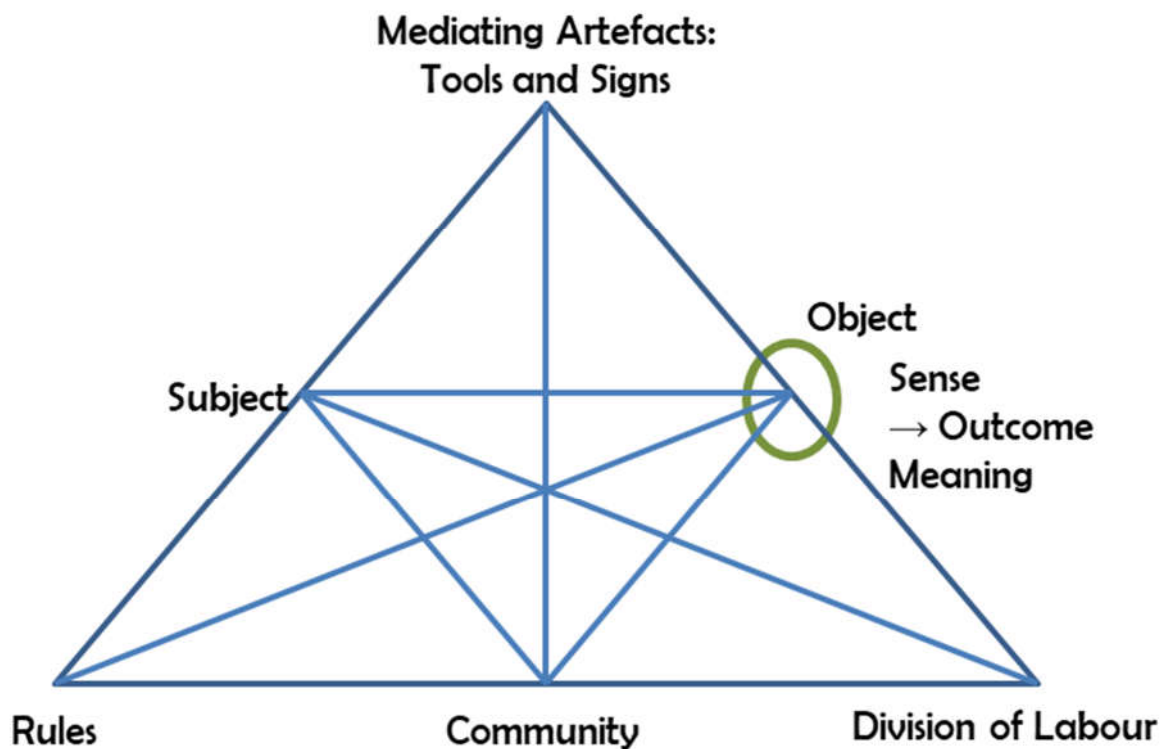


Figure 3.3: The structure of a human activity system (Engeström, 1987, p.78)

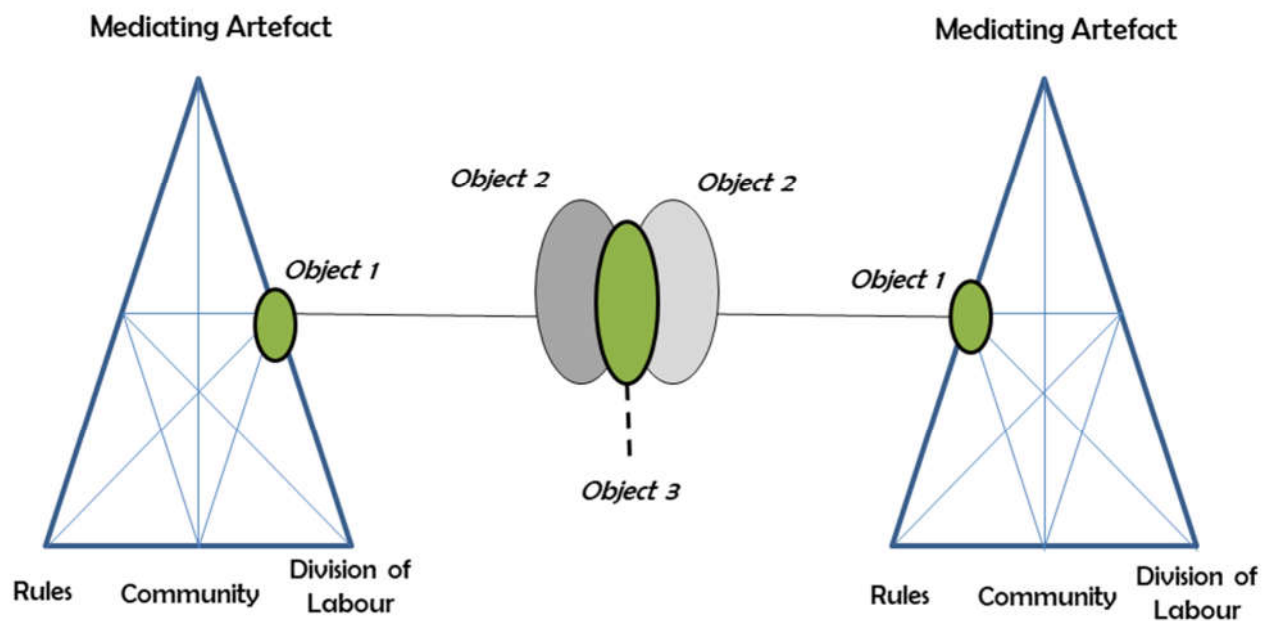


Figure 3.4: Third generation activity model that shows two interacting activity systems as minimal model for third generation of activity theory (Engeström, 1999a)

3.2.3 APPLICATION OF CULTURAL HISTORICAL ACTIVITY THEORY IN THE STUDY THOUGH EXPANSIVE LEARNING

By drawing on Cultural Historical Activity Theory, the agriculture curriculum and learning system became part of the processes of innovation within the Agricultural System. This allowed the curriculum and learning innovation context and process to be defined and supported through the associated expansive learning processes. Cultural Historical Activity Theory was implemented through a systems approach as a process-oriented descriptive methodology to support and track innovation processes within the activity systems as part of the Agricultural System towards Climate-Smart policy and curriculum responsiveness.

In the study, a formative intervention methodology was used as an open process reflexive methodology associated with Cultural Historical Activity Theory that aims at supporting collective engagement and change in the object of activity (Figure 3.5).

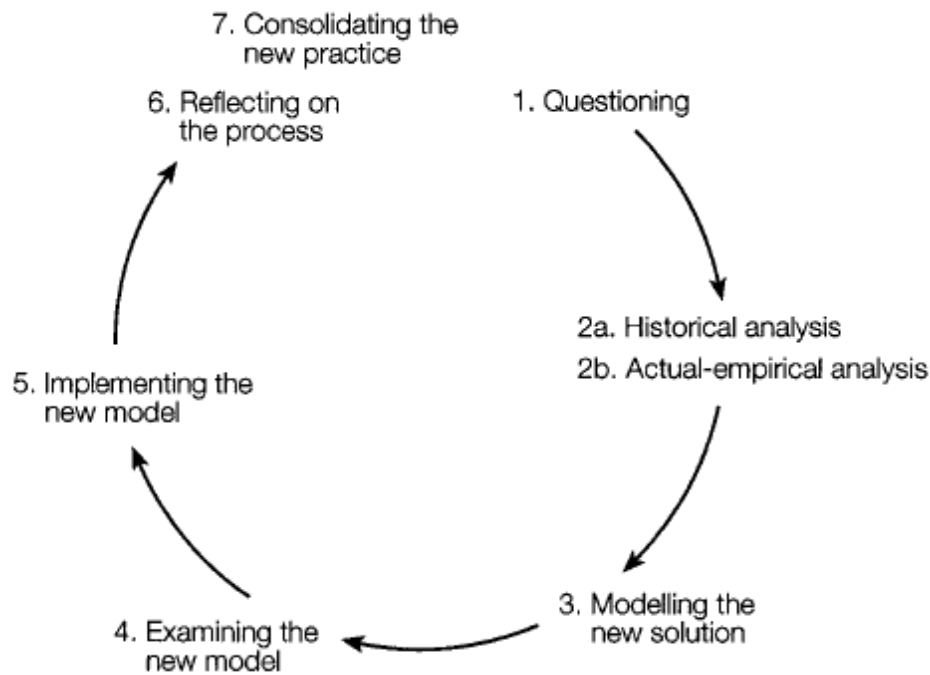


Figure 3.5: Expansive learning cycle (Engeström, 1999a, p. 384)

The expansive learning design allowed the study participants to identify the contradictions and tensions within the activity system by drawing upon the collaborative analysis and transformation of the activity's practices (Engeström, 2005). Engeström (1987) explained the four levels of contradictions. Primary contradictions occur in the inner conflicts and produce tensions within each element of an activity system, namely subject, object, instruments, community, rules and division of labour. Engeström (1987) explained primary contradictions of a modern activity system as derived from contradictions between value and the exchange value of commodities of a socio-economic formation of capitalism (Engeström, 1987). Thus, primary contradictions are approached through its manifestation in the discourse and actions of the components of the activity system. The primary contradictions are manifested in the secondary contradictions where the contradictions take form as concrete tension between the components of the activity system in question. "Tensions" as described by Engeström, related to secondary contradictions can be resolved by introducing or integrating new elements into the activity system that can lead to systems innovation. Bonneau (2013) explained that if new elements are introduced into the activity system, tertiary contradictions are expected to arise between the current activity system and the modelled future activity system. Quaternary contradictions can arise as the central activity system is reconfigured

between central activity system and neighbouring activity systems within the AIS (Bonneau, 2013).

The key indicator of expansive learning is the expansion of the object within the activity system (Engeström, 2016). There are three dimensions in which the object of the activity can expand (Engeström, 2000, cited in Engeström, 2016). The object can expand in the socio-spatial dimension, where the system expands by the increase in subjects or setting e.g. more lecturers join the expansive learning process or a learning network is established. Another indicator of expansive learning is the extension of the time perspective known as the temporal dimension expansion. As the expansive learning evolves, different contradictions can emerge that require the activity system to expand back in time to understand the newly emerge contradictions. Or in another scenario, the expansive learning is expanding the time frame to address the impact of the newly emerged contradictions. The third dimension of expansion is political-ethical and deals with human and societal consequences of the activity and accepting responsibility for those consequences (Engeström, 2016, p.8). Expansive learning is a process wherein learning and transformation is achieved through specific learning actions that form an expansive cycle. The typical sequence of this cycle may be simplified in the following steps (see Figure 3.5).

Questioning: During the first learning action, some of the activity system's practices are questioned, examined or rejected.

Analysing: The second learning action consists of analysing the situation through mental, discursive or practical transformation of the situation with the aim of finding the causes or mechanisms of the functioning of the system.

Modelling: The third learning action is the remodelling of the system by constructing new ways of working or engaging in activity system's practices.

Examining the model: The fourth learning action consists of running, operating and experimenting with the new model's dynamics, potentials and limitations.

Implementing the model: In the fifth stage of the cycle, the new model is practically implemented.

Reflecting: During the sixth learning action of expansive learning, participants reflect and evaluate the process and activity mode.

Consolidating: This involves the implementation of the new refined model of system or practice.

The methodology of formative intervention through the expansive learning process is built on the principles of ascending to the abstract and double stimulation which together makes transformative agency an essential outcome of innovative learning (Engeström, 2011 cited in Engeström, 2016). Through the expansive learning cycle, the initial abstract concept, in this case Climate-Smart Agriculture, is introduced and through the step-by-step formative intervention process, the abstract concept is enriched and transformed into a complex problem that develops into a new form of practice, in this case curriculum innovation (Engeström, 2016).

By means of applying the principles of double stimulus, the researcher did not limit the research to the usual method of offering the subject, research participants, simple questions to which they must respond. These principles allowed the researcher and research participants to develop a second series of stimulus with a special function of supporting curriculum innovation (Engeström, 2016). The first stimulus that the research participants were offered was the integration of Climate-Smart Agriculture into the province's strategic plans, thus providing an incentive to integrate the approach into the curriculum and learning activity system. The second stimulus developed by the researcher and research participants was the Climate-Smart Innovation Tool.

The study drew upon the expansive learning methodology approached as it offered a framework for analysing the interaction of the object under transformation, the mediating artefacts and the different perspectives of the participants in a progression of jointly achievable actions as described by Engeström (2008, cited by Engeström, 2016). In the study, the expansive learning processes were shaped within the unfolding innovations that were specific to the contexts of research and innovation in the case studies. Section 3.4 discusses the expansive learning lead intervention-innovation workshops where the participating college staff reviewed the Climate-Smart responsiveness of the curriculum supported by reflexive double stimulus mediating tools.

3.2.4 MORPHOGENIC SOCIAL THEORY AS AN INNOVATION LENS

Margaret Archer's morphogenic social theory (Archer, 1995) was used to support the analysis of innovation as formative change as the theory explains social change. Archer's

morphogenetic social theory which draws upon critical realism philosophy (Greener, 2005, cited in Togo, 2009) which recognises emergence in open systems. Archer (1995) stated that reality is stratified into levels that cannot be reduced to another level. An individual, such as a lecturer, cannot be reduced to the community, the college system, or the other way around. Archer (1995) argued that individuals and their structure, in the context of the study (the Agricultural Innovation System) are interdependent. However, individuals, as agents, function within and create structure and the structure is more than the individuals or agents. Weik (2006) explained that agency is attributed to human beings and that an agent can make free choices in action, but to some extent, the choices are determined by social forces. Thus agency, the capability to act, is determined in a way by structure, social forces but agents can also change structures. Seen from the other side, the structures are emergent and also cannot be reduced to the individual that created them. Sayer (2000) noted that the morphogenetic framework is a good complementary framework to support social theories, such as Cultural Historical Activity Theory. Both theories make an important contribution to the understanding of relationships between the individual and the system. Thus, through the complementary supported theoretical approach, the study could lift out the activity system work while also analysing the agency-led change.

3.3 RESEARCH METHODOLOGY

The research methodology, design and methods were influenced by the research objectives (Section 1.4) guided by the theoretical framework (Section 3.2). Throughout the study, the principles of Climate-Smart Agriculture, reflected in the emerging provincial policy responses to climate change, were used to guide and to build a picture of the future pathways of innovation towards a Climate-Smart responsive curriculum by the researcher. However, even though the colleges had broad objectives, the research was centred on the support and tracking of curriculum and learning innovation towards Climate-Smart responsiveness within the colleges as part of the wider system in the North West province.

This section discusses the process of data collection and the development of the Climate-Smart Innovation Tool as a reflexive double-stimulus tool. The researcher worked with college staff through a series of learning actions surrounding the core activity of support and tracking

curriculum innovation through an iterative process of expansive learning cycles (Section 3.2.3). Through a formative intervention engagement process, the researcher and research participants cooperatively engaged in the process of innovation. The system was analysed, contradictions were discussed, action plans were developed and innovation progress was reviewed through the support of the Climate-Smart Innovation Tool. The study supported and enabled the tracking of the curriculum and learning innovation process with the research participants, focussing on the process of innovation and not on the individual needs of participants. Here follows a description of the research design and process that that was used to review and track the process of innovation towards a Climate-Smart system within the Agricultural System of the North West Province.

3.3.1 RESEARCH DESIGN

At the beginning of the study, the North West's climate change response policies called for a Climate-Smart Agriculture approach as a responsive tool within the wider agricultural innovation systems approach being developed in policy (see Section 2.3.5). However, the approach was not fully conceptualised. Related discussions and strategic plans were in place but at a provincial level, no clear plan for educational integration was yet established. The colleges realised that the agricultural sector had developed new training needs shifting towards Climate-Smart Agriculture. This responsive approach was then identified by the colleges as a means to address the agricultural problems such as climate change adaptation, water scarcity, poverty and food security within the curriculum. However, the process was only at the idea phase and the implementation of innovation was unclear. A descriptive account follows of the four phases of the research that supported and tracked curriculum and learning innovation as a response to system drivers and the development of a reflexive curriculum innovation tool.

3.3.1.1 PHASES OF THE STUDY

To analyse the data and to progressively develop and focus the study within its formative interventionist case study design, four phases of research were used.

PHASE 1: CONTEXTUAL PROFILING

Phase One consisted of formative data gathering and analysis. The researcher was approached by the Director of READ during an Amanzi [water] For Food related interview

about providing support during the curriculum innovation process within the colleges. During Phase One the researcher started working with the college staff to compile a contextual profile. The development of a contextual profile was a necessary step to establish what was needed to support the colleges and to establish the foundation for formative intervention research. Data were gathered on the curriculum operation and practices to develop a clear view of the status of the colleges in relation to climate responsive curriculum development. The college staff from both case studies were interviewed throughout Phase One to enable the developing of a clear contextual profile that included information on the types of programmes, the structure of the programmes and the materials being used within the colleges. The data gathering process included the analysis of documents relating to Climate-Smart Agriculture relevant to the South African context, curriculum documents, Departmental policies, specific subject content syllabus and historical documents including old prospectuses of the colleges.

Individual interviews were conducted with the college lecturers and other stakeholders associated with curriculum and learning innovation in each case site, including with the Department of Rural, Environmental and Agriculture Development of North West province (READ) and the management of both colleges. The data gathered supported the need for a formative intervention process and an agreement within the colleges to start such a process. Through a systems approach, the contextual profile reflected a clear picture of the complexity of the North West Province Agricultural Innovation System. The need for institutional realignment and curriculum innovation due to the recent changes within the system was identified by the research participants interviewed. The research process for Phase One is outlined in Figure 3.6.

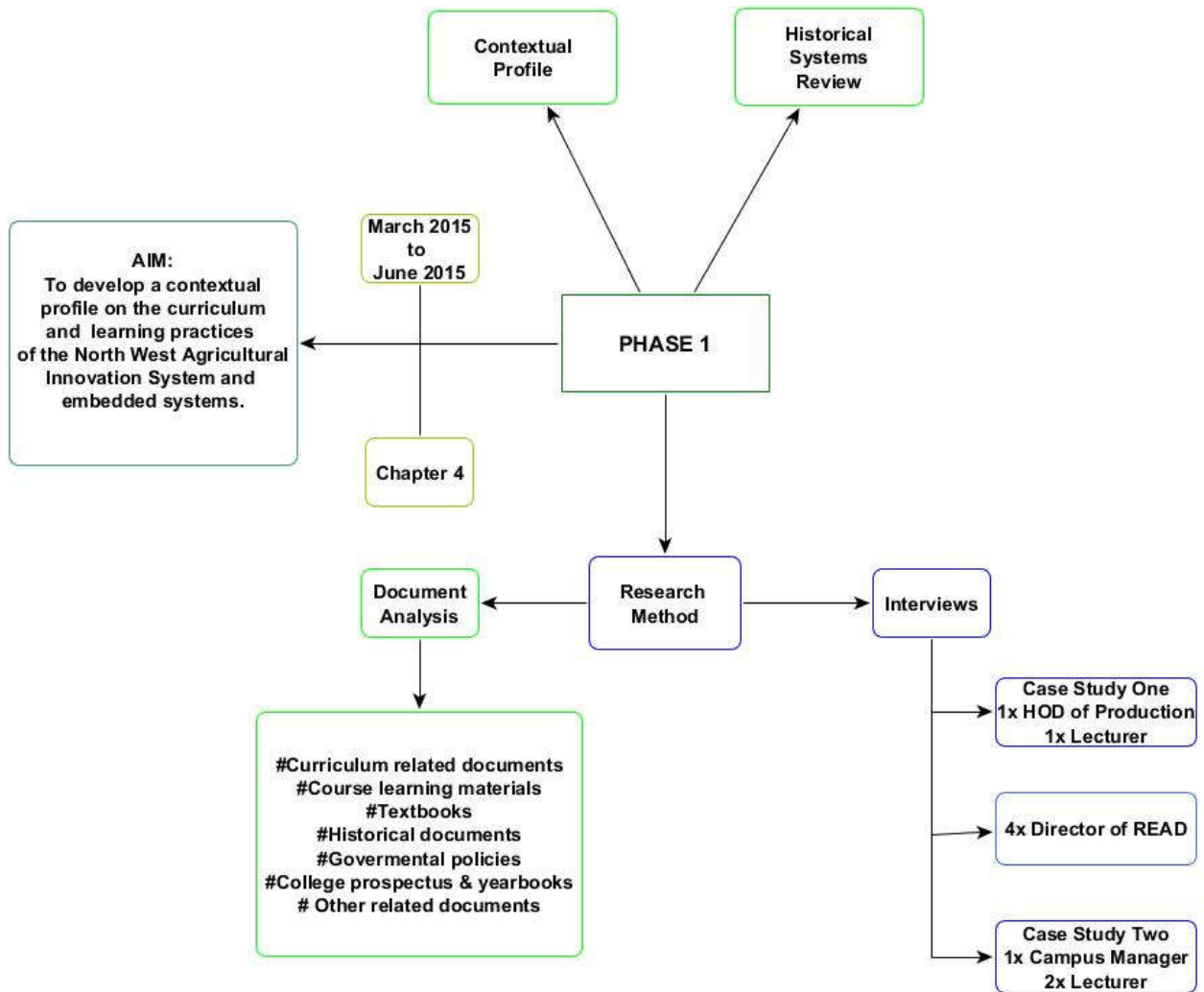


Figure 3.6: Phase One of the research

PHASE 2: FRAMING OF THE STUDY THROUGH CONSULTATIVE WORKSHOPS AND THE DEVELOPMENT OF THE CLIMATE-SMART AGRICULTURE INNOVATION TOOL

Phase 2.1 Consultative workshops

The identified need for alignment and innovation led to the decision to invite all the lecturers and management involved with the agricultural college curriculum and learning practices within the province to a meeting to discuss challenges and solutions to the issue. The preliminary consultative workshop was conducted at Potchefstroom College and all lecturers and representatives of the management team from both colleges attended (see Section 4.6). The aim of the workshop was to orientate the research participants around the central problems and challenges surrounding the curriculum alignment with the provincial policies and the possible integration of Climate-Smart Agriculture within the curriculum. The combining of both colleges for the preliminary workshop allowed the participants to see themselves as part of a learning network within a provincial Agricultural Innovation System. The participants completed a survey that aided in the data gathering to orientate the research (see Appendix 1).

A look at the contextual profile of the curriculum and learning practices allowed the participants to question the current system and the possibility of innovation towards a more Climate-Smart responsive curriculum. Through discussion and questions, the participants brought their own experiences into the conversation and collaboratively reviewed, analysed and produced a picture of each college's specific National Diploma curriculum. The participants formed a sense of how the curriculum was operating and what needed to be changed and updated. This allowed the participants to become aware of problematic aspects and challenges within their journey towards a Climate-Smart informed and responsive curriculum. The discussion turned to the matter of how to go about curriculum and learning innovation. The need for a tool that can assist in the formative intervention process and the development of solutions through innovation was raised. The workshop report is included as Appendix 4.

Phase 2.2 The development of a reflexive tool.

The consultative workshop led to the development of the initial Climate-Smart Innovation Tool by the researcher with input from the research participants (Appendix 5). The tool was based

on the conceptual and literature review work on Climate Smart-Agriculture (Section 2.3) and the climate change responses in the North West Province (Section 2.2), which was also linked to the innovation framework outlined in Section 3.2 (Figure 3.1). The tool was to be used as a reflexive double stimulation tool that could support the Agricultural Colleges to review and reframe the curriculum topics and learning system.

Other examples of curriculum evaluation tools were investigated and relevant aspects were adapted to produce an innovation tool that could be used throughout the formative intervention process. However, the study drew mainly upon the SARUA (2014) recommendations as outlined in Section 3.2.1, as well as on the concept developed by CGIAR Research Programme on Climate Change, Agriculture & Food Security (Beddington et al., 2011). The programme also focused on overcoming climate change challenges, threats to agriculture and food security by exploring new ways of helping vulnerable rural communities adjust to global changes in climate (Moorhead, 2009). Well-known Climate-Smart Agriculture issues such as carbon dioxide emissions, adaptation and resilience towards climate change were also included in the tool (FAO, 2013).

The United Nation's Millennium Project's Millennium Development Goals were investigated during the development of the tool (UNESCO, 2000). During the tool development phase, the Sustainability Assessment Questionnaire (SAQ) (University Leaders for a Sustainable Future [ULSF], 1999), the Auditing Instrument for Sustainability in Higher Education (AISHE) (Roorda, 2001) and Graphical Assessment of Sustainability (GASU) (Lozano, 2006), were examined.

The Sustainability Assessment Questionnaire's (SAQ) major strengths are that it is useful as a conversational and teaching tool and the assessment can help to identify weaknesses and set goals. However, the Sustainability Assessment Questionnaire is not practical for large universities to complete and there is no mechanism for comparison or benchmarking (ULSF, 1999). The Auditing Instrument for Sustainability in Higher Education (AISHE) was designed to measure the success in campus implementation of sustainability, while also creating a mechanism for knowledge exchange (Roorda, 2001). AISHE is an auditing method and a policy instrument that is process-orientated focussing on qualitative over quantitative measures. The United Nations Environment Programme's Unit-Based Sustainability Assessment Tool model was developed for use in the Swedish/Africa International Training

Programme (ITP) on Education for Sustainable Development in Higher Education. The main purpose of the tool was to facilitate reflexive learning, rather than precise measurement of sustainability occurrence and improvements within a Higher Education Institute. The tool was implemented as an educational tool in the Africa-Asia International Training Programme on ESD in Higher Education since 2009

These tools helped to form the basis for developing indicator competencies for a review tool, with built-in flexibility to be used at curriculum or subject level. Based on this, the United Nations Environment Programme's Unit-Based Sustainability Assessment Tool model developed by Togo (2009) was used as a guide and was adapted to suit this study to develop an indicator-based assessment tool. It has proven effective in the support of reflexive curriculum innovation processes for sustainability, although it has not been adapted for agricultural college or Climate-Smart Agriculture contexts before (Togo & Lotz-Sisitka, 2009; Togo, 2015).

The tool was compiled within a Microsoft Excel worksheet and printed as a booklet for research participants to complete during Phase 2.2 to review their curriculum alignment to Climate-Smart Agriculture (see Appendix 5.1). The aim was to develop a tool that could enable users to develop an insight into the 'whole' picture of Climate-Smart responsiveness within the college curriculum and to support and track innovation towards a Climate-Smart Agriculture curriculum and policies. The tool was designed in a way that an individual lecturer or manager can use it to review his/her subject curriculum outline and programme, teaching approaches, community engagement, assessment and staff expertise. The tool was also indicator-based as modelled in the Unit-Based Sustainability Assessment Tool (Togo & Lotz-Sisitka, 2009). Examples of the Climate-Smart Innovation Tool can be found in Appendix 5.

The driving factor for the development of the tool was the need to develop a reflexive tool for participants working on the agriculture curriculum and learning system to support and drive innovation. Many changes occurred during the development of the tool as the research participants made adjustments to suit their needs during Phase Three. The revision and refinement of the tool were a continuing process during the research phases.

Phase 2.3: Framing curriculum innovation within the Agricultural System and refining of the tool

During Phase 2.1 the research participants struggled with the questions on how the new strategies and policies could be implemented. Questions around what other colleges were doing in the same situation were raised (see Section 4.6 and Appendix 4). Thus, the researcher invited representatives of the proposed two case study groups to attend a two-day national curriculum development, knowledge dissemination and network building workshop presented by the Water Research Commission's Amanzi For Food project at Rhodes University on 12 and 13 May 2016. Representatives of farming communities, colleges, universities, radio stations, extension services and non-governmental organisations attended the workshop. Through this workshop, the representatives of the two colleges had discussions with lecturers of other colleges, farmers, extension officers and curriculum developers. It was also an opportunity for network building and understanding the role of curriculum and learning within the Agricultural System. During the Amanzi For Food workshop a new engaged model of curriculum innovation emerged which created knowledge from the multiple voices of lecturers, farmers, extension officers and students, which contributed to the competency-based learning endeavour of the Department of Agriculture and its associated colleges. The workshop is discussed in Chapter four. During the Amanzi For Food national workshop, the researcher gave copies of the Climate-Smart Innovation Tool to the representing participants of the two case studies so that the college staff could complete the tool. The data derived from the participants completing the tool were used to derive mirror data for Phase Three.

To summarise, during Phase Two a consultative workshop was held to discuss how to respond to policy integration of Climate-Smart Agriculture and the process of implementing these changes within the curriculum. The Climate-Smart Innovation Tool was developed and pilot tested during Phase 2.3. The tool was developed to function as a double stimulation tool in the formative intervention process of Phase Three. During Phase 2.3 representatives of the case studies attended a national workshop on agriculture curriculum development. Figure 3.7 outlines Phase Two of the study.

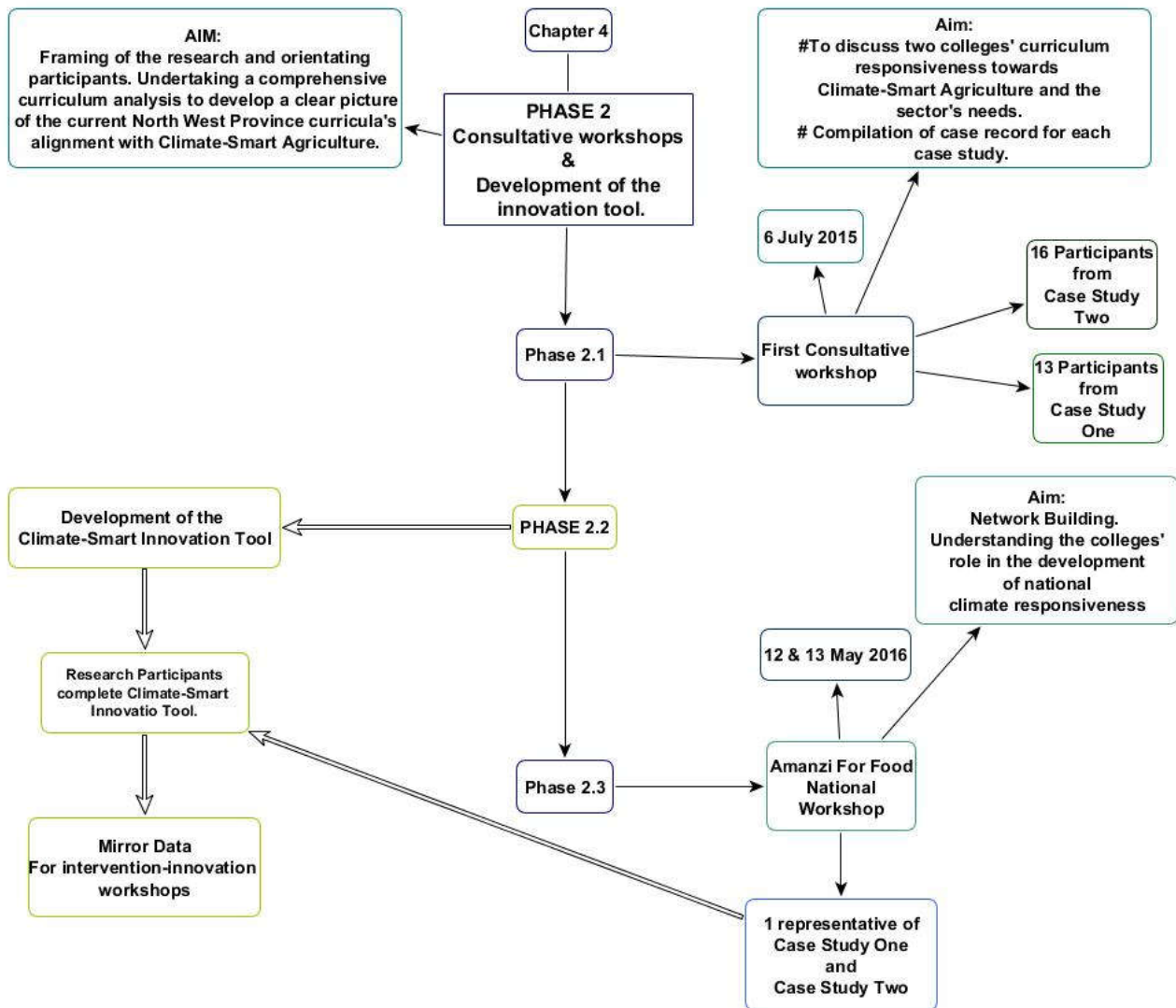


Figure 3.7: An outline of Phase Two of the study

PHASE 3: ITERATIVE PROCESS OF INNOVATION SUPPORT AND TRACKING WITH THE CLIMATE-SMART INNOVATION TOOL THROUGH EXPANSIVE LEARNING CYCLES

During Phase Three formative intervention research was undertaken and supported with the Climate-Smart Innovation Tool. Phase Three was developed as an iterative innovation support and tracking process. It consisted of three successive intervention-innovation workshops with expansive learning cycles of reflexive innovation. Phase Three was initiated during the first intervention-innovation workshops held with both case study groups at their separate locations.

Phase 3.1: Intervention-innovation workshops

All three intervention-innovation workshops for both case study groups worked within the same format adapted from the expansive learning process (see Figure 3.5). Each workshop initiated the questioning phase of the expansive learning cycle as the participants worked from mirror data to question, examined and identified problems within their systemic practices. The participants continued to discuss the progress made towards their object. The workshops then turned to the discussion of contradictions, the refinement of the reflexive tool and the development or remodelling of their innovation plans. The data and findings derived from the three intervention-innovation workshops are discussed in Chapter Six for Case Study One and Chapter Seven for Case Study Two.

The research participants completed the Climate-Smart Innovation Tool before the first intervention-innovation workshop and the data were mirrored back to them during the workshop. The development of the tool is discussed in Phase 2.2. The tool was used as a double-stimulus tool to activate innovation. A historical analysis of the activity systems was undertaken by the research participants and the data derived with the tool was used to develop a picture of the Climate-Smart responsiveness of the curriculum and learning systems in each case study. Thus, the workshop overflowed to the next phase of the cycle as the participants focused on the issue through historical and current system analysis. This discussion led to the surfacing of contradictions within the system. Solutions to the contradictions were also discussed after feedback was given by the participants of the Amanzi For Food workshop (see Appendix 6; Lotz-Sisitka et al., 2016). The content and improvement of the tool was also discussed. The workshops findings are discussed in Chapters Six and Seven. After the first intervention-innovation workshop at Potchefstroom college, a survey was also handed out to the third-year students. The data derived from the survey helped the researcher to fill in gaps and to mirror back the experiences of the students to the lecturers in the second intervention-innovation workshop

The previous workshop report, data derived from the tool and student survey were mirrored back to the research participants during the second intervention-innovation workshop for discussion. (The data on the innovation tool is discussed in Chapter 4, Section 4.9.) This allowed the research participants to identify the contradictions within the system within both case studies. Through this engagement process, the research participants could visualise the potential expansions of the curriculum and learning practices, thus allowing the

participants to identify the challenges, dynamics, practices and teaching methodology that required transformation or revision as aligned with the expansive learning cycle (Engeström, 1999b). The tool assisted in the remodelling of the innovation plans and the re-examining of the model for both case studies. The possible options for innovation became clearer to participants during the second intervention-innovation workshops. The discussion included the contradictions between the current system and a Climate-Smart Innovated system. At this stage, the reflection on possible changes and ideas on how to function better by working with and in a knowledge innovative system were the main topics of discussion. An in-depth report capturing the recommendations for curriculum innovation for the two case studies was compiled for further dialogue and collective review in the third of the intervention-innovation workshops.

The third intervention-innovation workshop and ongoing analysis of data emerging from the innovation process was aimed at initiating and further expanding the innovation of each case study's agriculture curriculum and learning activity system. During the third workshop, research participants focused on what types of innovation had occurred and where the innovations were initiated. The complexities within the system and challenges relating to innovations were also discussed. From these discussions the emergence of newly founded challenges and barriers that the participants were facing within and during their curriculum innovation journey surfaced. Based on this, the participants also remodelled the innovation plan and objectives. Phase Three is outlined in Figures 3.8 and 3.9.

Phase 3.1 consisted of feedback engagements between the researcher and participants to evaluate and reflect on the expansive learning cycles. During each intervention-innovation workshop, the participants questioned the system, analysed the system, surfaced contradictions within the system and mediated an intervention plan towards developing a responsive Climate-Smart system.

Phase 3.2 Refinement and utilisation of the reflexive tool

During Phase Three, the colleges reflected on existing curriculum practices, possible absences, contradictions, possibilities for transformation and change that exist at the interface of the existing systems. The researcher continuously and responsively

developed the Climate-Smart Innovation Tool to better align with the needs of the participants. The initial aim of the Climate-Smart Innovation Tool was to act as a double stimulation tool providing mirror data to the participants for identifying the problematic areas that hindered the innovation process. In this way, the tool facilitated the identification of the system's Climate-Smart responsiveness. The tool indicators allowed for the detection of specific areas of strengths and areas that may require future development in relation to Climate-Smart responsive concepts, principles and policies (see Appendix 5). It simplified more complex emergent properties, helping users to identify possible areas of innovation and success through a relatively easy review technique. The tool was initially designed for users to review the curriculum and learning responsiveness towards Climate-Smart Agriculture. However, individual lecturers also used the tool to review their professional responsiveness within relevance of curriculum content, community development programmes and competence of teaching strategies.

The initial tool was divided into sub-tools to cater better for the specific requirements of the participants and thus it could also be utilised by other Agricultural Training Institutes. The further development and refinement of the innovation tools allowed the college lecturers and management to focus on their own particular journeys of innovation and Climate-Smart responsiveness (see Appendix 5). Togo's (2009) research showed that the Unit-based Sustainability Assessment Tool (USAT) developed for university level sustainability assessment was widely taken up and used by other universities in Africa (Togo, 2015), and that the tool supported a regional movement of curriculum innovations. There was also interest in how the tool was developed and how it could be adapted to suit other institutions' needs (Togo, 2015). The study took these insights into account during the refinement and description of the use of the tool, noting particularly the importance of participants in diverse contexts adapting and customising the tools for their own context and reflexive self-assessments of their own praxis.

In line with the adaptive intent of the tool, during Phase Three it became apparent that the initial tool was not adequate to assist the lecturers and other participants to evaluate their curriculum. The challenges surrounding the innovation tool being in a booklet format or even a spreadsheet format was that it was not very user friendly (see Appendix 5.1). Lecturers found the written and spreadsheet version of the curriculum review tool tedious, time

consuming and not providing enough support and resources to assist in curriculum innovation (Section 5.3.2.2 and 6.3.2.2). Also, participants did not have direct access to their data as the data had to be entered into a spreadsheet, analysed by the researcher and then feedback was provided. The possibility of an online interactive innovation tool design that could also provide feedback and support to the participant directly after completing the review was thus explored (see Section 4.7 and Appendices 4.2 to 5.6).

During Phase Three, the tool was developed from a booklet form to an interactive online review format. At this stage sub-tools were also developed. Each online sub-tool structure and development is discussed with an example of each tool in Appendix 5. The online sub-tools were refined for specific areas such as Management, Individual lecturers, Departments, Lecturer in a specific department. The participating reviewer can decide which area of the curriculum he/she would like to review and then choose a specific tool e.g. Plant Production. In this way, the tools catered for an individual lecturer that wanted to develop his/her own subject and at the same time catered for a department or the management of the Institute following the initial logic of the Unit-Base Sustainability Assessment Tool (Togo, 2009; Togo & Lotz-Sisitka, 2009).

Examples of the full reports provided directly after a reviewer has completed his or her online evaluation are available after each example of the online sub-tools in Appendices 5.2 to 5.6. The report provided feedback on each category that the reviewer completed, with an explanation of what each category reviews and links to websites or resources that might assist participants to develop the category areas which he/she wishes to develop. The online sub-tools were developed in such a way that they could be used to assist individual lecturers, departments and other institutional units that are part of the innovation system identifying and tracking transformation.

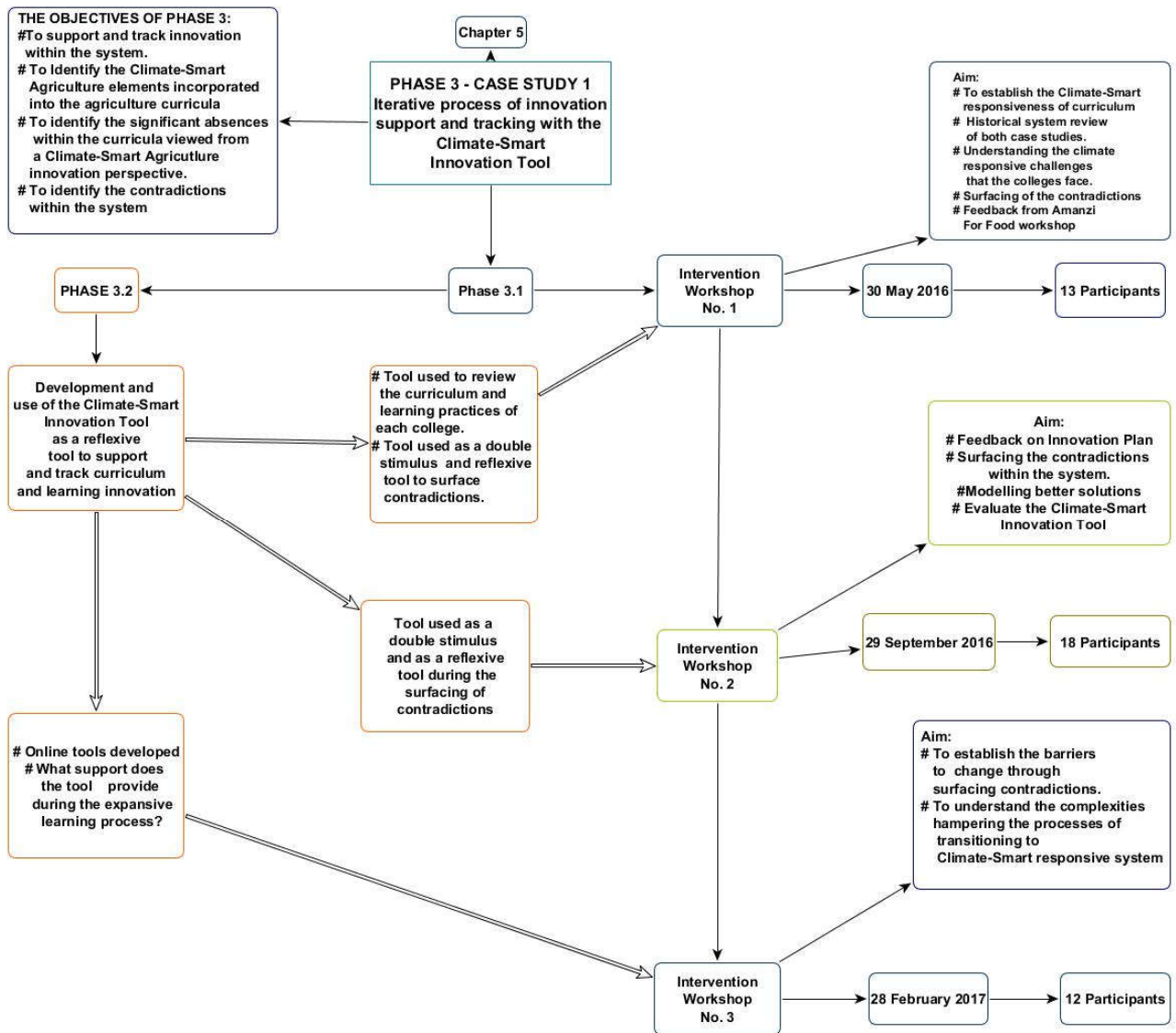


Figure 3.8: An outline of Phase Three of the study for Case Study One

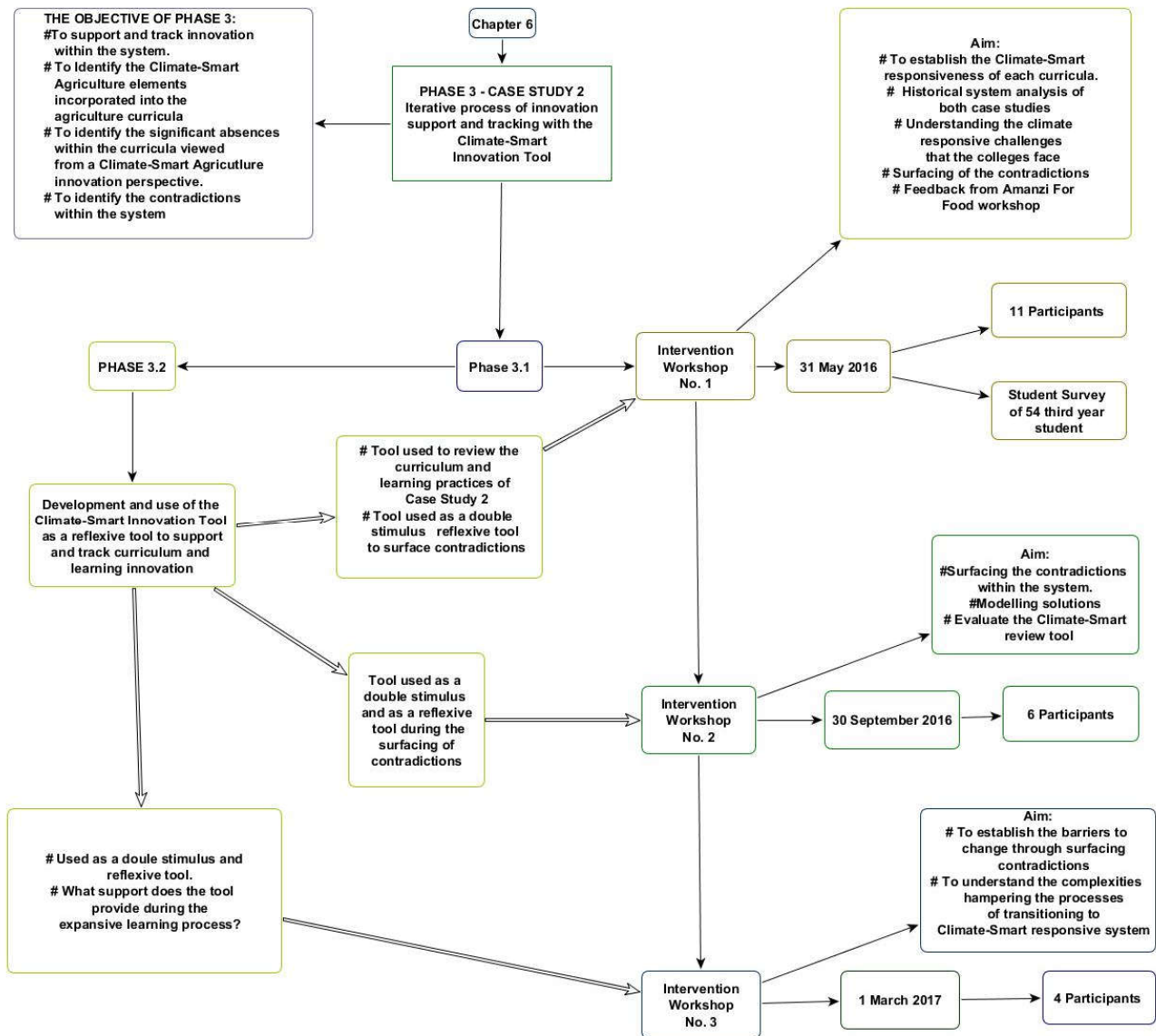


Figure 3.9: An outline of Phase Three of the study for Case Study Two

PHASE 4: A REVIEW OF THE DATA DERIVED FROM THE PROCESS OF EXPANSIVE LEARNING AND INNOVATION THROUGH THE CLIMATE-SMART AGRICULTURE INNOVATION FRAMEWORK

The aim of Phase Four was to investigate the expansive learning process within the colleges and provide feedback to the research participants. Phase Four aimed to determine how the expansive cycles related to the utilisation of the innovation tool and how the use of the tool articulated with the kind of change that was apparent in the college system. The driving factors of the innovation were also in question. During Phase Four, the achievements and outcomes of the expansive learning process were documented. Phase Four focused on the

formative intervention process by developing an understanding of the challenges and barriers hampering innovation and identifying the innovative processes that led to change during a time of institutional flux.

Phase 4.1: Review of innovation process

Phase Four of the research process is outlined in Figure 3.10. The feedback phase consisted of feedback discussions between the researcher and research participants. Feedback was also given by the research participants through the online Climate-Smart Innovation sub-tools. There was a period of more than two years (April 2015 to September 2017) to track the innovation through an expansive learning process towards policy implementation and a Climate-Smart responsive curriculum. The review of each curriculum and learning activity system and reflective discussion with the participants in Phase Four provided a clear view of the potential challenges and limitations of the agriculture curriculum towards Climate-Smart responsiveness.

Phase 4.2: Further development of the reflexive tool

Phase Four's aim was to work with the outcomes of the curriculum innovation process as mirror data to reflect on the systemic formative intervention and the use and potential value of the Climate-Smart Innovation Tool. The research focused on how use of the tool affected the expansive learning process, the type of innovation that occurred through the use of the tool and the factors that were driving the innovation process. During Phase Four, the final research question was answered:

How can an Agricultural Innovation System functionally foster the necessary knowledge and competencies for transitioning to a climate responsive system of curriculum and learning innovation within a system of flux?

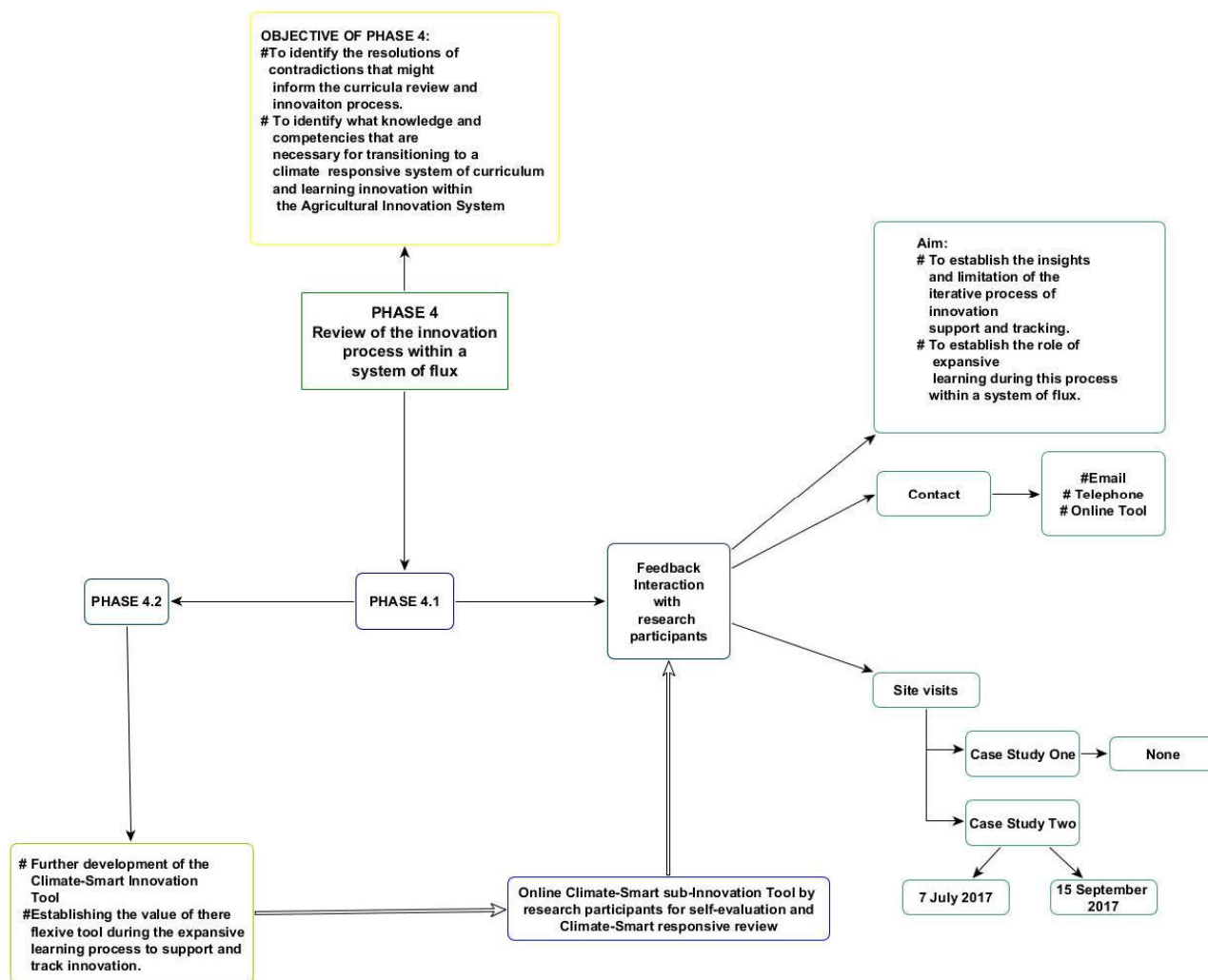


Figure 3.10: An outline of Phase Four of the study

3.3.1.2 CASE STUDY

This study adopted a case study research design as this allowed for in-depth investigation, identification and exploration of the initial, transitioning and existing curriculum situation, while uncovering contradictions and possible expansions towards a Climate-Smart responsive curriculum. The research design allowed for the determination of the transformation challenges within the agriculture curriculum and learning innovation process (Yin, 2003). Multiple research methods of data collection were used to ensure the trustworthiness of the research findings as the research was based on multiple embedded case studies within the Provincial Agricultural Innovation System (see Section 3.3.1.1). The unit of analysis for Case Study One and Case Study Two was an iterative process of innovation support and tracking towards a Climate-Smart responsive curriculum. These case studies were connected to each other as they share objectives within their systems including the Provincial Agriculture

Strategic Plan and policy implementation (see Figure 1.1; READ, 2015b). The case study design seemed most appropriate because it allowed for comprehensive research methods in accordance with the intensive research design that is typical of research underpinned by Cultural-Historical Activity Theory and expansive learning (Sayer, 2000). The application of Cultural Historical Activity Theory required the researcher to analyse the tools, the object and subjects within the activity system by interrogating their relationships, histories and contradictions both within the provincial system and between the systems (Sayer, 2000).

3.3.1.3 CASE STUDY PROTOCOL

Rigour in the research was sought through careful planning and designing a case study protocol as recommended by Yin (2003) and implemented as suggested by Mukute (2010). Below follows a brief description of field procedure, case study questions and case study report design.

FIELD PROCEDURES

An official e-mail of introduction was sent ahead of interacting with the management of the two Agricultural Colleges. In addition, phone calls were made to Mr. Serage to discuss the project as part of the Amanzi For Food project and to schedule a project introductory meeting. He was, at the time, the Head of Department of Environmental, Agriculture and Rural development department of North West Province (READ) and had oversight of the management of Taung Agricultural College and Potchefstroom College of Agriculture. After our initial meeting and discussion, the preliminary consultative workshop was planned and held during July 2015. An introductory PowerPoint presentation explained the objectives of the project. After each workshop and interview, e-mails were sent out to the participants to thank them for their cooperation and these included a workshop report. The participants signed a participation letter indicating that they acknowledged their participation as part of the research project. Verbal consent was granted for some interviews. Each report was sent to the participants and management for comments and alterations. At the end of the four phases, a report was sent to all research participants to report on what had emerged from the research process as well as to ask for their feedback.

CASE STUDY QUESTIONS

During the first phase, data was gathered by examining college curriculum documents, reports, historical documentation, educational and agricultural policies. During Phase Two a survey was given to each participant with the aim of establishing the participants' knowledge on climate change and climate change responses (see Appendix 1). The first consultative workshop also included questions of discussion to aid in the understanding of how the curriculum was functioning and the challenges surrounding curriculum innovation.

CASE STUDY REPORTS

The framework used for data analysis for this study was structured around the formative intervention research process (see Sections 3.2.2 and 3.2.3). It was informed by the research objectives and the theory which was the foundation of this study (Sections 1.8, 1.9 and 3.2). NVivo 11 software was used to compile an in-depth case record of each case study. NVivo software was chosen as it is software that supports qualitative and mixed methods of research. During this research process, NVivo was utilised to organise and manage all the data and records of each case study. Data in the form of document analysis, consultative and intervention workshops, personal interviews, group interviews and curriculum review analysis, by means of the Climate-Smart Innovation Tool, were stored. The data gathered on each case record were properly organised using Nvivo 11 to sustain and validate the research. Each case study's data was kept for future use in the writing of the thesis and for evidence of the research and engagement with research participants. A record for both case study sites was compiled.

Each case record included:

- Evidence of key communication with research participants of the case study,
- Samples of interview records,
- Data derived from the Climate-Smart innovation tool,
- Agenda for consultative and intervention (innovation) workshops,
- Reports made on each of the workshops facilitated for both cases;
- Samples of comments on the reports and associated feedback from research participants;
- Selected audio recordings and videos of innovation workshops; and
- Reflections on the research processes.

The case study records were the foundation of the research and helped to consolidate all sources of data. Mendeley Desktop was also utilised to create a database of all the documents referenced and read for research purposes during this study. For convenience, Appendix 6 includes the Case Study Records.

3.3.2 RESEARCH PROCESS

3.3.2.1 CHOOSING THE STUDY SITE

Potchefstroom and Taung Agricultural Colleges were chosen for the two studies as the Department of Environmental, Agriculture and Rural Development of North West Province has adopted new strategic goals and strategic objectives since the 2014/2015 financial year which include the promotion of a Climate-Smart Agriculture in these colleges (READ, 2015a). The Department of Rural and Agriculture Development of the North West was supportive of the research project and at the beginning of the project the Principal of the two colleges had in fact requested that such an expansive process of curriculum innovation be facilitated in the two colleges (D. Serage, personal communication, May 27, 2015). The two colleges share a similar agro-ecological context, they have different offerings and specialisms, which made the case studies diverse in their applications and co-innovation of a Climate-Smart responsive curriculum. However, both colleges share the same climate change conditions and provincial climate research is relevant to both colleges. This allowed for diversity in the case review at curriculum level, yet also for some synergies at the contextual social-ecological system level, allowing for richer interpretations and insights into the development of the Climate-Smart Innovation Tool through the diverse input of the research participants.

3.3.2.2 NEGOTIATION OF ACCESS

As the study could also be classified as a social scientific study, access to the premises and research participants was required (Bloor & Wood, 2006 cited in Mukute, 2010). Access to the research does not only include physical access, but also relationships with the research participants, social access, trust building by respecting others, listening carefully and being consistent and dependable. Access to the North West Province's Agricultural Colleges was negotiated through initial telephonic and electronic communications with Mr. Serage, who granted access. Research relationships were developed and managed by continuous feedback to research participants including e-mailing workshop reports, the development of

the tool and other informative documents that participants might benefit from. All comments and suggestions from participants were welcomed and documented.

3.3.3 RESEARCH METHODS

The research followed an iterative process of expansive learning cycles within a case study design in which insight into complex activity systems was sought through innovation support and tracking towards Climate-Smart responsiveness. Qualitative research methods were used. These research methods are discussed below.

3.4.3.1 SEMI-STRUCTURED INTERVIEWS

Semi-structured interviews were used to generate most of the initial data in Phase One of the research. This research method allowed information to be obtained from different sources and offered flexibility as to acquiring the relevant information from individuals as each participant had different perspectives and fields of specialty. An interview protocol was developed (discussed in Section 3.4.1.2) before engagement with participants in an informal conversation. The follow-up questions during the interviews and follow-up interviews were shaped by the research subjects through issues arising from the discussion. Interviews were in the form of face-to-face individual interviews and interviews by telephone.

During Phase Two, various deliberations during, before and after the two workshops between the researcher and the participants occurred. During the research process, other stakeholders in the agricultural education system and sector were also interviewed. These interviews included representatives of Biocontrol, Amanzi For Food, local farmers and fellow researchers. During Phase Three, interviews were held with the campus managers, farm managers, Head of Departments and lecturers. The number of people interviewed and who these people were also depended on availability, questions that needed answering and the eagerness of the lecturers. During Phase One and a section of Phase Two, it was easier to organise interviews in Potchefstroom because of its location and accessibility. A relatively low response rate from both case studies to feedback reports on workshops and other engagement where a potential threat to the validity of the findings in Phase Two. However, these concerns were addressed by using these findings as 'mirror data' in the follow-up intervention-innovation workshops.

3.3.3.2 DOCUMENT ANALYSIS

Documents and policies often carry a history and therefore culture and context. Given that the study was embedded in Cultural Historical Activity Theory that values the historical and cultural context of the present as well as the past, document analysis formed an important part of the data gathering methods. The analysis of documents, articles and policies allowed the development of a clearer picture of the agriculture curriculum and learning activity systems of the North West; this kind of analysis is neither obstructive nor reactive. The documents that were used in the study included books, course outlines and programmes, scientific articles, brochures, reports, and policies. A comprehensive collection of all documents analysed for each case study, Climate-Smart Agriculture research and policy section was compiled in a Mendeley Desktop database for future referral (see Appendix 6). Documents were critically evaluated during the document analysis stage and the historical circumstances of these documents were kept in mind, a practice which is consistent with good research. Historical analysis documents ranged from publications dating 1915 (UDA, 1915) to the present. Some documents were borrowed from the college library, scanned and reviewed. Documents were analysed in Mendeley Desktop and notes were made within this programme. Data analysis were also used to verify data from other sources such as interviews and observations.

3.3.3.3 OBSERVATIONS

Observations allowed the researcher to include not only what the participants said, but also their actions. Observation enables a researcher to see directly what is occurring at the time of the research and the research context. This allows a researcher to obtain authentic and unexpected relevant data (Cohen, Manion & Morrison, 2007). At both case study sites, a tour through the campus and farming facilities was arranged to observe the functioning of the college to assist in the development of a clear contextual profile of both case studies in Phase One. Observations during the expansive learning process were captured by video and audio recordings during the intervention-innovation workshops. The recordings were replayed for analysis and authentication continually through the research process.

3.3.3.4 RESEARCH PROCESS

During the research process, data were generated and analysed by following an iterative innovation support and tracking process adapted from the expansive learning process research method developed by Engeström through intervention workshops (Virkkunen & Newnham, 2013). The method was used for data generation and data analysis. The Climate-Smart Innovation Tools aided in the data generating of mirror data used during the formative intervention workshops as explained in Chapters Five and Six. The adapted expansive learning process was implemented and used as it facilitates both intensive transformations and continuous step-by-step innovation (Engeström et al., 2016). The research process is outlined in phases in Figures 3.6, 3.7; 3.9 and 3.10. The initial contact sessions were voice recorded and later interviews and workshop proceedings were video-recorded. During each workshop, an attendance list was sent around and participants signed a research participation agreement that included his/her contact details (see Appendix 6). After each session, reports were compiled and e-mailed to all the participants for comment.

3.3.3.5 VALIDITY AND TRUSTWORTHINESS

In order for the data from a qualitative study such as this formative intervention study to be valued, the data must be reliable and valid. During the research process, data validation and trustworthiness were ensured by using various methods of data gathering. The validity of the research findings was ensured by making use of triangulation, member checking and keeping continuous contact with the participants of the study. Various data generating methods were used to ensure the validity of the research findings as stimulated by triangulation. These data generating methods included document and policy analysis, interviews, observation of learning and practical facilities, consultative and formative intervention workshops applying expansive learning processes. Interviews with READ and other Provincial Agricultural Innovation System stakeholders and various sources including libraries and relevant websites provided additional information to the research.

During this research, data derived from the Climate-Smart Innovation Tool was used as part of a double stimulation process. The mirror data discussed during the intervention-innovation workshops can also be viewed as a method of member checking. The workshop reports were also e-mailed to all participants for feedback and review as another method of member

checking. A third layer of member checking took place at the beginning of each workshop as mirror data was presented to participants, reflected and commented on. During the intervention-innovation workshop session, the main findings of the research were presented as part of the member checking and feedback process. During the third intervention workshop and feedback, the participants commented on the main findings and thus validated the research's findings.

Mukute (2010) commented on the useful insights obtained during the exchange of knowledge within one's research community. During PhD weeks, other meetings and student forums the research data was shared and discussed. Not only fellow students commented on my research, but I also sent my research to other experts including Erna Kruger for comment. This helped with seeing the research through different lenses (Mukute, 2010). The quality of the data was also ensured by the prolonged duration of the study and the amount of contact sessions and communication between the researcher and participants (see Figures 3.6, 3.7, 3.8, 3.9 and 3.10). Most of the workshops were conducted within a day; however time before and after the workshop was used to discuss research informally with participants and observe the changes and development within the respective curriculum and learning activity system.

3.4.3.6 ETHICS

Sound research is a moral and ethical endeavour and should be concerned with ensuring that the interest of the research participants is always considered and never harmed as a result of the research (Halai, 2006). The research process was undertaken with an ethic of respect for people, respect for knowledge, respect for knowledge and democratic values while also respecting the quality of educational research (Bassey & Bera, cited in Murray, 2006). Hammersley and Traianou (2012, p. 2) explained that the British Educational Research Association (BERA) identified five core ethical principles, namely:

- Minimising harm,
- Respecting autonomy,
- Protecting privacy,
- Offering reciprocity,
- Treating people equitably.

Keeping these principles in mind, the research process was planned and executed while considering all the ethical issues. Special attention to negotiating access, prior informed consent, including consent for taking pictures of the participants during the study, the aim of the project was discussed with the management and research participants, as recommended by Hammersley and Traianou (2012). Negotiating access is discussed in Section 3.4.2.2. However, e-mails and conversations by telephone were initiated before the first contact session with the Principal of the two colleges. During the research process, ethical issues were considered and researched (Singer, 2008; Halai, 2006; Murray, 2006). The researcher obtained informed consent from all those who were directly involved in the research process; an example of the consent form can be seen in Appendix 2. Due to management and staff changes, negotiating access had to occur again when the Principal was transferred and access to the two Case study sites was renegotiated with the two campus managers who were both very accommodating. Negotiating access to Case Study Two was renegotiated for the third time when a new campus manager was instated. All communications were positive. All participation was on a voluntary basis and the respondents had the right to withdraw at any time. The research participants were briefed on the purpose of the study and their roles as participants during contact sessions or interviews were carefully clarified.

3.4 CONCLUSION

Chapter Three has discussed the theoretical framework and methodology that structured the research process. The research process consisted of four phases guided by Cultural Historical Activity Theory within a systems approach. The methodological research methods allowed the researcher to track the process of innovation, the complexities within the system and the suggested implementation efforts to obtain a systemic view of the change towards Climate-Smart responsive curriculum. The researcher worked with the outcomes of the curriculum innovation process as mirror data to reflect on the iterative formative intervention, and the use and potential value of the Climate-Smart Innovation Tool. Chapter Four continues to discuss Phase One and Two of the research process.

CHAPTER 4

CONTEXTUAL PROFILE, THE PRELIMINARY WORKSHOPS, AND THE FIRST CLIMATE-SMART AGRICULTURE SELF- ASSESSMENT

4.1 INTRODUCTION

Chapter Four presents the data and analysis generated in Phase One and Two of the study. Chapter One described the North West Agricultural Innovation System and Chapter Two discussed two innovation drivers of the system namely Climate-Smart Agriculture and policies. Chapter Four begins with a summative contextual profile of each of the agricultural college case studies. The chapter continues to discuss the preliminary consultative workshop and the National Amanzi For Food workshop engagements. The chapter concludes with the analysis of the Climate-Smart Innovation Tool scores of both colleges.

Chapter Four focusses on the following research questions of Phase One and Two of this study, namely:

- 1.1 How are the current National Diploma of Agriculture curricula constituted?
- 1.2 How can a reflexive tool be developed for review, support and tracking of curriculum innovation towards Climate-Smart responsiveness?
- 1.3 Are there examples of curriculum innovation tools for sustainability that can be adapted for climate smart responsiveness? If so, how can this be done?
- 2.1 How can college staff involved in the offering of the National Diploma in Agriculture be engaged through formative intervention to explore practical options for curriculum innovation utilising Climate-Smart Agriculture?

4.2 CONTEXTUAL PROFILE OF CASE STUDY ONE

Taung Agricultural College was established in 1965 and has undergone several institutional and governance changes until recently when the college registered a new curriculum. Figure 4.1 is a satellite image of the college indicating clearly the infrastructure of the college. Figure 4.2 is a picture of the main building and entrance to the lecturing facilities. The college is situated at Greater Taung Local Municipality in North West Province at Dr Ruth Segomotsi Mompati District between Hartswater and Vryburg and about 30 km from Hartswater and

70 km from Vryburg (see Figure 4.3). PH Moeketsi Agricultural Secondary School borders on the college's west side. Taung Agricultural College is part of the Hartswater Irrigation Scheme that is a sub-section of the Vaalharts Irrigation scheme. The Vaalharts irrigation scheme started in 1933 but was only completed in 1946. Bloemhof Dam was constructed in the 1970s to reduce the pressure on the Vaal Dam and to feed the Vaalharts weir (Van Vuuren, 2010).



Figure 4.1: A satellite image of Taung Agricultural College campus (copied from Google Maps: <https://www.google.co.za/maps/@-27.5456856,24.7693176,809m/data=!3m1!1e3> Accessed 24 April 2017)

In the 1970s under separatist policies of the apartheid states, former homeland areas were declared 'independent'. This resulted in the central government's withdrawal and

Bophuthatswana administration taking over. The Taung Irrigation Scheme was incorporated into the former homeland area between 1970 until 1990s (Acha, 2014). The irrigation scheme provided economic development for smallholder farming, job creation and rural development within the surrounding area (Tekana & Oladele, 2011, p. 69). There are more than 400 smallholder farmers working on the scheme (DoA, 2013, cited in Acha, 2014; F. Klinck, personal communication, May 27, 2017). Acha (2014) identified some major problems faced by the Taung Irrigation Scheme. These problems include lack of capital, institutional structure, water pricing, marketing, transport and theft of crops. Approximately 3 500 hectares are under irrigation in Taung area (READ, 2015b). Since the irrigation scheme's development, farmers have mainly used the system to grow lucerne, ground nuts, potatoes, grains and vegetables. In recent years, farmers are successfully growing pecan nuts, cotton, olives, citrus, apricots, grapes, watermelon and peaches (Van Vuuren, 2010).



Figure 4.2: The entrance to the main building and lecturing facilities at Taung Agricultural College

The college was previously known as L.M. Mangope Agricultural College. In 1994 the Taung Agriculture College Amendment Act No. 16 of 1994 amended the L.M. Mangope Agricultural College Act of 1989 and changed the name to Taung Agricultural College (DoA, 1994). Until 2002 the Taung Agricultural College offered a Bachelor of Technology in Agricultural Management over three years on behalf of Pretoria Technikon which was accredited at the

same level as Technikon qualifications (Bapela & Mariba, 2002, p. 64). With the Bachelor of Technology, the college also offered a Higher Certificate in Farming Management for two years. A provincial report (2002) indicated that the outcome aims of these courses focused on skills relating to self-employment and employment in the agriculture public sector. The college lost its institutional accreditation from the Certification Council of Technikon Education in 2002 (DACERD, 2010).

After the loss of accreditation, the college offered vocational⁸⁸ N3 to N6 programmes in Farming Management as well as Further Education Training (FET) for future farmers. However, the vocational programme was discontinued in 2009 when new innovative educational programmes were developed (DACERD , 2010).

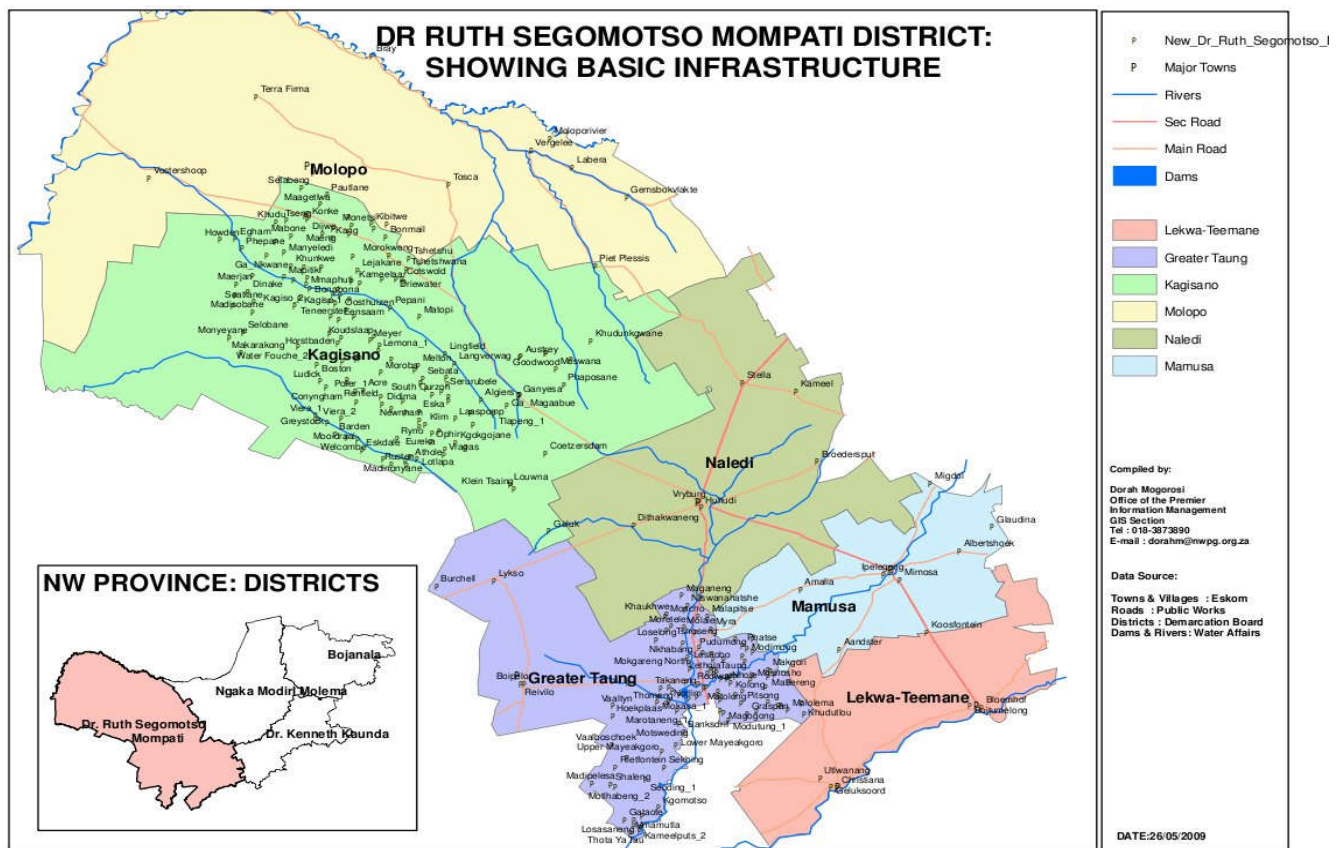


Figure 4.3 A map of Taung Agricultural College's location (TAC, 2014a)

⁸⁸ Practical or first-hand skills that help a person to master a specific trade.

Taung Agricultural College reopened in 2010 following the national transformation of colleges of agriculture by DAFF and was ready to offer a Diploma in Agriculture specialising in Mixed Agriculture, effective from January 2010 (READ, 2016). About R3 million was allocated to the college to reopen its doors in 2010 (Gwantyu, 2010). Abrie van Vuuren was the Head of Campus during the reopening of the college. The Diploma offered at the college aligned with the Diploma in Mixed Agriculture offered at Potchefstroom College of Agriculture. According to Boitumelo Tshwene, Member of the Executive Council (MEC) for Department of Agriculture, Conservation, Environment and Rural Development (DACERD), in order to complete the upgrading process of the college, Taung College had to collaborate with Potchefstroom College in a sustainable partnership to ensure the success of both colleges (Gwantyu, 2010).

There were seven graduates in 2012 with Diplomas in Agriculture, specialising in Mixed Farming (RSA, 2012). The college's infrastructure was proficiently upgraded. Taung Agricultural College developed a National Diploma in Agriculture specialising in Irrigation in 2013. In December 2012, the college received candidacy phase accreditation from the Council of Higher Education and the qualification was then successfully registered with the South African Qualifications Authority (SAQA) (RSA, 2012). The acting Head of Campus at the launch of the Diploma in Irrigation in 2013 was Mr. F Klinck. During 2014 Taung Agricultural College received the Haldor Topsoe R10 million donation to create an excellent centre of irrigation technology. The College committed itself to development which also included a soil science and water management laboratory of R3.3 million. The laboratory was for soil and water analysis for the college and farmers from the surrounding communities close to the Vaalharts irrigation scheme. During this revamp of the college Ms. Prudence Matlhoko was the Head of Campus. The upgrade also included a specially designed multi-purpose truck termed "College on Wheels" that could be used to access people who needed services related to farming and farming management. This R1.1 million farmer training truck was fully equipped with TV/video, a sound system, a solar panel and a mobile stock handling facility as well as training materials in various languages (RSA, 2015). The college still offers the Diploma in Agriculture specialising in Irrigation accredited by the Council of Higher at NQF level 6 (RSA, 2012; TAC, 2014a). The Irrigation programme is a unique course and the college is the only institution in South Africa offering a Diploma in Irrigation.

4.2.1 STRUCTURE OF TAUNG AGRICULTURAL COLLEGE

The College Campus head is Mrs Prudence Matlhoko (in 2018) who reports to the Principal, also known as the Director of Structured Agricultural Training and Empowerment for the Department of Rural, Environmental and Agriculture Development for the North West province. (Mr. Serage was the principal of both Taung and Potchefstroom college until 2016 June, but since then the position has been filled by Dr Mabe). The principal reports to the Head of READ, who in turn reports to the National Department of Agriculture, Forestry and Fisheries. Taung College aims to provide and facilitate education and training to all participants in the agricultural sector as stipulated by the Higher Education Act, 1997 (Act No. 101 of 1997) as amended. The purpose of the college as outlined in the Prospectus is to “provide accredited higher agricultural education and training towards pioneering sustainable enhanced agriculture” (TAC, 2014c). The college comprises various sections and managers including managers of Irrigation, Engineering, Economics & Information Technology, Animal Production, Crop Production, Farm Management, Corporate and Student Admin. A total of 102 personnel is required to form the full quota of staff for the college. The estimate is that 89 staff members are currently employed (F. Klinck, personal communication, March 30, 2017; TAC, 2014a). The farm section has the highest number of staff (28 personnel), followed by student administration staff, while the technicians have the lowest number of staff. Academic staff consists of 15 lecturers.

The College owns land for crop and irrigation including six hectares for Horticulture and centre pivots of 30, 20 and 10 hectares. The dryland that forms part of the college spreads out for 48 hectares. The college also runs a tandem dairy parlour that is fully automated, a broiler house, layer house, a piggery, a small stock unit, a large stock unit and 15 hectares of paddocks (TAC, 2014a). Learning resources include a library centre with a study area for the students and a computer room for 40 students. There are six hostels with the capacity for 156 students. The kitchen and dining hall can cater for 300. Various facilities for sports and recreational purposes are in place including a rugby field, a soccer field and two tennis or netball courts (TAC, 2014a).

4.2.2 TAUNG AGRICULTURAL COLLEGE’S NATIONAL DIPLOMA IN AGRICULTURE

The National Diploma in Agriculture in Irrigation consists of 360 credits consisting of two and a half years on campus for theoretical and practical learning concluded with six months of

experiential learning on a farm or at another relevant practical institute. The curriculum is offered by the Departments of Irrigation, Crop Production, Farm Management and Animal production. Table 4.1 list the subjects under each department (TAC, 2014c).

These subjects are presented in five lecture halls for between 30 and 50 students and the college also has an exam hall for up to 100 students. There are three laboratories on the campus grounds for Soil Science, Animal Science and Crop Science. Practical workshops offered by the college include arch welding, gas welding, carpentry and mechanical workshops.

Table 4.1: List of the academic departments of Case Study One and the subject areas offered within these departments

Department	Specialised subjects	
Irrigation	Fundamentals of Irrigation Hydraulics and Flow Measurement Irrigated Pasture Management Evaluation of Irrigation systems Irrigation Equipment and System Design Automated Irrigation Systems Drainage System and Design	Soil and Water Conservation Natural Resource Management Chemigation Irrigation Management Irrigation Management Practices Irrigation System Evaluation Maintenance of Irrigation Dams
Crop Management	Agri Botany Soil Science Veld Management Crop Protection Soil Fertility Soil Survey	Vegetable Production Winter Crop Production Fruit Production Summer Crop Production Chemigation Evaluation of Irrigation Systems
Animal Production	Anatomy & Physiology Pig Production Small Stock Production	Beef Cattle Production Poultry Production Diary Production
Farm Management	Agricultural Economics Computer Applications Agricultural Marketing Agricultural Financial Management	Rural Development Agri-business Management Research Principles Farm Trades

The assessment at the college is based on learning outcome assessment procedures which include a variety of assessment methods such as tests, examinations, practical sessions, reports, oral presentations, portfolios, posters, case studies, projects, observations, essays etc. Students are frequently assessed using integration of knowledge, skills, values and attitudes across the assessment tasks (TAC 2014a; F. Klinck, personal communication, May 13, 2016). Taung Agricultural College has aligned itself from a traditional base of learning programmes towards a transformative outcome based education (OBE) approach (TAC 2014c, p. 4). The Diploma in Agriculture specialising in Irrigation is accredited by the Council of Higher Education for 360 credits.

The college is located within rural communities most of which are still trapped in poverty and food insecurity. Taung Agricultural College, through its students and the Haldor Topsoe donation, established an outreach programme aimed at improving the livelihood of the Taung community. The Taung district hospital was identified as one site that would benefit from this. The project's objective was to establish food plots at the hospital to contribute to food security. In addition, the college is in the process of procuring mobile training for training farmers at their localities.

4.3 HISTORICAL REVIEW OF TAUNG AGRICULTURAL COLLEGE

This section briefly reviews Case Study One as an activity system by using the Cultural Historical Activity Theory (CHAT) framework of rules, mediating tools, community, subject, object and division of labour from a historical point of view. This historical review has been compiled through document analysis and supported by interviews with stakeholders within the activity system (Chapter 3, Section 3.2.2).

4.3.1 RULES: AGRICULTURE AND ENVIRONMENTAL POLICIES INFLUENCING FARMING AND SOCIAL TRANSFORMATION

Policies and sound governmental legislation drive innovation in the Agricultural System and sub-systems. These policies are discussed in Chapter Two and depicted in Figure 1.1 as one of the system drivers of innovation. This section briefly summarises the agricultural policy driven objective changes within the Agricultural Innovation System over time. The agricultural policies, strategic plans and operational changes affected the agricultural college as the college's curriculum aligns with the system's needs and objectives. From 1965 until 1994 the

focus of the Agricultural Sector's objective was to develop commercial farming by mainly white farmers and support agricultural research (UDA, 1915). Taung Agricultural College's role since 1965 was to cater mainly for Black Agricultural Training, as there were separate Black and White Agricultural Training facilities. Taung College was situated in Bophuthatswana, an independent homeland. Farming within the North West Province during this time was done by white commercial farmers that owned their own land and smallholder farmers and subsidy farmers that mostly farmed in the Bophuthatswana independent homeland that did not own the land (DAF, 2008). The Taung irrigation scheme was incorporated into the independent homeland from the 1970s (Acha, 2014). However, in the North West Province, as in the whole of South Africa, separate agricultural extension services were provided for the commercial farmers and the smallholder farmers. However, the extension services within the homeland territories were not as successful as expected because the extension officers were not trained in smallholder farming and tried to apply the same farming techniques used in commercial farming (Acha, 2014).

Agriculture curriculum innovation has shifted since democracy was established in 1994. After 1994 it was imperative to address the legacy of apartheid in all areas of human activity and particularly in agriculture and education. The White Paper on Agriculture in 1995 aimed to address these issues (DoA, 1995). The government also realised that poverty, especially in rural areas and among rural women needed to be addressed. In the former homelands, resource degradation was caused mainly by poor living conditions and overpopulation. The 1995 White Paper of Agriculture focused on the need to establish equitable access to appropriate and effective extension and training to be ensured, with the emphasis on farming communities who lacked access in the past. At this time, the Agricultural sector's focus shifted to address food insecurity, to support homestead and smallholder farmers, to improve educational equity and to address skewed racial access to agricultural resources (DoA, 1995). The land reform programme resulted in a large increase in the number of full-time smallholder farmers which required several agricultural policy changes.

The former Bophuthatswana self-governing homeland area was part of the North West Province prior to 1994. Thus, the upliftment of smallholder farmers and land ownership affected the Agricultural Innovation System drastically. The focus turned to developing an integrated extension service that not only catered for commercial farmers, but also for the smallholder farmers. These changes had an impact on the agricultural curriculum and training

activity systems as the need for equitable access to agricultural education by all races and genders arose and the focus shifted from commercial farming to food security and support to smallholder farmers. After 1994 the South African government started to focus on the development of the Agricultural Sector through visionary policies, programmes and strategies. The government focused on agricultural training and governance structures aiming to develop a curriculum focused on the Sector's challenges and skills development (Didiza, 2005; DAF, 2008).

In 2002 the government developed Provincial Agricultural Education and Training Task Teams for each province to assess curriculum and learning practices within the provinces (DAF, 2008, p.16). This led to the launch of the National Agricultural Education and Training Strategy in 2005. The strategy is a driver for the current agricultural curriculum and learning innovation. The strategy aimed to address the needs of the country's economy and improvement of agricultural production through quality agricultural education and training (DoA, 2005b). The first change in focus was the change of the dualistic agricultural landscape, where 20% of the farmers produced 78% of agricultural products commercially. The other 78% farmers that included the subsistence and smallholder farmers produce 22% of South Africa's produce (DAF, 2008). During 2005 the Department of Agriculture also developed the Norms and Standards for Extension and Advisory training in South Africa. The Norms and Standards focused on developing Agricultural Colleges into Agricultural Training Institutes as Centres of Excellence in the provision of agricultural education and training (DAF, 2008). The Norms and Standards affected the Agricultural Colleges dramatically. The document explains how the Department of Agriculture plans to transform the colleges by revamping and restructuring them into Institutes. The focus would be on the transformation to Centres of Excellence, which influences curriculum and curriculum innovation (DoA 2005b). In 2005, the colleges were under provincial governance; this remains the case within the North West Province, but the idea is to incorporate the Agricultural Training Institutes at a national level. These Institutes focus on developing scarce agricultural practical oriented knowledge and competencies. The Agriculture Education and Training Strategy and Norms and Standards also impacted the colleges, arguing that a focus on specialisation was needed to align with local or provincial farming patterns. For example, Grootfontein Agricultural College in the Eastern Cape focuses on small stock farming and Elsenburg in the Western Cape focus on wine and deciduous fruit. Thus, pressure on the colleges in the North West Province to also specialise began.

The challenges faced by the colleges, according to the Agriculture Education and Training Strategy, included fragmentation and lack of coordination, poor and inconsistent quality control, a largely ineffective and non-responsive education and training system, poor access to agriculture education and training by emerging farmers and lastly a shortage of critical skills⁹ (DAF, 2008; DAFF, 2010). Since 2005 the Agricultural Sector's focus remained generally consistent, however the urgency of the changing climate was included in the sector's challenges. The Agricultural Sector Skills Plans also include climate change responses, food security, water scarcity and sustainable agriculture (DAFF, 2011; 2012; 2013a). Since 2013, the North West Province's climate response strategy adopted the Climate-Smart Agriculture approach as a response to the effects of climate change on the agriculture system including the agricultural educational system (READ, 2015b). The Agricultural Sector Skills Plan for 2011 to 2016 (AgriSETA, 2014) emphasised capacity building, curriculum and learning development, lecturer training, the importance of expanding the investment in research and technology to understand climate change and bioenergy demand (AgriSETA, 2014). The North West Agricultural System's climate change response strategy objectives included:

- The shift of commercial farming to include smallholder farmers and subsistence farmers;
- A response to climate change challenges by adopting and implementing Climate-Smart Agriculture approach as the province's climate response strategy,
- Encouraging Agricultural System innovations through curriculum and learning development, capacity building, making sure that the curriculum is relevant and aligned and focused on lecture training and infrastructure development (DARD, 2012), and
- Food security, poverty upliftment and rural development (AgriSETA, 2014; DAF, 2008; DAFF, 2012, 2013; READ, 2013, 2015a).

Taung College responded to these changes over the years. Firstly, it changed from an All Black Agricultural Training College to an agricultural college open to all races and genders. It developed a curriculum and established a Centre of Excellence in Irrigation in 2014 when the Diploma in Agriculture specialising in Irrigation was launched.

⁹ Scarce skills refer to those occupations in which there are a scarcity of qualified and experienced people, currently or anticipated in the future, either (a) because such skilled people are not available, or (b) they are available but do not meet employment criteria. Critical skills refer to specific, key or generic and "top up" skills within an occupation. (AgriSETA, 2016, p.19)

4.3.2 MEDIATING TOOLS

4.3.2.1 CURRICULUM CONTENT

The college's curriculum has changed drastically over the years since its opening in 1965. The historical innovation within the college curriculum started when it changed from a Bantu Education driven curriculum (prior to 1994) to a B.Tech in Agricultural Management (after 1994). Then it changed to the Vocational N3 to N6 programmes¹⁰ in Farming management in 2002 until 2010 when it switched to the same curriculum as Potchefstroom College. Finally, in 2013, the college developed its own specialised curriculum in Irrigation.

4.3.2.2 PRACTICAL LEARNING SITES

The college was revamped after 2010. Practical learning facilities included a fully automated tandem dairy parlour, a broiler house, layer house, a piggery, a small stock unit, a feedlot, beef cattle, horticulture, irrigated crop production and 15 hectares of paddocks (TAC, 2014a). In 2014 the college developed a soil science and water management laboratory. The laboratory was for soil and water analysis for the college and farmers within the Vaalharts irrigation scheme. However, during the study the laboratory was not functional. The laboratory infrastructure was complete, but no scientific equipment was in place. Thus, the laboratories were not used due to a lack of funding. However, plans are in place to develop these facilities further as all the other upgrades have been successful.

4.3.2.3 CURRICULUM INNOVATION TOOLS

The Vaalharts irrigation scheme is a curriculum innovation tool as it led the college to specialise in irrigation being situated within the Irrigation scheme. Since the introduction of Climate-Smart Agriculture in North West Province's Agricultural Strategic planning in 2013. The approach was seen as a climate response tool for curriculum development.

4.3.3 COMMUNITY

4.3.3.1 STUDENTS OF TAUNG AGRICULTURAL COLLEGE

The profile of college students has also changed. Prior to 1994, the students consisted of Black males. After 1994 the aim was to open the college to all races and genders. Since 1994 the composition of the students has changed drastically, mainly from a gender perspective.

¹⁰ The N3 to N6 programmes are part of the National Accredited Technical Education Diploma (NATED) vocational programmes that are offered at FET colleges under the auspices of the Department of Higher Education and Training. N3 is equal to a NQF level 3 and N6 is equal to a NQF level 6.

In 2016 60% of the students were females; all the students were still Black African. The type of student that enrolled in the college has also changed. The students enrolled at the college between 2002 and 2009 were FET¹¹ students and most of these students had agricultural backgrounds. However, it is increasingly evident that the students that are enrolled in the current Agricultural Diploma have no agricultural background (F. Klinck, personal communication May 27, 2017). It is becoming clearer that the students apply for admission to the college for other reasons such as admission to other courses because the admission to the college is affordable compared to other educational institutes. The admission fee for 2017 was R7 200 per semester including hostel fees and tuition for the first year; for the second and third year student fees are less, making this an affordable option for those who cannot afford other higher education options (TAC, 2017a).

4.3.3.2 TAUNG IRRIGATION SCHEME

The Taung Irrigation Scheme is governed by the Rural, Environmental and Agricultural Department of the North West that manages the irrigation scheme. It governs the distribution of water to various hydraulic units and individual plots alongside the Irrigation canals. Taung Irrigation Scheme co-operatives manage the farmers, determine irrigation times, advise farmers on irrigation methods and maintain the water distribution system (Acha, 2014). Within the Scheme, the farmers are managed as primary agricultural co-operatives and secondary agricultural co-operatives. These co-operatives consist of a collaboration of individual farmers working towards the same goal managed by Taung Irrigation Scheme. Collaborative arrangements benefit the farmers through easier market access from both an input and output perspective (Acha, 2014).

4.2.3.3 FARMING COMMUNITIES

The farming community structure has not changed much over the years. Some smallholder farmers are becoming more self-sufficient and own their own land. As mentioned in Section 4.2, farmers mainly use the irrigation system to grow lucerne, ground nuts, potatoes, grains and vegetables. Farming of pecan nuts, cotton, olives, citrus, apricots, grapes, watermelon and peaches has also been successful (Van Vuuren, 2010).

¹¹ FET stands for Further Education and Training and is one of the bands of the South African education system. Further Education and Training comprises of non-higher vocational and occupational education and training offered at colleges, as well as the last three years of high school (Grades 10-12).

4.3.4 SUBJECTS (ACTORS)

The lecturers are the activity system's subjects or actors who are participating in the expansive research process of this study. As the curriculum has changed over the years so have the specific needs of the teaching and training staff. Subject expertise from Farm Management to Mixed Agriculture to specialising in Irrigation forced the lecturers to learn new practices and knowledge. The Agriculture Education and Training Strategy emphasised the importance of lecturer development towards staff with specific expertise in functional fields (DoA, 2005a). Management and staff changes have also affected dynamics amongst the teaching and training staff.

4.3.5 OBJECT OF THE ACTIVITY SYSTEM

The object of the activity system has changed considerably over the years. Figure 4.4 indicates the shift in Case Study One's activity system's object and the drivers that initiated these changes. Prior to 1994, the objects were based around teaching agricultural students under the Bantu Education policies. After 1994, the object changed to educating all students equally to develop skills for Farm Management within the Taung Irrigation scheme. After 2002, the object was based around vocational skills and the focus was on skills relating to self-employment and employment in the agriculture public sector (Bapela & Mariba, 2002). In 2005 the object of the college changed to transforming to an Agricultural Training Institute that serves as an Institute of Excellence that is aligned with the Agricultural Sector's needs and new developments. In 2010 the object shifted to equip graduates with the necessary skills and competencies within a mixed agricultural framework. In 2013 the object shifted again to skills and competencies in irrigation.

Rules of the system affect the activity system's object, thus policies play an important role in object innovations, as described in Section 4.3.1. The North West Department of Agriculture adopted a Climate-Smart Agriculture approach as a climate change response tool and this is also a driver currently influencing the curriculum object. The main object since 1994 has not shifted and that is to equip graduates with the necessary skills and competencies to play a functional role in addressing the Agricultural Innovation System's needs, challenges and skill requirements. As the rules and system drivers change, as explained above, the activity system's object shift towards focussing on smallholder farming, irrigation and Climate-Smart responsiveness, including water resource management and food security.

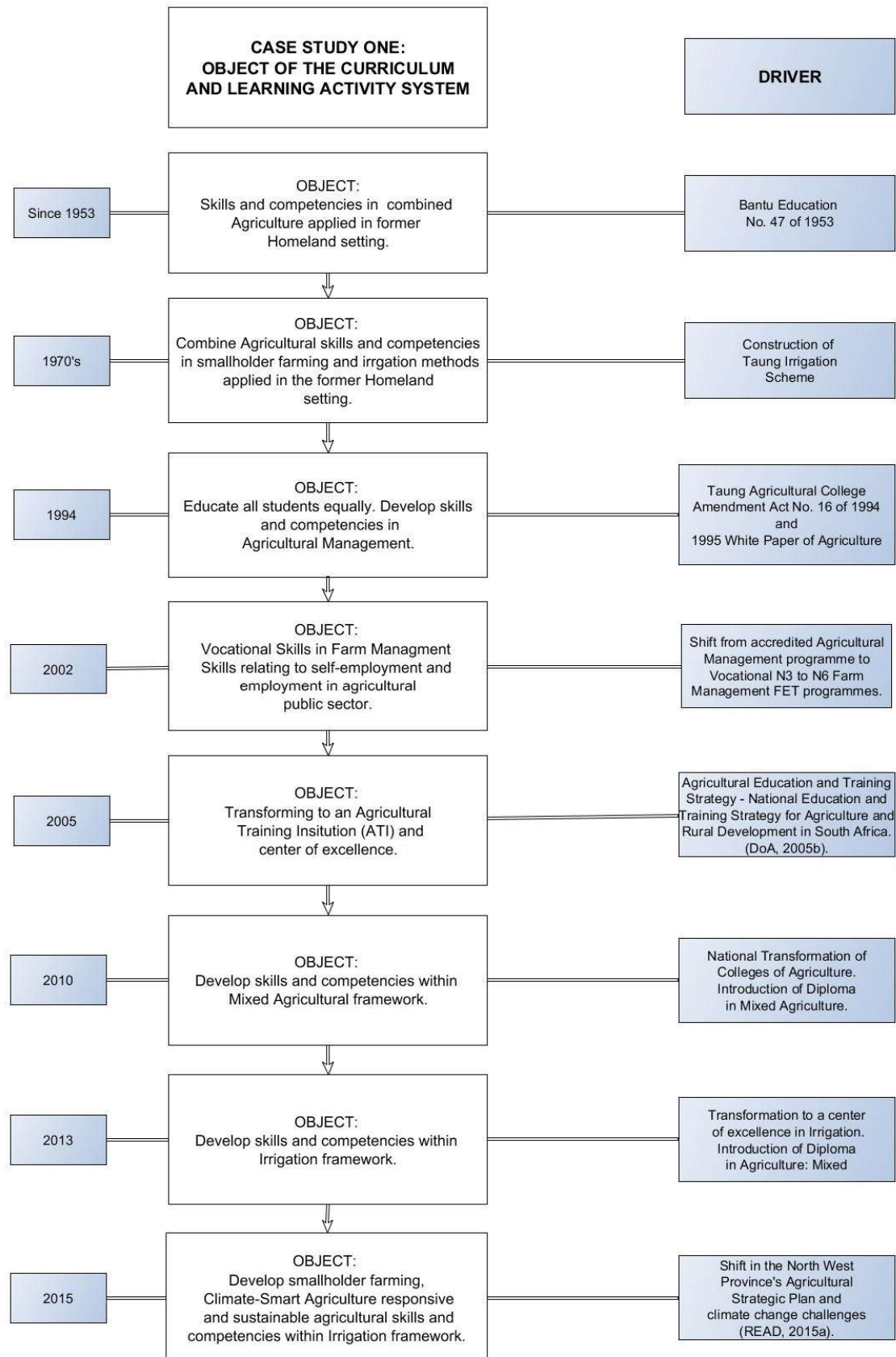


Figure 4.4: A diagram indicating the shift in Object and the influential drivers of Case Study One

4.3.6 DIVISION OF LABOUR

The shift in Division of Labour were mostly due to the changes in the activity system's object. As the object changed, the curriculum focus changed and therefore the teaching staff, mainly lecturers, had to update their knowledge and skills to the demand of the curriculum. Training needs of the college changed to specialisation in irrigation methods.

4.4 CONTEXTUAL PROFILE OF CASE STUDY TWO

The college is situated on the southwest side of Potchefstroom. It is 5km away from the city centre and is 717 hectares. Figure 4.5 is a satellite image of the college. Figure 4.6 is a picture taken on the campus with one of the hostels in the background.



Figure 4.5: A Google satellite image of Potchefstroom College of Agriculture

(<https://www.google.co.za/maps/search/Potchefstroom+College+of+Agriculture/@-26.7325487,27.0642963,1349m/data=!3m1!1e3?hl=af> viewed 30 April 2017)

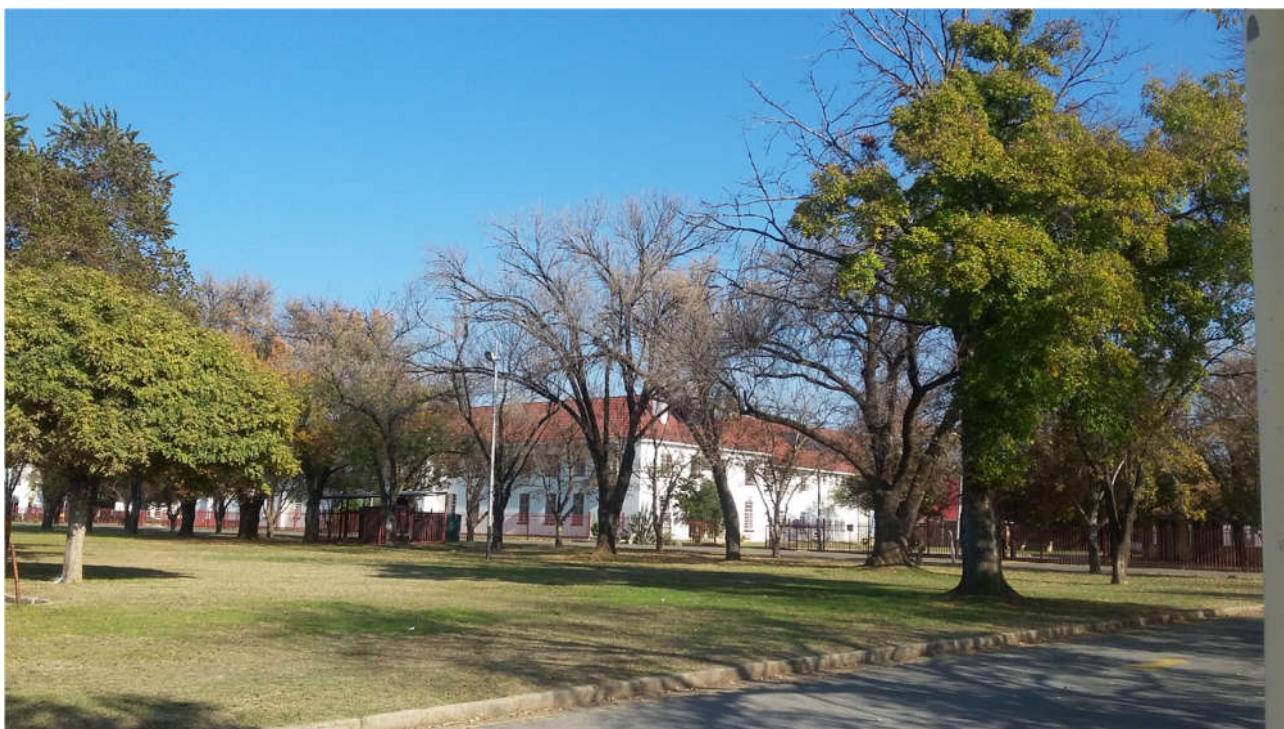


Figure 4.6: Potchefstroom College of Agriculture campus

Potchefstroom College of Agriculture's history dates back to the unsettled times before the Anglo-Boer War. The Transvaal Agricultural Union held its first congress in 1897 where the delegates planned the development of an experiment station and agricultural school for the whole country. During the second congress in 1898 at Potchefstroom, the Union requested to speak to the Government about an agricultural school. However, the Anglo-Boer War stopped any further development. After the war, urgent plans were necessary to stimulate agriculture as food was insufficient for South Africa's rapid development (Agenbach, 1972). The Transvaal Agriculture Department was re-established under the British regime in the report dated 31 July 1902 entitled "*Copy of a Report presented to His Excellency, the Governor, prior to the establishment of the Department*" written by Mr. F. B. Smith, the appointed Agricultural Advisor by his Excellency, King Edward VII, in 1902 (UDA, 1915, p. 79). In 1902 Potchefstroom College was established as the first experimental agriculture farm North of the Vaal River (Department of Agriculture and Water [DAW], 1985) by Mr. F.B. Smith, Director of Agriculture of the Transvaal Colony and Alexander Holme (DoA, 1972). In 1909 the farm expanded into an agricultural training facility and Mr. Holme was the first principal (DoA, 1972). The first lecturer in Agriculture was Mr. Duncan Davidson that transferred from the College of Science in Dublin, Ireland (Agenbach, 1972). Twenty-four

students enrolled for the one-year diploma August 1909 (DAW, 1985). The college catered for whites only from its inception until 1994.

In January 1916, the Union Department of Agriculture (UDA) decided that the agricultural training facilities need to work hand-in-hand and that the curriculum should be consistent between all training facilities. The Department officially established five agricultural training facilities around the country and the college's doors opened officially for students as Potchefstroom School of Agriculture and Experimental Farm (UDA, 1915, pp. 79-80). In a Union Department of Agriculture report dated January 1915, the department reported that the lecturers at Potchefstroom would be presenting lectures and demonstrations to the community on important features of agricultural work and nature studies (UDA, 1915, p. 81). The curriculum outline for Potchefstroom School of Agriculture in 1916 consisted of a two-year course which gave "a sound practical as well as technical training to the young farmer". An optional third-year course was also available for the student who wished to specialise in certain subjects. Upon completion of the two-year course, the student was granted either the Diploma of the Institution or a Certificate in Agriculture, depending on satisfactory levels in the examinations. After completion of the third-year, students received the special Honours Diploma (UDA, 1915, p. 95). All five Schools of Agriculture (Agricultural Colleges) presented Horticulture, Poultry, Husbandry, Dairying, Cropping and Stock Farming as subjects. However, each School of Agriculture had a specialty that was the driver of their curriculum content. Potchefstroom School of Agriculture was the agriculture representative of highveld conditions and specialised in cultivation of crops under irrigation and otherwise, cattle, maize and other cereals (UDA, 1915).

In 1939 the School of Agriculture was re-established as an Agricultural College (DAW, 1985). In 1952 Potchefstroom College of Agriculture became the headquarters of the Highveld agricultural region and the college was recognised as Potchefstroom College of Agriculture and Research Institute (DAW, 1985, p. 3). By the end of 1956, a total of 35 students graduated from the two-year diploma at the college and 46 students completed their first year successfully (DoA, 1957, p. 4). About 500 farmers attended short courses on stock diseases, tractors, poultry, cattle production, and bee farming in 1957. The diploma mainly focused on mixed agriculture. The curriculum comprised of 50% practical and 50% theoretical training (DoA, 1957, p. 4).

Between 1966 and 1970 the college presented a one-year diploma in agriculture. However, in 1971 the two-year diploma was reinstated (DAW, 1985). The research and investigational work undertaken was coordinated by the Division of Chemistry of the Department of Agriculture (ARC, 2014). In 1985 the college's educational programme was aligned with the South African Christian National Education Policy of the Apartheid State which stated that it had to be Christian orientated (DAW, 1985). The curriculum was divided into two subdivisions relating to the Highveld region agriculture, namely Agronomy and Animal Husbandry. Agronomy subjects included Plant Sciences, Climatology, Crop Protection and other topics relating to Agronomy. Animal Husbandry included all relevant topics such as Dairy Farming, Piggery and Poultry. Other sections in the curriculum focused on Agricultural Economy, Veterinary Sciences and Agricultural Organisation including structure of the organisations, farming communities and group dynamics (DAW, 1985, p. 7).

4.4.1 STRUCTURE OF POTCHEFSTROOM COLLEGE OF AGRICULTURE

During 2015 the College Campus head was Mr. Lufuno Thovhakale; however he resigned in October 2016 and Ms. Oneile Sebitloane was transferred to this position. The campus head reports to the Director of Structured Agricultural Training and Empowerment who reports to the Head of READ, who in turn reports to the National Department of Agriculture, Forestry and Fisheries. The management team also includes Heads of Departments for the subject disciplines, practical farm, corporate and student administration. The staff consists of management, academic lecturers, corporate service, student administration, maintenance, farmers and technicians.

4.4.2 POTCHEFSTROOM COLLEGE OF AGRICULTURE'S NATIONAL DIPLOMA IN AGRICULTURE: MIXED AGRICULTURE

The college offers a Diploma in Mixed Agriculture (NQF level 5 & 6) that is accredited with the Council of Higher Education. The Diploma covers mixed agriculture in the Highveld region of South Africa, to satisfy the needs of prospective commercial farmers and the agricultural industry within the North West Province (PCA, 2009). The Diploma in Agriculture: Mixed Agriculture comprises a two-year full-time study at the college and then a third year of study and experiential learning at an agriculture business such as a farm or other institute. During the third year the students acquire practical skills and experience working at an agricultural business while completing short courses and assignments. During the first two years, the

learning programme consist of theory, practical classes and self-study sessions. All subjects for the first two academic years are compulsory. There are limited prospects for specialisation in the third year of the Diploma. During the first-year, the curriculum focus is to develop knowledge and competencies relating to basic farming skills, animal and plant production, entrepreneur's skills and soil content. All subjects are specified in Table 4.2. During the third year (NQF level 6), an experiential learning approach is implemented. Third-year students are assigned to a farm or other agricultural institute where they can gain practical experience. During the third-year, students attend short courses on campus while completing enterprise assignments on various topics. The college monitors the experiential learning through log sheets, site visit reports and student presentation at the completion of the third year (PCA, 2011). Short courses that third-year students attended during 2016 included Beef Cattle Judging, Irrigation, Artificial Insemination, OHS Safety, Labour Management and Greenhouse Management. The curriculum is divided into five subject disciplines (PCA, 2014) according to speciality area. The departments include Crop Production, Farm Management and Animal production. Table 4.2 lists the subjects under each department (PCA, 2014).

Table 4.2: List of the academic departments of Potchefstroom College of Agriculture and the subject areas offered within these departments (PAC, 2014)

Department	Specialised subjects	
Animal Production	Anatomy & Physiology of farm Animals Animal Health, Dairy Production Management, Pig Production Management, Small Stock Production Artificial Insemination	Poultry Production Management Beef Cattle Production, Management, Animal Breeding Animal Nutrition
Agricultural Engineering: Farm Trades	Farm Building and Structures Basic Farming Mechanics, Basic Welding	Agriculture Mechanisation
Agricultural Management and Computer	Agriculture Economics, Computer Application, Agricultural Entrepreneurs Labour Management	Agri Marketing, Agri Financial Management, Research Principles, Occupation Health and Safety
Plant Production	Agricultural Botany Soil Science Veld Ecology Agronomy Vegetable Production Cultivated Pastures	Crop Production, Grazing Systems, Plant Breeding Greenhouse Management Soil Fertility, Fruit Production Irrigation Management

4.5 HISTORICAL REVIEW OF POTCHEFSTROOM COLLEGE OF AGRICULTURE, CASE STUDY TWO

This section, like the previous historical review of Case Study One in Section 4.3 is structured using the Second Generation Cultural Historical Activity System's framework of rules, mediated tools, community, subject, object and division of labour. Section 4.4 describes the historical systems view of Case Study Two as a curriculum and learning activity system.

4.5.1 RULES: AGRICULTURE AND ENVIRONMENTAL POLICIES INFLUENCING FARMING AND SOCIAL TRANSFORMATION

The same policies and rules discussed in Section 4.3.1 and depicted in Figure 1.1 govern the activity system for Case Study Two. Agriculture curriculum innovation has changed since democracy was established in 1994 when governmental policies and mandates changed enormously. After 1994 the college opened its door to all South Africans. The curriculum was still based around Mixed Agriculture in the Highveld area. During 2017 the college was still transforming to an Agricultural Training Institute towards a "centre of excellence".

4.5.2 MEDIATED TOOLS

4.5.2.1 CURRICULUM CONTENT

The college's curriculum has been updated as time passed, but the main object of the curriculum is to train commercial farmers in Mixed Agriculture in the Highveld area stayed consistent over the years.

4.5.2.2 PRACTICAL LEARNING SITES

The most recent upgrade of the campus facilities included Biogas facilities for energy production. Learning and practical facilities at the college include 45 hectares cultivated land, an orchard, abattoir, veterinary services and a dairy unit. The Potchefstroom Veterinary Laboratory that is part of the college received international accreditation from the South African National Accreditation System (SANAS) in 2012. It was the first government veterinary laboratory to be internationally accredited for Veterinary Serology and Microbiology (DARD, 2012).

4.5.3 COMMUNITY

4.5.3.1 STUDENTS OF POTCHEFSTROOM COLLEGE OF AGRICULTURE

Over the years, the curriculum objects have not changed drastically although the students have. Before 1994 the Agricultural College was only for Whites. The main shift is that the student composition has changed from students that had a commercial farming background to students that do not have any background in Agriculture. The number of enrolments for Potchefstroom College of Agriculture for 2005 were 291 students (76 Black, 215 White, no Coloured or Asian population). There were 34 female students enrolled for 2005. The number of graduates for 2005 was 90 students (7 Black and 52 white) of which 11 were female. There were 33 students that graduated from the college in 2012 of which 11 were female (Wordpress, 2012). Fifty students graduated in December 2015. In 2016 there were 85 first-year students, 60 second-year students and 57 third-years (51 Black and 6 White). The student population has also shifted to almost 50% of the students being female in 2017 and as shown above, the racial demographics have also shifted from predominantly white male to almost the full cohort of third-years being Black students in 2017.

4.5.3.2 FARMING COMMUNITIES

The farming communities consist mainly of commercial farmers focused on mixed agriculture and there are many smallholder farmers in the surrounding area. The sector consisting of farmers who have shown a degree of success and understanding of agriculture has also developed since 1994.

4.5.3.3 GRAIN CROPS - AGRICULTURAL RESEARCH COUNCIL (ARC) – GRAIN CROP INSTITUTE

The Agricultural Research Council (ARC) is a statutory parastatal body established in terms of the Agricultural Research Act, 1990 (Act 86 of 1990). The Grain Crops Division of the Agricultural Research Council was established in 1981 in Potchefstroom. It is situated on the same campus as Potchefstroom College of Agriculture. The research focus involves cultivar evaluation, plant breeding, improvement of crop quality, weed control, tillage, plant nutrition, water utilisation, plant pathology, entomology and nematology (ARC, 2014). It also focusses on training the community.

4.5.4 SUBJECTS (ACTORS)

The lecturers are the subjects or actors that are participating in the expansive research process during the study. There have been no significant curriculum changes over the years thus the lecturers' knowledge pool is secure. However, the incorporation of Climate-Smart Agriculture is a challenge for the lecturers.

4.5.5 OBJECT OF THE ACTIVITY SYSTEM

The main shift in object and the influential drivers of these changes are depicted in Figure 4.7. Since 1915 the college focused on mixed agriculture relevant to the Highveld region. In 1994 the college opened its doors to all South Africans. The object of the college changed to educating all students equally to develop skills and competencies in mixed agriculture. During the introduction of the Agricultural Education and Training Strategy of 2005, Case Study Two's object shifted to the transformation into an Agricultural Training Institute. In recent years, the shift in object included a shift from commercial farming to inclusion of small-scale farming, sustainable agriculture and Climate-Smart Agriculture concepts and practices.

4.5.6 DIVISION OF LABOUR

The lecturers innovated and translated the mixed agriculture curriculum for the students. Teaching staff were responsible to develop and update the curriculum as new agricultural research and methods arose.

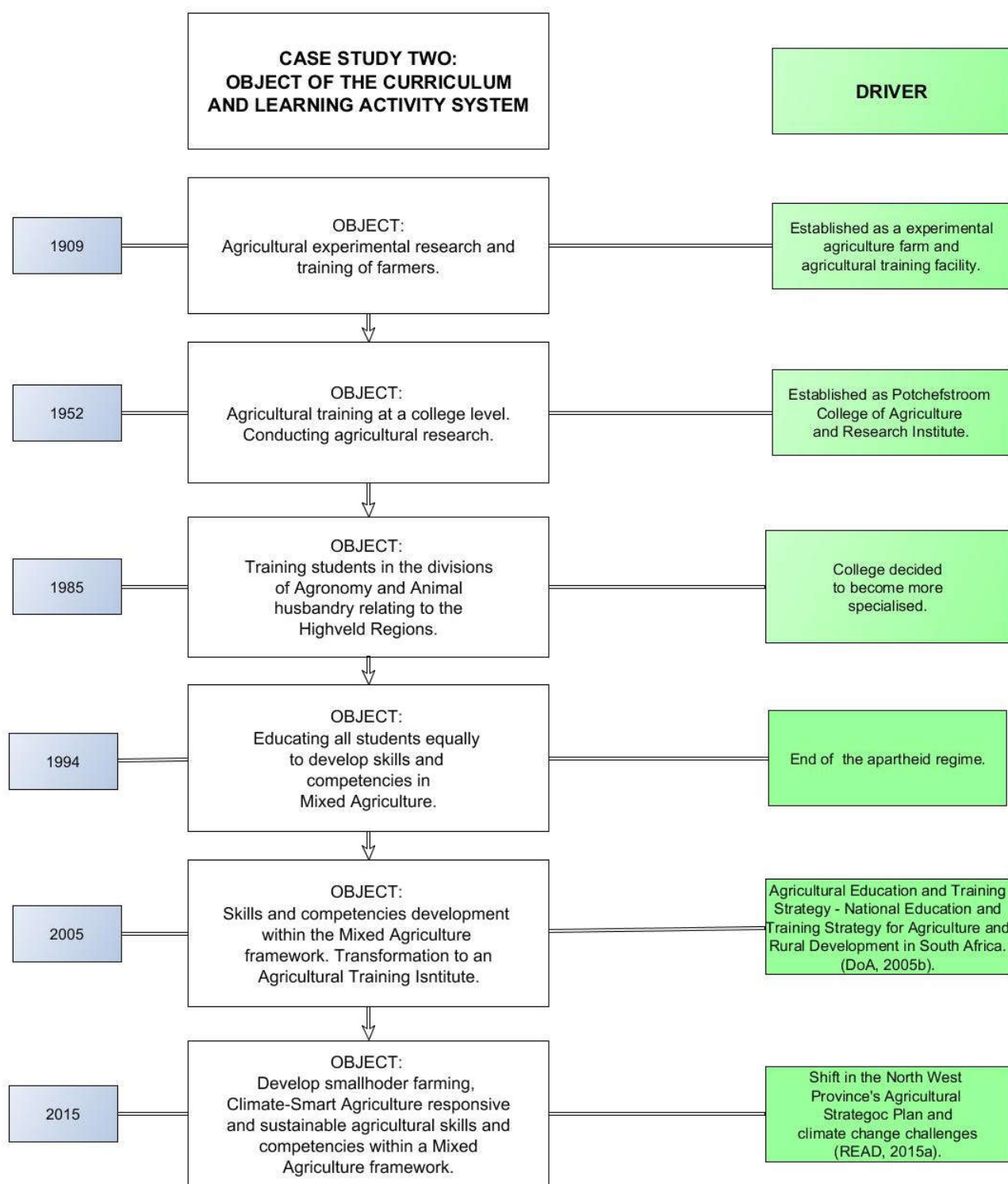


Figure 4.7: The shift in Object and the influential drivers of Case Study One

4.6 PRELIMINARY CONSULTATIVE WORKSHOP

On 7 July 2015 a full-day consultative curriculum workshop, “Climate Change and Water Conservation Farming toward curriculum development”, took place at Potchefstroom Agricultural College. The workshop was part of Phase Two of the study, embedded in the Amanzi For Food project led by the Environmental Learning Research Centre at Rhodes University. The purpose of the initial consultative workshop was to orientate the research around the central problems and challenges surrounding the transitioning towards a more Climate-Smart responsive curriculum. The combination of both colleges for the first workshop session allowed the participants to see themselves as part of a learning network within a Provincial Agricultural Innovation System. The purpose of the workshop was to bring lecturers and managers from the two Agricultural Colleges within the North West Province together to learn more about climate change and to identify opportunities for curriculum development towards Climate-Smart Agriculture.

4.6.1 ATTENDEES OF THE CONSULTATIVE WORKSHOP

Attendees included the lecturers and managers of the Agricultural Colleges that participated in the study. Thirteen participants from Taung College attended and sixteen from Potchefstroom college. Figure 4.8 is a group photo of the Potchefstroom workshop participants.



Figure 4.8: The participants and Prof Rob O'Donoghue on the left, at the first consultative workshop in July 2015 (Photograph taken by Heila Lotz-Sisitka)

4.6.2 OBJECT OF THE CONSULTATIVE WORKSHOP

The aim of the workshop was to collaboratively review and develop a picture of the current Agricultural Colleges' position on the integration of climate change challenges and response systems into the curricula. Through this workshop, participants could form a sense of how the college is currently addressing these issues and what needs to be changed and updated within the curriculum and learning practices. The main object of the workshop was to identify how the colleges were responding to the impact of climate change, what approach the colleges were taking to become better aligned and to develop an innovative approach for the inclusion of climate change responsive topics into the North West Provincial curricula.

4.6.3 WORKSHOP PROCEEDINGS

Research participants began by completing a survey on climate change challenges and responses (listed in Appendix 1). The survey helped the research participants realise to what extent they were aware of climate change challenges. The discussion then turned to the effects of climate change on the agricultural sector and the role that the participants thought the college curriculum played in responding to these challenges. The Climate-Smart Agriculture approach that was taken up by READ at policy level as a response to climate change was also discussed. The discussion led to the problem of what to do next and how the colleges could take up the climate responsive approach. The attendees were then divided into six groups and asked to discuss specific questions (see Table 4.3) in their groups (see workshop report in Appendix 4).

The research participants discussed these questions in groups. After lunch group responses were discussed amongst all the participants. The researcher and participants compiled summative answers to the questions, while discussing the problems and tensions around these questions. Table 4.3 is a summary of this discussion. The workshop also allowed the participants to become aware of problematic aspects and challenges within their journey towards a Climate-Smart informed and responsive curriculum. Through discussion and questions, participants jointly analysed the causes of the problems and decided on innovative transitioning solutions to aid in the transitioning and innovation of the Agriculture curricula within the North West Province.

Table 4.3: List of questions and summarised responses of the workshop participants

Colleges' position	Tension and problems that colleges are experiencing	Innovation transitioning plan
What is the colleges' current position on climate change challenges and Provincial Agricultural System's climate responsive strategy?		
No clear position	The current content does not clearly address the problems surrounding climate change, water conservation or food insecurity. The curricula of the colleges do not focus enough on indigenous knowledge.	Include climate responsive topics in curriculum
Is there a need for a separate new course on climate responsive topics?		
No course content that covers specific topics of climate responsive topics or Climate-Smart Agriculture adequately	There is a need for a course that covers climate change and water conservation	Short courses covering specific components of Climate-Smart Agriculture and Rain Water Harvesting & Conservation can be presented in the third year
What are the colleges transitioning approach towards the whole institutions approaches such as green campus etc.		
No official actions in place	Campuses do not practise Rain Water Harvesting and Conservation methods. No green campus incentives	Lecturers must be more engaged with these topics and involve students. Colleges must implement rain water harvesting and conservation around the campuses.
Which partners or stakeholders will engage in the transitioning of the curriculum towards climate responsiveness?		
Learning network needs development	Inclusion of students, surrounding agricultural businesses, farming communities and research institutes	The curriculum must be designed in such a manner that knowledge flow will infiltrate the community. The colleges must collaborate with the ARC.

4.6.4 WORKSHOP OUTCOME

The workshop allowed participants to develop a sense of urgency to include climate responsive strategies within the curricula of the Province. It also led to the decision to utilise Climate-Smart Agriculture in the teaching and learning practices of both colleges. However, the participants expressed their concern about their knowledge and competency level regarding Climate-Smart Agriculture and related topics. A need for training and another type of assistance such as a review tool emerged from the discussion. The main outcome of the workshop was that participants were made aware of the problem, but they also realised that it was not only their college facing these challenges.

4.6.5 IDENTIFICATION OF SHARED OBJECT

The workshop allowed the participants to discuss and develop a clear picture of the problems and challenges colleges are facing during the realignment within the Agricultural System towards climate responsiveness. At the workshop participants could discuss their current position and how they were responding to the climate change challenges and Provincial Agricultural System's climate responsive strategy. This led to the joined object formation of the colleges. The participants jointly decided that transitioning towards a more climate responsive curricula was required and that climate responsive approaches such as Climate-Smart Agriculture needed to be adopted.

4.6.6 SOLUTIONS

The workshop participants jointly decided on specific solutions and innovative transitioning plans that would assist the colleges in their journey towards climate responsiveness.

- On campus:
 - Trap rainwater run-off from buildings;
 - Reuse grey water from hostels; and
 - Include Climate-Smart Agriculture as a campus response to climate change.
- Within the curricula:
 - Develop a third-year course that includes climate responsive topics;
 - Support for workshop participants during the innovation process.
- Develop a learning network to support innovation
- Schedule training for the college staff in Climate-Smart Agriculture and the effects of climate change

- Develop a review tool that the college staff could use to review and support curriculum innovation process

4.6.7 INNOVATIVE PROCESSES

The workshop was successful as it opened up discourse amongst participants considering the possibility of institutional, educational and individual innovation towards a more climate responsive Agricultural System. The workshop participants decided to focus on network building and developing a more comprehensive understanding of Climate-Smart Agriculture as a response to climate change. Both colleges decided to attend the curriculum development workshop of Amanzi For Food at Rhodes University in May 2015, where they could learn from other colleges and stakeholders (see Section 4.8).

4.7 DEVELOPMENT OF THE CLIMATE-SMART INNOVATION TOOL

In Phase Two after the initial consultative workshop, a draft Climate-Smart Innovation Tool based on the conceptual and literature review work on Climate-Smart Agriculture in the North West Province (Sections 2.2 and 2.3), which was also linked to the Climate-Smart innovation framework outlined in Section 3.2. The tool was developed in draft, in response to the findings from the preliminary workshop in Table 4.3 above. The object of the tool was to assist the Agricultural Colleges to review and reframe the agriculture curriculum innovation process further, to extend and expand initial outcomes from the preliminary workshop. During the initial development, the tool was mainly based on and supported by the inductive analytical processes that examined the drivers and conversion factors of the Climate-Smart Agriculture concept, the agricultural knowledge flow within systems and the agricultural curriculum responses to the approach. The researcher investigated other examples of curriculum evaluation tools and sustainable assessment tools and adapted relevant dimensions to produce a tool that could be used by the research participants to support and track innovation. The development of the tool is discussed in Section 3.3.1.1.

The tool in Phase Two was indicator-based and was modelled on the United Nations Environment Programme's Unit-Based Sustainability Assessment Tool (USAT) and the aim was to extend and expand initial outcomes from the preliminary workshop. The USAT model was adapted to develop indicator-based assessment tool. It was used to guide the development of the tool as the USAT model is based on a disciplinary framework where

assessment is possible at the level of individual departments and units (Togo & Lotz-Sisitka, 2009). The USAT model was useful and it has proven capacity to support reflexive curriculum innovation processes for sustainability, although it has not been adapted as an indicator for Climate-Smart responsiveness or within an Agricultural College context (Togo & Lotz-Sisitka, 2009; Togo, 2015). The USAT method of indicator clusters within cluster groups was used to guide the format of the Climate-Smart Innovation Tool. The various sections of the tool are also adapted from the USAT's three sections namely, Part A: Teaching, Part B: Operations and Management and Part C: Student Involvement (Togo, 2009).

The first draft of the Climate-Smart Innovation Tool was developed as a Microsoft Excel worksheet and printed as a booklet. The finalised Climate-Smart Innovation Tool booklet can be found in Appendix 5.1. The tool was designed to stimulate reflexivity and further dialogue and discussion. The reviewer, a teaching staff or management member could use the tool to review Climate-Smart responsiveness of his or her specific or overall curriculum outline and content, teaching approaches, community engagement, assessment, staff expertise, operations and management of the college. The tool was also developed to be used by management to assess the colleges' overall Climate-Smart responsiveness. The driving factor for the development of the tool was the need to establish the level of Climate-Smart Agriculture policy and approach integration into the agriculture curriculum. The different parts of the system include curriculum content, teaching approaches, assessment, student and community involvement, management unit contributions and college policies. The tool facilitated a quick identification of the Agricultural College or individual actors of the system's Climate-Smart responsiveness. It allows the detection through the tool indicators of specific areas of strengths and areas that may require future development in relation to Climate-Smart responsive concepts, principles and policies. It therefore simplifies more complex emergent properties but helps to identify areas of innovation and success through a relatively easy review technique. Thus, the tool is a type of "rapid assessment" that allows for catalysing reflexive deliberation and further investigation and discussion of the findings that merge from the tool.

Section A deals with teaching approaches that include the theoretic and practical curriculum content's Climate-Smart responsiveness. It focusses on student competencies, research, community engagement, assessment and staff expertise and willingness to participate in the process of innovation towards Climate-Smart responsiveness. During the development of

Section A's clusters and indicators I drew upon Togo's (2009) sustainability review tool, the DAF (2008) curriculum review report, the DAFF (2010) curriculum review report and SARUA (2014) competencies. Section A consists of 49 indicators in seven clusters (see Appendix 5.1).

The first cluster, C1, of Section A is: *Staff expertise and innovation*. This cluster reviews the level of expertise of the lecturer in relation to the Climate-Smart Agriculture approach. It also considers if the participating reviewer finds the integration of these topics relevant and the willingness of the participating reviewer to incorporate these topics within the curriculum. Attitude towards further training and what type of training the specific participating reviewer might find useful are also reviewed.

The *Development of Climate-Smart Agriculture awareness competencies among students*, C2 cluster of indicators, determines to what extent the teaching approach contributes to the development of the Climate-Smart responsive competencies and skills among students. This cluster addresses development of critical thinking skills, informed decision-making, anticipatory skills, respect for others, system thinking skills, anticipatory skills and other responsive competences (SARUA, 2014; FAO, 2013). These competences are essential to prepare graduates to engage in adaptation and resilience practices and climate-smart responsive practices (SARUA, 2014). The selection of these competencies to inform indicators in the Climate-Smart curriculum response tool was guided by SARUA (2010).

Cluster C3, *Climate-Smart Agriculture general topics*, focusses on what type of general topics are included within the curriculum. Cluster C4, *Examination (Assessment) of Climate-Smart Agriculture topics*, reviews to what extent Climate-Smart responsive concepts are practically and theoretically assessed within the Diploma programme/ Department or the lecturer's specific subject.

Cluster C5, *Practical curriculum content and research*, focusses on the extent of integration of Climate-Smart responses within the practical projects and assignments. It establishes whether Climate-Smart Agriculture practical competencies are integrated within the practical projects.

Indicators of Section B are listed in Appendix 5.1 as part of the Climate-Smart Innovation Tool Booklet. Section B consists of 45 indicators in eight clusters. This section focusses on

the curriculum content outline of topics related to Climate-Smart Agriculture within the Diploma. Section A and B of the tool focusses on the curriculum content and teaching approaches whereas Section C reviews the management practices of the institute (see Appendix 5.1). Section C of the tool includes the review of student involvement in voluntary community engage activities related to Climate-Smart Agriculture. This cluster also includes indicators to evaluate student orientation programmes, career counselling and student politics and governance for Climate-Smart responsiveness, collaboration of students and management on these topics and student involvement in Climate-Smart responsive practices in residences. Section C of the tool also evaluates the policy and mission statements of the Agriculture College or Training Institute's relation towards the inclusion of Climate-Smart responsive topics and Climate-Smart Agriculture principles within the curriculum policies. This tool also reviews the alignment of the Agriculture College or Training Institute with the national and provincial agriculture strategic plan on agriculture education (READ, 2015b; AgriSETA, 2014). The driving factor for the development of the tool was the need to establish the level of Climate-Smart Agriculture policy and approach integration into an agriculture curriculum throughout the agriculture college system. The whole Climate-Smart Innovation Tool Booklet can be found in Appendix 5.1.

4.8 NATIONAL AMANZI FOR FOOD – SECOND CONSULTATIVE WORKSHOP

The National Workshop of the Water Research Commission Amanzi for Food Project on the Action Oriented Strategy (AOS) for knowledge dissemination and training for competencies development of water use in homestead gardening and rainwater harvesting for cropland food production was held on 12-13 May 2016 at Rhodes University in Grahamstown, South Africa. Even though Amanzi For Food focusses mainly on the knowledge dissemination of rain water harvesting and conservation, it has also built a learning network. Colleges such as Fort Cox have shown great success in their integration of rain water harvesting and conservation practical techniques and network building (Lotz-Sisitka et al., 2016). The project is also climate responsive. This workshop was a great opportunity for the representatives of the North West Provincial Colleges to build networks and share knowledge.

4.8.1 ATTENDEES OF THE NATIONAL AMANZI FOR FOOD WORKSHOP

A representative of Taung Agricultural College and a representative of Potchefstroom College of Agriculture attended the two-day workshop. There were 30 attendees from other Agricultural Colleges, Extension Offices, Farmers Associations, Universities, radio stations, Water Research Commission and non-governmental organisations. Figure 4.9 is a picture of the Amanzi For Food workshop participants taken on the last day of the workshop.



Figure 4.9: Participants at the Amanzi For Food National Workshop outside the Environmental Learning Research Centre, Rhodes University (Lotz-Sisitka et al., 2016)

4.8.2 OBJECT OF THE WORKSHOPS

The workshop objects were presented through an Action Oriented Strategy for knowledge dissemination allowing each group that was part of the Amanzi For Food network to discuss their challenges in adapting climate responsive practices.

4.8.3 OUTCOMES OF THE AMANZI FOR FOOD WORKSHOP

The researcher and the two college representatives used these two days to discuss the workshop proceedings and interesting findings. The researcher had formal interviews as well as discussions during the workshop with the two college representatives. The outcomes of the workshop from this study's point of view and the two college representatives included:

- Relationships between college representatives and other workshop attendees were established;
- Climate responsive challenges and integration challenges faced by all the education systems were explored;
- An action plan relating integration of climate responsive topics was developed with the other colleges; and
- The information presented during the two days was contextualised by the college representatives and applied to their own situation.

4.8.4 SOLUTIONS AND THE WAY FORWARD

- Rain water harvesting and conservation materials need to be included in the curriculum and suggestions of how to include and integrate the materials are important as well as how to find ways to incorporate the materials. It is also critical to know why we are incorporating rain water harvesting and conservation into the curriculum.
- Colleges need to address issues of food security and sovereignty even at household levels and shift focus from only the commercial side of agriculture to include subsistence agriculture. Decision makers need to be involved in how to do this and in deciding on what needs to change and be assessed. What has already been done needs to be considered as this might speed up the process going forward.

4.8.5 TOWARDS INNOVATION

All the discussion that took place during the workshop was reported back to the other research participants during the first intervention-innovation workshop (see Sections 5.2.2.3 and 6.2.2.2). The Climate-Smart Innovation Tool was developed during Phase Two after the first consultative workshop and tested by the two college representatives at the Amanzi For Food workshop. Some changes were made and copies for each research participant at both colleges were sent back to the colleges. The research participants were then asked to complete the Climate-Smart Innovation Tool before the next contact session.

4.9 CONCLUSION

Chapter Four has clarified the historical journey of both case studies. The chapter summarised what curriculum was in operation, how the curriculum was organised, what materials were being used and what programmes were presented at the two colleges. Many institutional and policy changes occurred during the years that affected the object of the colleges. Chapter Four continued to describe the consultative workshops that framed the study and the initial development of the tool. Chapter Five follows with an outline of the score analysis of the initial Climate-Smart Innovation Tool (see Appendix 5.1) which the research participants from both case studies completed prior to the first intervention-innovation workshop.

CHAPTER 5

INNOVATION TOOL FOR MOBILISING REFLEXIVITY ON CLIMATE-SMART AGRICULTURE WITHIN THE AGRICULTURAL CURRICULUM AND LEARNING ACTIVITY SYSTEM

5.1 INTRODUCTION

Chapter Five describes the Climate-Smart responsive indicative picture of the two case studies through presenting the score analysis of the Climate-Smart Innovation Tool (see Appendix 5.1) completed by the research participants, college teaching and management staff, before the first intervention-innovation workshop during Phase Two of the research process (see Sections 6.2 and 7.2). During Phase Two the tool analysis helped to answer research question 2.3 (See Section 4.1) namely:

What Climate-Smart Agriculture elements (context, content, competencies, knowledge dynamics) are incorporated into the current National Diploma agricultural curricula content and practices, if any, at the start of the curriculum innovation formative intervention process?

Through the indicative analysis of the case studies by means of the tool, a tentative picture of the system's components, functioning and operations were obtained that stimulated reflexivity and further dialogue and discussion during the follow-up intervention-innovation workshops (see Sections 6.2 and 7.3). The data presented in this chapter are from the research participants' answers obtained via the tool and not from any additional information obtained during the subsequent intervention-innovation workshops, interviews or other research methods. The tool analysis was not a definitive assessment, but rather a tool that provided a preliminary Climate-Smart innovative picture of both case studies that allowed for further investigation and discussion of these findings as mirror data during the intervention-innovation workshops (see Sections 6.2 and 7.3). Thus, the tool supported Climate-Smart Innovation processes within the curriculum and learning practices of the North West Provincial Agricultural System.

All research participants received a Climate-Smart Innovation Tool Booklet comprising of Section A: Curriculum, teaching approach and student-community engagements; Section B: Curriculum content outline of topics related to Climate-Smart Agriculture within the Diploma; and Section C: Climate-Smart Innovation – Management and institutional policies. The

reviewers selected the score from six assessment criteria (see Table 5.1). Completed booklets were sent back to the researcher who used the score analysis tables to calculate the score for each completed tool and then compiled a summative score analysis in Microsoft Excel (see Table 5.2). From the spreadsheet the researcher was able to graphically represent the score analysis.

Table 5.1: Assessment criteria used for the Climate-Smart Innovation Tool Score analysis

RATING			% Equivalent
0	None	There is no evidence on the indicator	0%
1	Unsatisfactory	The indicator does not meet the necessary requirements	20%
2	Needs development	Indicates performance, but improvement is required	40%
3	Adequately	Evidence show adequate Climate-Smart responsiveness	60%
4	Meets requirements	Evidence indicates that the Climate-Smart responsive standard has been met	80%
5	Exceed requirements	Evidence indicate that expectations has been exceeded and Climate-Smart responsiveness has been successfully attained	100%

After the completion of the tool by the research participants, the researcher used the score analysis table for each section to establish the Climate-Smart responsiveness of each review (see Appendix 5.1). Table 5.3 is an example of the score analysis table used for Section C: Climate-Smart Innovation Tool – Management and institutional policies. The total percentage Climate-Smart responsiveness of an indicator cluster can be calculated from the total score received within each indicator cluster. The overall Climate-Smart responsiveness score of the review can then be calculated from the total of the scores (see Table 5.2).

Table 5.2: Score analysis for Section C: Climate-Smart Innovation Tool - Management

Score analysis for Section C: Climate-Smart Innovation Tool - Management				
Indicator Cluster	Topic	Score	Total Score	% Climate-Smart responsive
P1	Curriculum outline and National Diploma		/30	
P2	Operations and Management		/35	
P3	Student Climate-Smart responsiveness and participation		/35	
P4	Policies and written statements		/35	
Total Climate-Smart responsiveness for Section C		$(\%P1 + \%P2 + \%P3 + \%P4 + \%P5 + \%P6 + \%P7) \div 7$		

5.2 CLIMATE-SMART AGRICULTURE INNOVATIONS AT CASE STUDY ONE, TAUNG AGRICULTURAL COLLEGE: THE FIRST SELF-ASSESSMENT

A total of 13 research participants in Case Study One completed the initial Climate-Smart Innovation Tool Booklet prior to the first intervention-innovation workshop.

5.2.1 CLIMATE-SMART INNOVATION TOOL - DEPARTMENTS

Section A and B of the Climate-Smart Innovation Tool was used to review and develop an indicative picture of the Climate-Smart elements incorporated into the current National Diploma's content, teaching and learning practices. The college is divided into five Departments namely, Crop Production, Animal Production, Soil Science, Agricultural Management and Irrigation. These five Departments form the basis of the National Diploma. Section A and B's score analysis for the Departments Plant Production, Animal Production and Irrigation is discussed below. The Indicator Clusters and indicators evaluated by the Climate-Smart Innovation Tool – Section A is outlined in Table 5.3 and the Indicator Clusters and indicators of Section B are listed in Table 5.4.

Table 5.3: Scoring sheet outlining the indicators, clusters and codes of Climate-Smart Innovation Tool – Section A

SECTION A: Curriculum, teaching approach and student-community engagements		
Cluster Indicators	Code	Indicator
C1 Staff expertise and innovation	A1	The level of expertise of staff members in the area of Climate-Smart Agriculture
	A2	The level of training that staff members have completed in any of the aspects concerning Climate-Smart Agriculture including Climate Change etc.
	A3	The extent to which staff members are willing to integrate Climate-Smart Agriculture aspects / topics within their practical framework
	A4	The extent to which you as lecturer are willing to teach Climate-Smart Agriculture topics

C2 Development of Climate-Smart Agriculture awareness competencies among students	B1	The capacity to make informed decisions related to Climate-Smart Agriculture issues and challenges
	B2	Critical thinking skills
	B3	Systems thinking skills to understand complex problems from an integrated social-ecological systems perspective to solve Climate-Smart related problems
	B4	To anticipate possible scenarios and consequences, while assessing the vulnerability and risk of a specific agriculture system at risk of Climate-Smart Agriculture related problems
	B5	The competence to adapt by conceptualising appropriate alternatives and responses that are sustainable and viable through planning and strategic development.
	B6	To consider the implications of decisions and how these decisions can affect the current and future well-being of the surrounding community, agriculture system and ecological systems.
	B7	To be able to engage in adaptive management and to participate in social innovations that generate new practices
	B8	A sense of responsibility towards the community, ecological system and the environment, while understanding the role one has to play as part of these systems
	B9	Integrated problem solving
	B10	Respect of the opinions of others
	B11	Does the teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking?
	B12	Does the teaching approach create awareness of values and ethics including respect for other people's opinions, democracy, respect for planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms?
	B13	Does the teaching approach capacitate the learner for social learning and innovation by exposing students to knowledge concerning the past, present and future Climate-Smart challenges.?
	B14	Does the teaching approach develop Climate-Smart Agriculture core competencies such as adaptability and problem solving skills?
	B15	Does the teaching approach follow an interdisciplinary approach where various knowledge are combined and connected?
	B16	Does the teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts?
C3	D1	Climate Change
	D2	Rural wealth creation

Climate-Smart Agriculture general topics	D3	Food security
	D4	Agriculture as a sustainable profit-making business using sustainable agricultural practices
	D5	Development of entrepreneur skills
	D6	Organic farming
	D7	Renewable energy
C4 Examination (assessment) of Climate-Smart Agriculture topics	E1	The extent to which Climate-Smart Agriculture aspects are practically assessed during course
	E2	The extent to which Climate-Smart Agriculture aspects are examined during course
	E3	The extent to which Climate-Smart Agriculture aspects are considered in evaluating and assessing projects
	E4	The degree to which Climate-Smart Agriculture aspects are assessed in evaluating service learning programmes
C5 Practical curriculum content and research	F1	The extent to which the department (staff and students) are involved in research in the area of Climate-Smart Agriculture
	F2	The extent to which the department pursues solutions for the climate change challenges and vulnerability within local community and context by applying Climate-Smart Agriculture practical techniques.
	F3	The extent to which the department within the study programme is collaborating with other research organisations in pursuit of solutions to Climate-Smart Agriculture problems and adaptability.
	F4	The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching.
	F5	The extent of the practical application of Climate-Smart Agriculture competencies in student practical sessions
	F6	The extent to which bursaries for studying Food Security and water harvesting are granted
	F7	Using practical methods to practise Climate-Smart Agriculture in farming and other activities on campus
C6 Community engagement	G1	Extent of community engagement (staff and students) involved in community engagement in the area of food security and rural development utilising the Climate-Smart Agriculture approach
	G2	Level of commitment of the college resources to Climate-Smart Agriculture projects in the community
	G3	The degree to which local agriculture issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of the department's community engagement.
	G4	The extent to which the department collaborates with other stakeholders in addressing the household and small-scale farmers' climate change challenges.

	G5	The extent to which aspects of Climate-Smart Agriculture are used in the selection/execution of community engagement projects.
C7 Climate-Smart Agriculture integration within the formal curriculum	H1	The degree to which issues and challenges surrounding the sustainable increase of agriculture productivity and income form part of the teaching programme
	H2	The degree to which issues and challenges surrounding the adaptation and building resilience to climate change forms part of the teaching programme
	H3	The degree to which issues and challenges surrounding the reduction of greenhouse gas emission by the agriculture industry forms part of the teaching programme
	H4	The degree to which issues and challenges surrounding food insecurity and small-scale farming forms part of the teaching programme.
	H5	The extent to which the programme is relevant to climate change challenges of the farmers and extension officers
	H6	The degree to which interdisciplinary education forms a component of the curriculum e.g. linking extension education, food security and climate change

Table 5.4: The scoring sheet outlining the indicators, clusters and codes of Climate-Smart Innovation Tool – Section B.

SECTION B: Curriculum content outline of topics related to Climate-Smart Agriculture within the Diploma		
B1 Animal Production	TA1	Sustainable livestock management and pasture management
	TA2	Indigenous knowledge
	TA3	Techniques to capacitate livestock farmers to enhance resilience towards Climate change effects such as increase in pathogens and increase in variations of temperature
	TA4	Adaptation to Climate Change problems and challenges affecting livestock farming
	TA5	Reducing Carbon footprint of livestock farming.
	TA6	Methods to increase nutrition quality that will increase reproduction efficiency. Protect against diseases and reduce Greenhouse gas emissions
B2 Crop / Plant Production	TC1	The benefits of mixed farming
	TC2	Sustainable crop management
	TC3	Indigenous knowledge inclusion
	TC4	Resilience to Climate Change
	TC5	Adaptation to Climate Change problems and challenges
	TC6	Reducing Carbon footprint of crop production

	TC7	Methods to increase yield while sustaining natural resources and ecosystems
	TC8	Methods to reduce agriculture expansion by intensification on already established cultivated land.
B3 Natural Resources – Water	TW1	Sustainable water management
	TW2	Indigenous knowledge on sustainable water management
	TW3	Integration of watering system and fish farming
	TW4	Monitoring, improving and maintaining water quality of water resources
	TW5	Water harvesting techniques (Adaptation and resilience practices to save and manage water resources)
	TW6	Hydroponics
B4 Natural Resources - Soil	TS1	Adaptation and resilience practices to improve quality of soil and decrease erosion
	TS2	Indigenous knowledge and practices to improve quality of soil
	TS3	Sustainable management of soil quality while increasing yield and productivity of livestock and crop production
	TS4	Reducing carbon footprint
	TS5	The sustainable increase in nutrient cycle
	TS6	Water harvesting techniques
B5 Horticulture	TH1	Adaptation and resilience to climate change
	TH2	Indigenous knowledge and alternative farming techniques
	TH3	Reducing carbon footprint
	TH4	Sustainable increase in productivity and incomes in a sustainable way
C6 – Natural Resources – Renewable energy	RE1	Solar power
	RE2	Bio-technology
	RE3	Biogas

5.2.1.1 CLIMATE-SMART INNOVATION TOOL - CROP PRODUCTION DEPARTMENT

The subjects managed by Crop Production are listed in Table 4.1. Score analysis for this section was calculated from four Climate-Smart Innovation Tool Booklets completed by lecturers which taught subjects within this department. The scoring sheet outlining the indicators, clusters and codes are listed in Table 5.3 and 5.4. The overall average calculated cluster scores of Section A & B are illustrated in Figure 5.1. The indicative radar graph depicting the Climate-Smart responsiveness of the Crop Production Department to all

indicators within the clusters are illustrated in Figure 5.2. The Crop Production Department scored the highest for Indicator Cluster C1 at 40%. Indicator A3 and A4 scored 2 and 4 respectively, indicating that the lecturers are willing to integrated Climate-Smart Agriculture within their teaching and learning practices. The Department's average score for Indicator Cluster C2, the development of Climate-Smart Agriculture awareness competencies among students was 28% as the curriculum focusses on systems thinking skills (Indicator B3) and critical thinking skills (Indicator B2). Indicator Cluster C3 scored an average of 26% with only Indicator D5 scoring high at 4. This indicates that the college does focus on developing entrepreneur's skills. Examinations and assessment of Climate-Smart Agriculture awareness topics, Indicator Cluster C4 scored 5 with all indicators scoring 0, except for E1 that scored 1 % and 0%. The Practical curriculum and research development, Indicator cluster C5, scored 23% with indicator F2 scoring 3 Indicator cluster C6, community engagement scored an indicative 32% and there was no indication that Climate-Smart Agriculture topics were included in the formal curriculum (Indicator Cluster C7 scored 0%). Climate-Smart Agriculture responsive topics related to Crop Production were at 30%. Integrated topics included benefits of mixed farming (Indicator TC1), sustainable crop management (Indicator TC2) and indigenous knowledge inclusion (Indicator TC3).

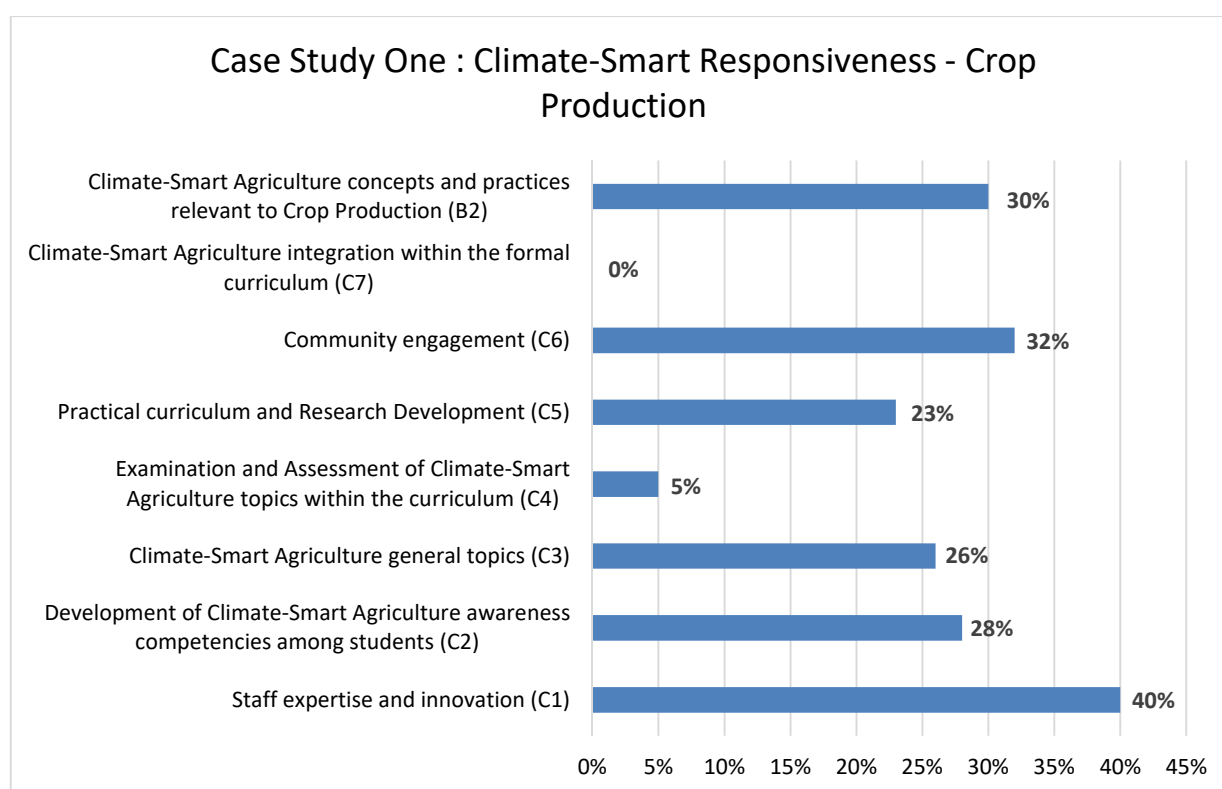


Figure 5.1: Climate-Smart Innovation Tool – Section A (Curriculum, teaching approach and student-community engagements) and Section B (Crop / Plant Production) calculated average Indicator Cluster score analysis of Case Study One

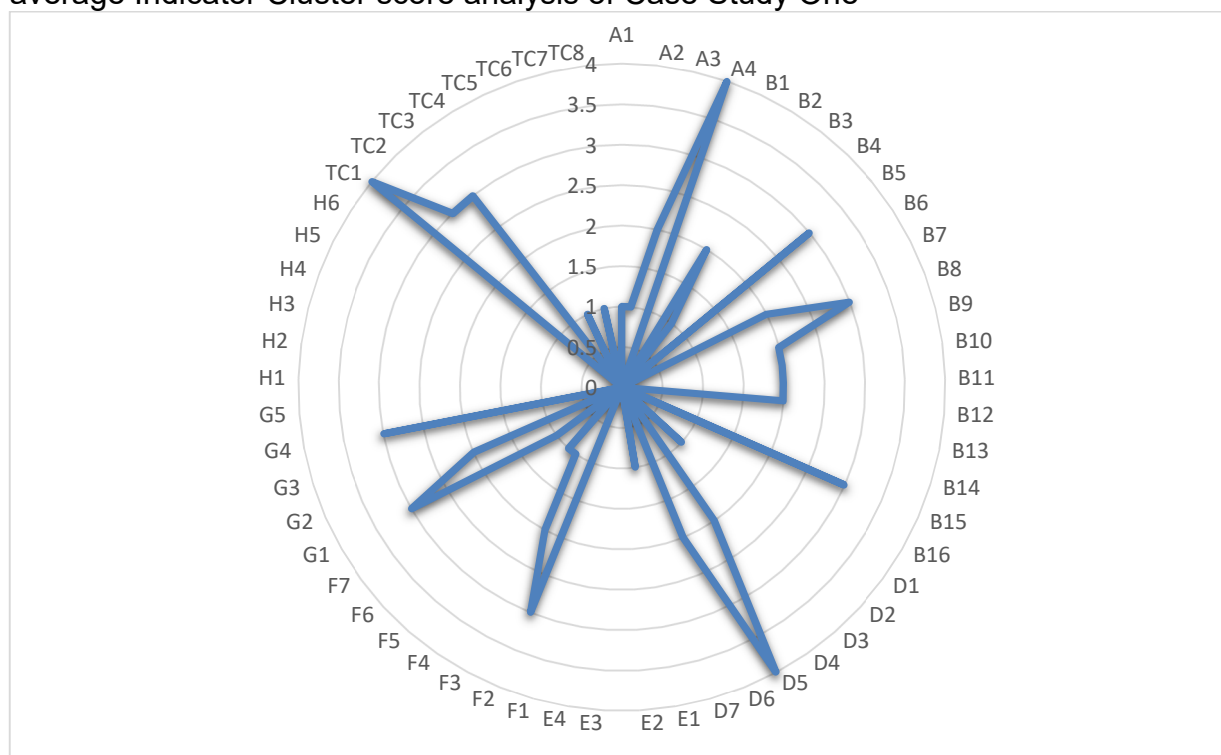


Figure 5.2: Climate-Smart Innovation Tool Section A (Curriculum, teaching approach and student-community engagements) and Section B (Crop / Plant Production) indicator score analysis of Case Study One

5.2.1.2 CLIMATE-SMART INNOVATION TOOL - ANIMAL PRODUCTION DEPARTMENT

Table 4.1 lists the subjects managed by Animal Production Department. Score analysis for this section was calculated from four Climate-Smart Innovation Tool Booklets completed by three lecturers and one Head of Department which taught within this department. This was used to calculate an average Indicator Cluster score analysis of Case Study One. Figure 5.3 shows the calculated average Indicator Cluster score analysis for this Department and Figure 5.4 provides the score analysis on each indicator within Section A and B of the tool. The Department of Animal Production scored a satisfactory 56% in Indicator Cluster C2, developing Climate-Smart awareness competencies amongst students. Indicator B2 (Critical thinking skills), B3 (Systems thinking skills) and B4 planning skills all scored high at 4. This indicates that the department's teaching programme is generally focused on developing competencies within students. The level of staff expertise needs development, Indicator Cluster C1, development as this indicator scored 2 (40%). The tool analysis indicated that the Department is aware that Climate-Smart Agriculture responsive topics should play an

important part in the curriculum and that the department planned to integrate relevant concepts into the curriculum in the near future.

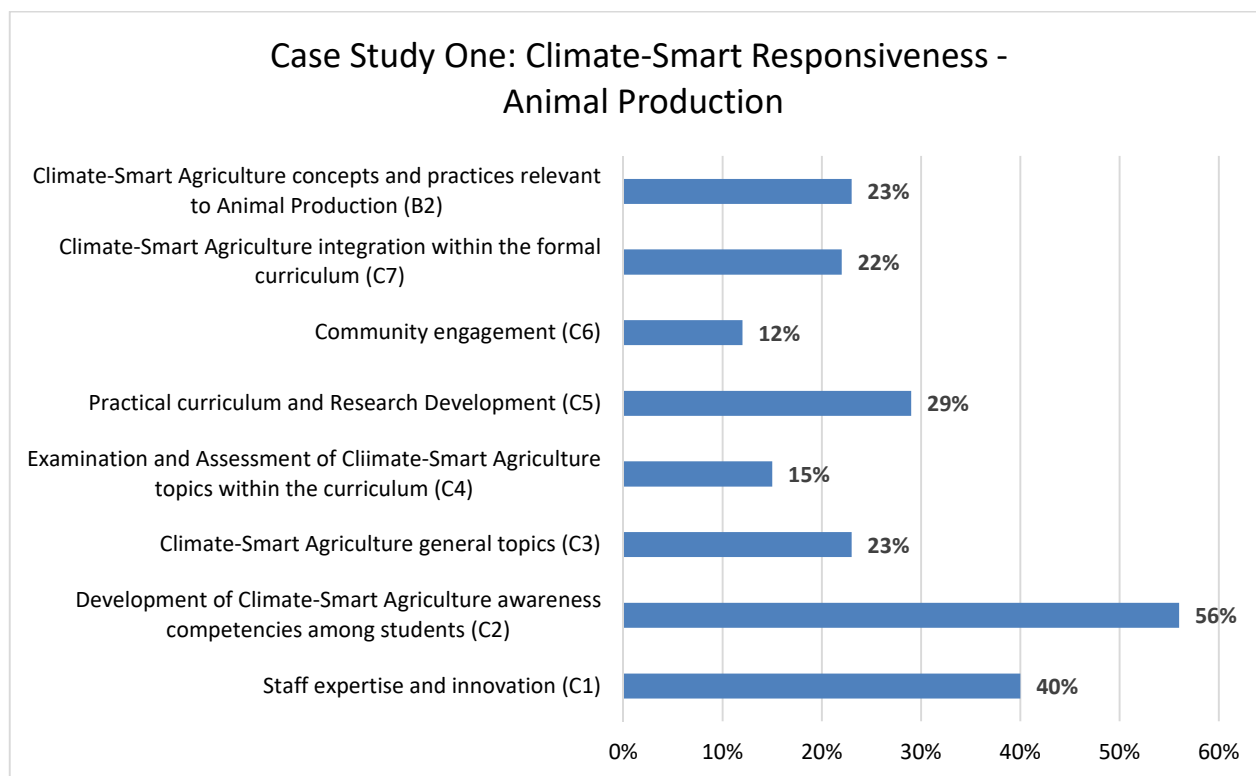


Figure 5.3: Climate-Smart Innovation Tool – Section A (Curriculum, teaching approach and student-community engagements) and Section B (Animal Production) calculated average Indicator Cluster score analysis for the Department of Animal Production, Case Study One

Indicator Cluster C3, Climate-Smart general topics scored an average of 23%. An inclusion of climate related topics within the curriculum were expected as the college curriculum is a relatively new and an informed curriculum. Indicator D5 scored 4, indicating that the Department focusses on the development of entrepreneur's skills. The examination and assessment of Climate-Smart Agriculture topics scored low at 15% (Indicator Cluster C4). The Practical Curriculum and Research Development Indicator Cluster C5 indicated that Climate-Smart responsive topics are integrated informally into the practical components of the curriculum at 29%. This score analysis suggested room for development and innovation within the practical projects and teaching.

Indicator F1 indicates that there is no formal research or research projects in the field of Climate-Smart Agriculture or climate responsiveness currently done in the Department. Cluster C6, Community engagement section, scored the lowest at 12%. Indicator G4 scored

2, highlighting the collaboration of the college with other stakeholders within the community. Indicators G2, G3 and G5 scored zero.

Through these scores one could tentatively conclude that the Department is not involved in community initiatives that address Climate-Smart responsive issues or focused on green job creation, poverty eradication and food security. The integration Climate-Smart Agriculture responsive topics within Animal Production Department curriculum content scored 20% (Cluster C7). Topics surrounding adapted sustainable livestock and pasture management is included within the curriculum (Indicator TA1 scored 4).

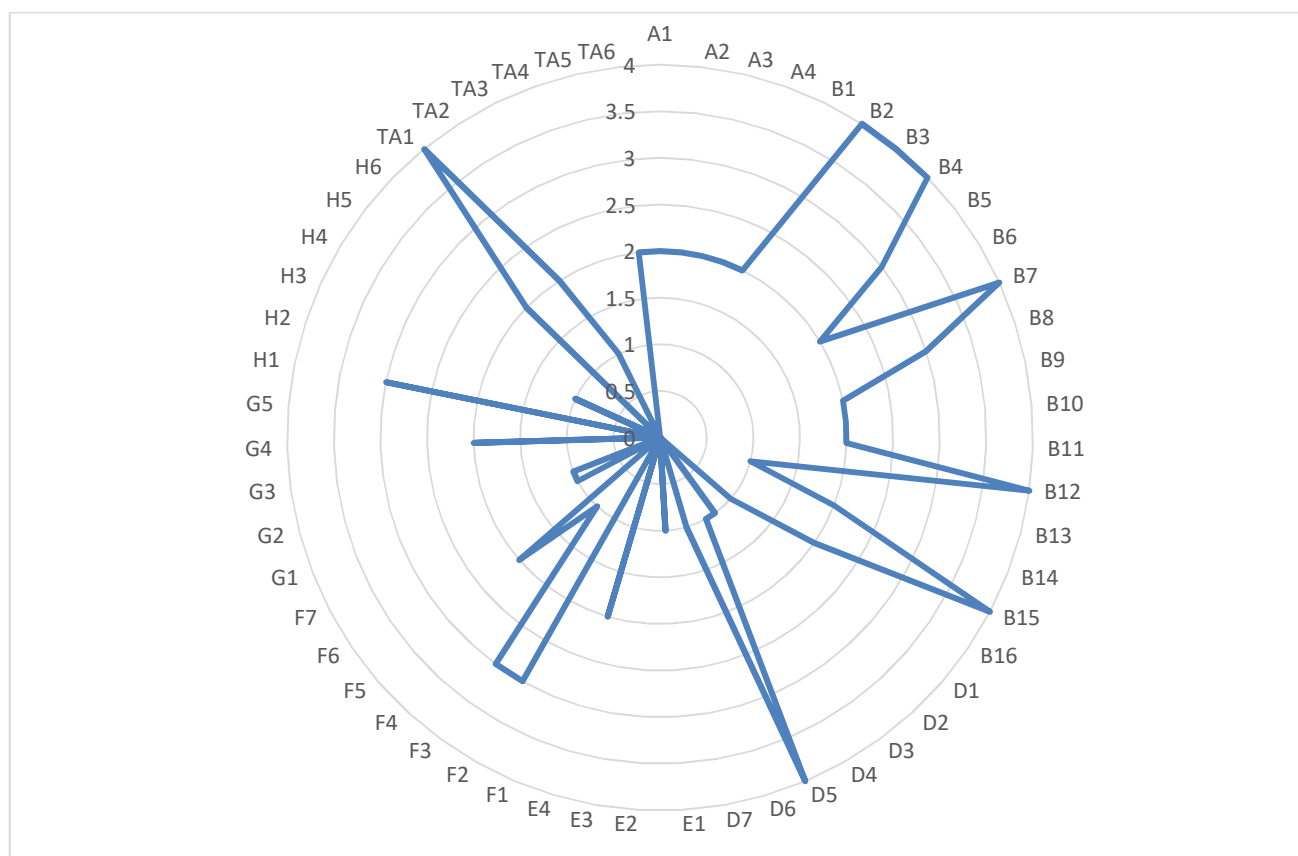


Figure 5.4: Climate-Smart Innovation Tool Section A (Curriculum, teaching approach and student-community engagements) and Section B (Animal Production) indicator score analysis for the Department of Animal Production, Case Study One

5.2.1.3 CLIMATE-SMART INNOVATION TOOL - IRRIGATION DEPARTMENT

The score analysis in Section 5.1.1.3 is based on the completion of the tool by two lecturers and one Head of Department that taught subjects within the Irrigation Department. The subjects managed by the Irrigation Department are listed in Table 4.1. Four Departmental

representatives completed the Climate-Smart Innovation Tool Booklet and the score analysis for this section was calculated by the researcher from these completed tools. The scoring sheet outlining the indicator, clusters and codes are listed in Table 5.3 and 5.4. The score analysis of the Irrigation Department is illustrated in Figure 5.5 and 5.6.

Score analysis of the tool indicated that the Department of Irrigation is to some extent Climate-Smart responsive. Indicator Cluster C1 (Staff expertise and innovation) scored the highest at 60%. Indicator A3 and A4 both scored 5, indicating that the staff of the Department recognise the importance of integrating Climate-Smart Agriculture into the curriculum and learning practices. The development of competencies among students (Indicator Cluster C2) rated 33% and the inclusion of general Climate-Smart Agriculture topics (Indicator Cluster C3) scored 11%. Indicator D5 (Development of entrepreneur skills) scored the highest, 3, of all indicators of Indicator Cluster C3. Indicator Cluster C4 (Examination and Assessment of Climate-Smart Agriculture responsive topics) scored 40%. Indicator Cluster C5 (Practical curriculum content and research) scored 31%. Indicators F1 and F6 scored zero, indicating that no climate responsive research is conducted in the Department and no bursaries for studying food security or water harvesting are available. Indicator G1 scored 4 within the Cluster C6 (Community engagement). This indicates that, according to the score analysis, the Department is engaged in community involvement projects focussing on food security and rural wealth development. Cluster C7 (Climate-Smart Agriculture integration within the formal curriculum) scored an average of 30%. Cluster B3 (Climate-Smart Agriculture concepts and practices relevant to Irrigation: Natural Resource Management – Water) from Section B of the tool scored 33%. Indicator TW1 scored high at 4 (80%) indicating the inclusion of sustainable water management practices within the curriculum and learning practices of the Department.

Case Study One: Climate-Smart Responsiveness - Irrigation Department

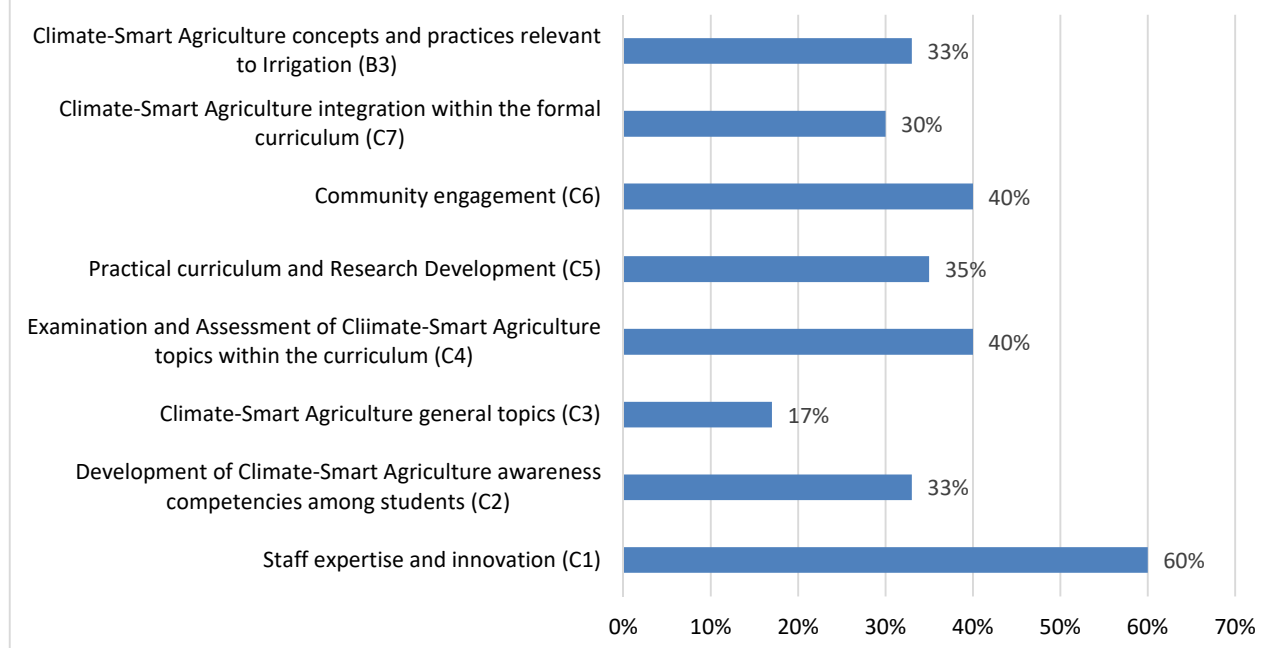


Figure 5.5: Climate-Smart Innovation Tool – Section A and Section B (Natural Resources – Water (B3) calculated average Indicator Cluster score analysis for the Department of Irrigation Case Study One

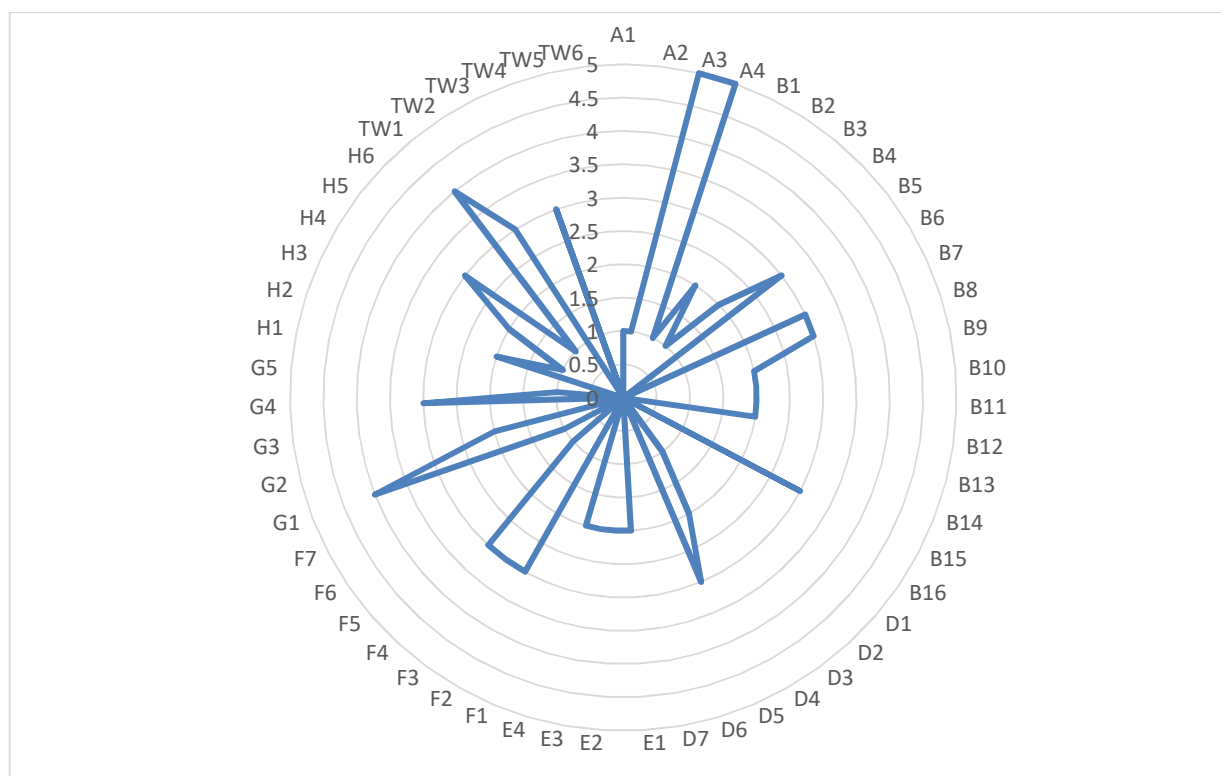


Figure 5.6: Climate-Smart Innovation Tool Section A and Section B (Natural Resources – water, B3) indicator score analysis for the Department of Animal Production, Case Study One

5.2.2 CLIMATE-SMART AGRICULTURE INNOVATION TOOL: SECTION C – MANAGEMENT AND INSTITUTIONAL POLICIES

All research participants completed Section C of the tool; however, only the tool reviews completed by the two management team members, Heads of Departments, were used to generate a score analysis. It is most likely that the management team would have had a more reliable view on Section C, as they work daily within with the management and institutional functioning of the system. The indicator codes and descriptions of the questions are listed in Table 5.5.

Table 5.5: Scoring sheet outlining the indicators, clusters and codes for Climate-Smart Innovation Tool: Section C – Management and institutional policies

P1 Curriculum Outline of the National Diploma	I1	The extent that issues and challenges surrounding the sustainable increase of agriculture productivity form part of your teaching programme
	I2	The extent that challenges surrounding adaptation and building resilience to climate change are covered within the institute's teaching programme
	I3	The extent that the challenges relating to greenhouse gas emission are included in the Diploma
	I4	The extent to which food security and homestead farming are covered in the curriculum
	I5	The extent to which the curriculum is relevant to the Climate-Smart Agriculture responsive challenges that farmers and extension officers are facing in South Africa
	D6	The extent to which interdisciplinary education forms a component of the curriculum e.g. linking extension education, food security and climate change
P2 Operations and management	O1	The degree of waste reduction practices on the campus
	O2	The extent of recycling practices on the campus
	O3	The extent to which practices to reduce greenhouse gas emissions are implemented on campus
	O4	The extent to which energy conservation practices are implemented on campus
	O5	The extent of Climate-Smart Agriculture awareness on the campus
	O6	The extent that water saving practices are implemented on campus
	O7	The extent to which rain water harvesting and conservation practices are implemented on campus

P3 Student Climate-Smart Agriculture responsiveness & participation	S1	Is there a student climate and environmental organisation or group on campus?
	S2	Do students have access to career counselling that focusses on work opportunities related to climate change and agriculture sustainability?
	S3	Are sustainable and environmental practices practised within the residence or dormitories by students (e.g. recycling and waste reduction)?
	S4	Is there a community garden programme that students are involved in?
	S5	Are students involved in practical programmes that promote food security, homestead gardening and entrepreneurship?
	S6	Do student assessment projects allow for the practical application of Climate-Smart Agriculture concepts?
	S7	Does the college have a Climate-Smart Agriculture responsive awareness programme that promotes awareness of climate change, food security and sustainable agriculture?
P4 Policies & written statements	PS1	The extent to which the province's policies related to agriculture reflects the educational engagement with Climate-Smart Agriculture and responsiveness
	PS2	The extent to which national and global Climate Change issues inform decision making processes in the institutes policy and structure
	PS3	The level of support that your College / Agriculture Training Institute receives for the integration of Climate Smart Agriculture and climate responsiveness aspects into the Diploma
	PS5	The level of integration of Climate-Smart Agriculture concepts such as sustainability into the existing institutional policies
	PS6	The level of integration of Climate Change and other Climate-Smart Agriculture concepts into the institutes vision and mission statement
	PS7	Level of implementation of policies related to Climate-Smart Agriculture concepts
	PS8	Level of future consideration to improve the integration of Climate-Smart Agriculture concepts in the next policy review cycle

Case Study One's overall scores for Section C was average. As the innovation tool is an indicator of the Climate-Smart responsiveness of the curriculum, this score analysis can be used to track the curriculum innovation of the college. The overall average cluster scores of Section C are illustrated in Figure 5.7. The Climate-Smart responsiveness of all indicators within the clusters are illustrated in Figure 5.8. Case Study One scored overall the highest in the Policies and written statements section (Indicator Cluster P4) at 38%. The institute scored 2 (40 %) in all the indicators within Indicator Cluster P4 (The level of integration of Climate-Smart Agriculture concepts such as sustainability into the existing institutional policies) except for P5 that scored 3 (60%). The positive score indicates that the college is aware of provincial policies that reflect the educational engagement with Climate-Smart Agriculture

and responsiveness. It also indicates that climate change issues inform the decision-making process in the institute's policy and structure. Management of the college reflected that the college has a good deal of support to assist in the integration of Climate-Smart Agriculture and climate responsiveness aspects into the Diploma. There was integration of sustainability into the existing institutional policies. The vision and mission of the Agricultural College is also committed towards Climate-Smart responsiveness.

The college scored 33% for Indicator Cluster P1 (Curriculum outline and National Diploma) that focusses on the integration of Climate-Smart responsive concepts into the National Diploma. The assessment indicated that topics such as the sustainable increase of agriculture productivity (Indicator D1), adaptation, building resilience to climate change (Indicator D2) and greenhouse gas emission challenges (Indicator D3) form part of the curriculum as these indicators all scored 2 (40%). The extent to which the curriculum is relevant to farmers and extension officers that face climate change challenges also scored 2 (40%, Indicator D5). However, food security and homestead farming is only covered to a slight extent and scored 1 (20%, Indicator D4). Indicator D6 scored 1 (20%), due to a lack of interdisciplinary education and articulation of information between subjects that can link extension education, food security and climate change. The scores collaborated with the curriculum content. Taung Agricultural College curricula was newly developed in 2014, therefore certain topics aligned with Climate-Smart responsiveness are included within the curriculum. Subjects that are Climate-Smart Agriculture orientated include Natural Resource Management, Soil and Water Conservation and Rural Development.

The section on Operation and Management scored 17%. There are no waste reduction practices or recycling practices on the campus as indicated by indicators O1 and O2. Indicators O3 and O4 scored low at 2 (40%) indicating that the campus is aware of the importance of reducing greenhouse gas emissions and conserving energy. Indicator O5 scored at 3 (60%) as a Climate-Smart Agriculture awareness campaign was initiated in 2016. However, no water saving practices, including Rain Water Harvesting and Conservation practices, have been implemented on campus. Thus, Indicators O6 and O7 scored zero. Indicator Cluster P3 (Student Climate-Smart responsiveness and participation) scored zero on all indicators.

Case Study One: Climate-Smart Responsiveness - Management and Institutional Policies

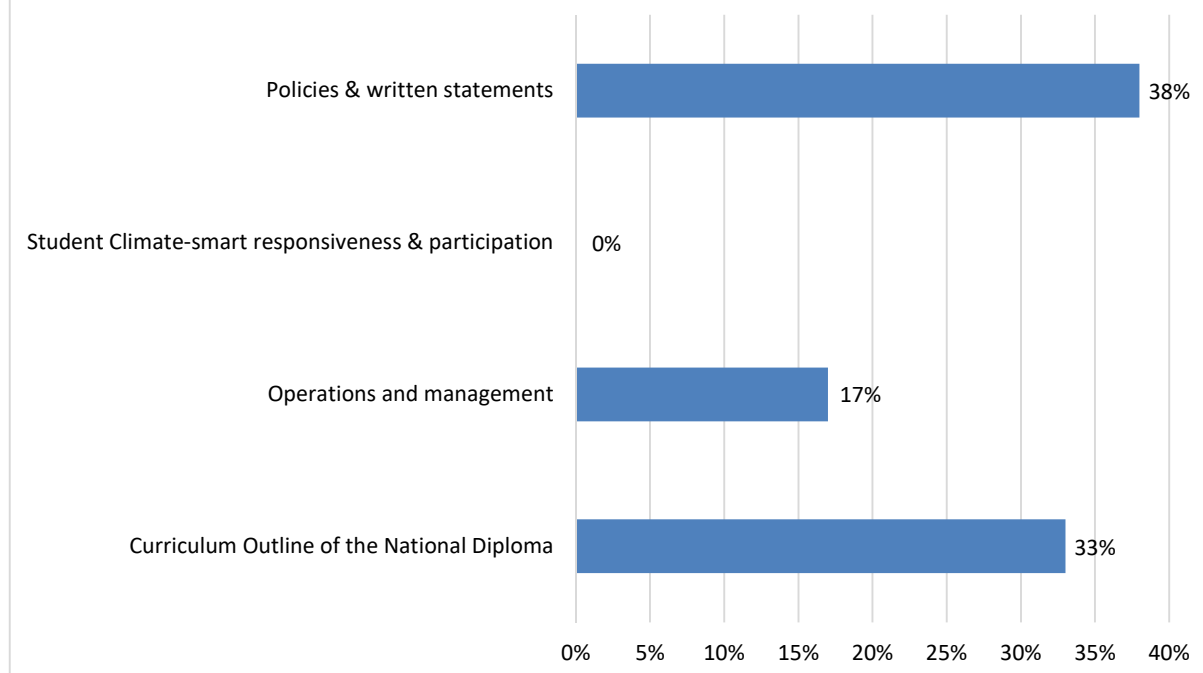


Figure 5.7: Climate-Smart Innovation Tool – Management and institutional policies calculated Indicator Cluster score analysis of Case Study One

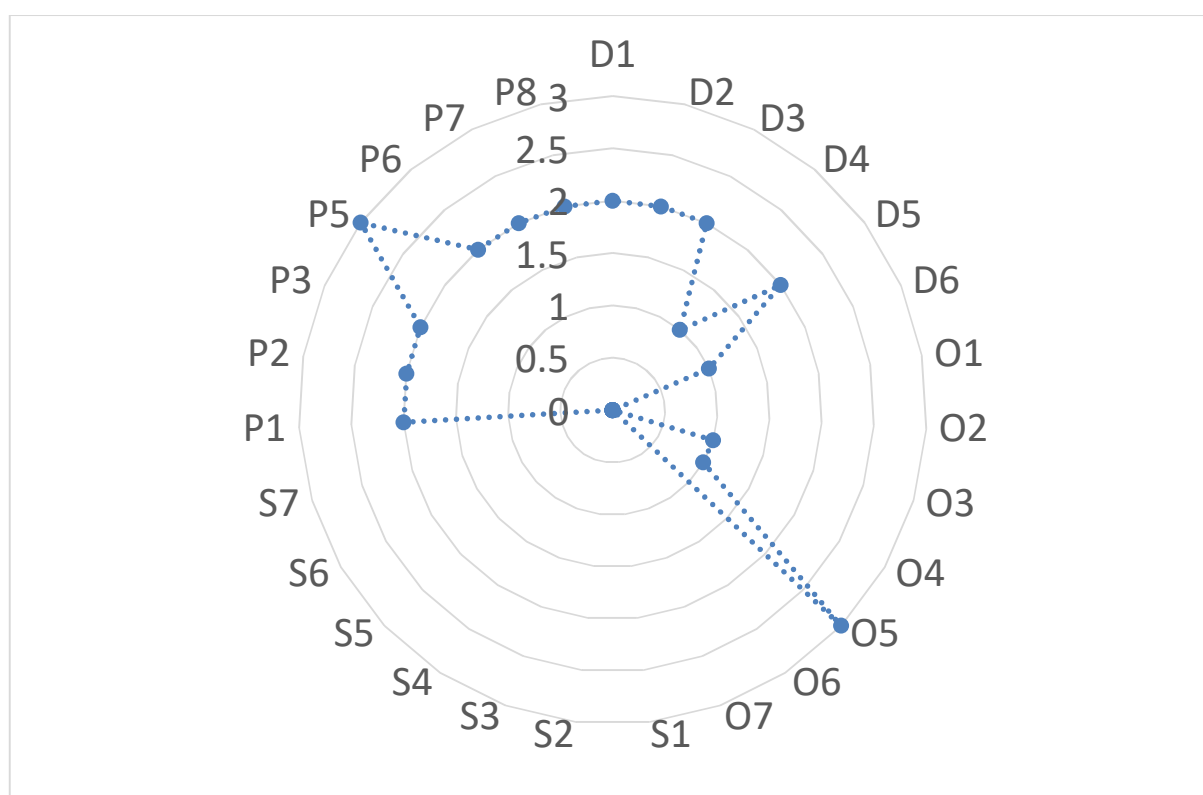


Figure 5.8: Climate-Smart Innovation Tool – Management and institutional policies indicator score analysis of Case Study One

5.2.3 NATIONAL DIPLOMA IN AGRICULTURE – IRRIGATION CLIMATE-SMART

RESPONSIVENESS

The indicative Climate-Smart responsiveness score analysis was derived from 13 tool reviews completed by the Departments of Crop Production (4), Animal Production (4), Irrigation (3) and Farm Management (1). The average of each Indicator Cluster was calculated. The score analysis was used as mirror data during the intervention-innovation workshops in Phase 3, as the score analysis provides an indicative picture of the level of Climate-Smart responsiveness of Case Study One through the eyes of the research participants that completed the tool (see Figure 5.9). The aim of the tool score analysis was to provide the researchers with a reflexive tool that could initiate and support innovation.

From the score analysis, one could conclude that there are not enough Climate-Smart Agriculture topics integrated into the National Diploma of Agriculture – Irrigation (see Figure 5.5). The staff expertise and innovation cluster (Indicator Cluster C1) scored the highest at 47% focussing on the willingness of staff members to participate in curriculum innovation. All the indicators belonging to the Climate-Smart Agriculture integration within the formal curriculum clusters (Cluster C7) scored low at 8%. General topics (Cluster C3) scored 22% while Examination and assessment (Cluster C4) scored 20% and the Practical curriculum and research (Cluster C5) was rated at 29%. The Community engagement indicator clusters (C6) rated 28%. The development of awareness among student indicator cluster (C2) scored 39%, while the average score analysis indicating the responsiveness of the Diploma to climate change and other Climate-Smart Agriculture related topics was 36%.

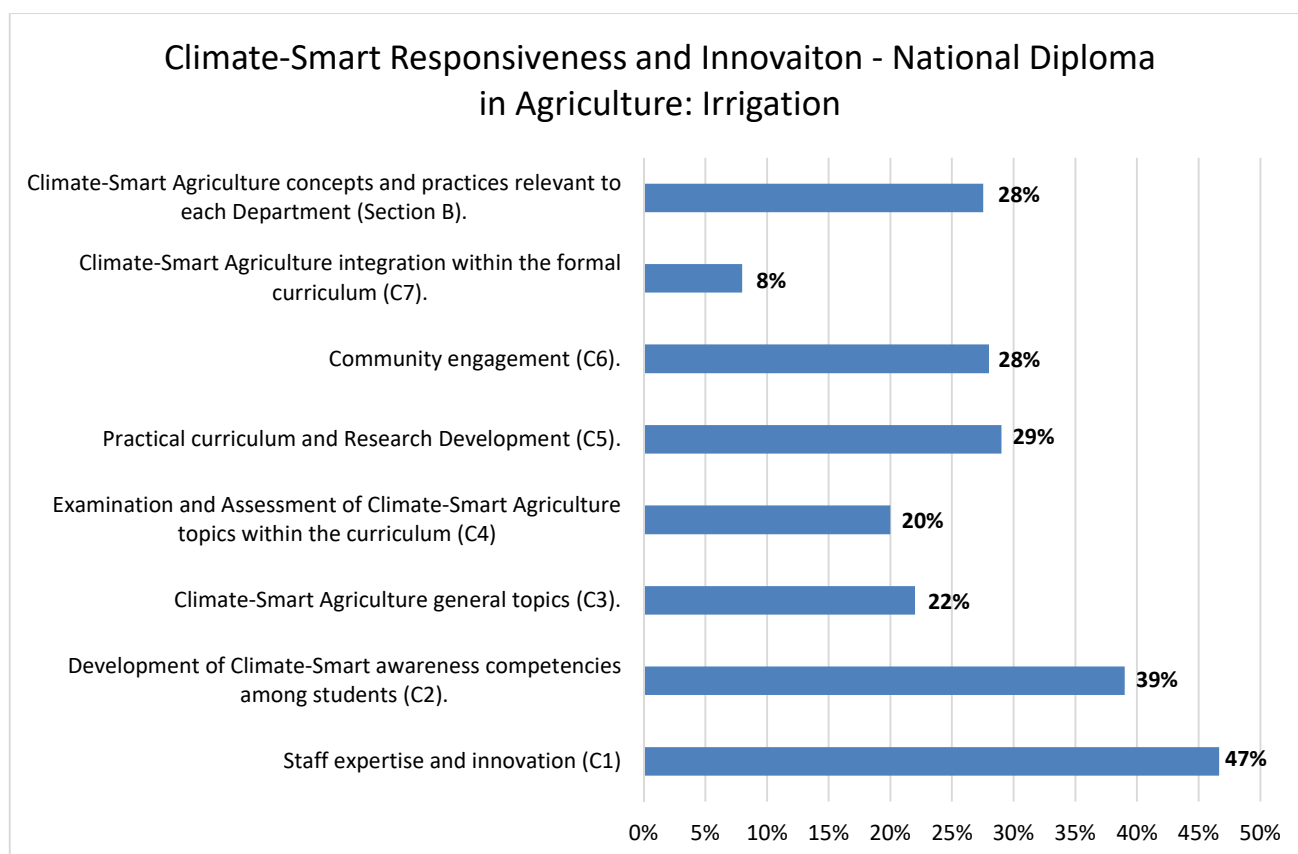


Figure 5.9: The score analysis of the Climate-Smart Innovation Tool for Diploma in Agriculture: Irrigation

5.3 CLIMATE-SMART AGRICULTURE INNOVATIONS AT CASE STUDY TWO - POTCHEFSTROOM COLLEGE OF AGRICULTURE: FIRST SELF-ASSESSMENT

Eleven research participants completed the Climate-Smart Innovation Tool Booklet prior to the first intervention-innovation workshop in Phase 3.

5.3.1 CLIMATE-SMART INNOVATION TOOL – DEPARTMENTS AND LECTURERS

The Climate-Smart Innovation tool for teaching staff is designed to assist the lecturer to review the curriculum from his/her point of view. The tool review is an indicative analysis that assists the reviewer to develop an understanding of Climate-Smart Agriculture constituents, curriculum innovation and visualise the Climate-Smart responsiveness of the curriculum or subject framework that the participant is involved in. The assessment criteria used for the tool score analysis are explained in Table 5.1. Tables 5.3, 5.4 and 5.5 list the scoring sheet outlining the indicators, clusters and codes of Section A, B and C. The college is divided into

four Departments namely, Plant Production, Animal Production, Agricultural Engineering and Farm Trades, and Agricultural Management and Computer.

5.3.1.1 THE CLIMATE-SMART INNOVATION TOOL RESULTS FOR PLANT PRODUCTION DEPARTMENT

Score analysis for this section was calculated from four Climate-Smart Innovation Tool Booklets (Section A and Section B) completed by teaching staff who taught within the Plant Production Department. The subjects offered by the Department are listed in Table 4.2. Figure 5.10 shows the calculated average Indicator Cluster score analysis for the Plant Production Department and Figure 5.11 depicts the score analysis of each indicator within Section A and B of the tool.

The department obtained scores below the suggested range across all indicator clusters in most instances but scored high (75%). Indicators A3 and A4 scored 5 indicating staff willingness towards innovation and transition. Indicator Cluster C2 scored 40%. Indicators B2 (Critical thinking skills), B3 (System thinking skills) and B9 (Integrated problem solving competencies) all scored 4. According to the tool reviews, the Department offers subjects that are Climate-Smart responsive. The Climate-Smart general topics included within the subjects taught by the Plant department included Sustainable agricultural practices and renewable energy. This cluster scored 23%. The Indicator Cluster C4 (Examination and Assessment) scored 20%. All indicators were zero except for indicator E1 that scored 1.

The tool review indicated that there is not much research activity related to Climate-Smart responsiveness in the Department and practical application is also low. The Practical curriculum and Research development cluster (C5) scores were 17%. Indicator F3 scored 3 with an explanatory note on one of the completed tools noting that partnerships with a focus on Climate-Smart responsiveness were developing between individual Department members and research institutes with regard to practical application of teaching gardens. Indicator Cluster C6 (Community engagement) score analysis of 20% indicates a level of engagement with the surrounding community (Indicators G1 and G4 scored 2). Indicator Cluster Climate-Smart Agriculture integration within the formal curriculum scored the lowest at 0%. All indicators for Cluster C7 scored zero. The average analysis core of the Plant Production Department was 29%, indicating a slight Climate-Smart responsiveness.

Case Study Two: Climate-Smart Responsiveness - Plant Production

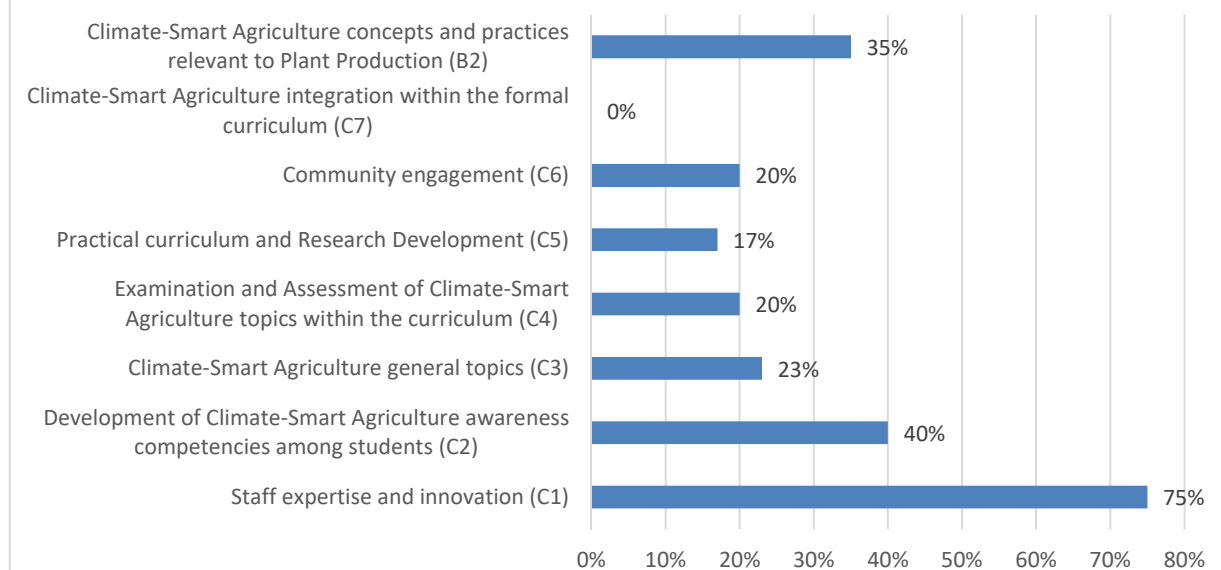


Figure 5.10: Climate-Smart Innovation Tool – Section A (Curriculum, teaching approach and student-community engagements) and Section B (Plant Production) calculated average Indicator Cluster score analysis for the Department of Plant Production, Case Study Two

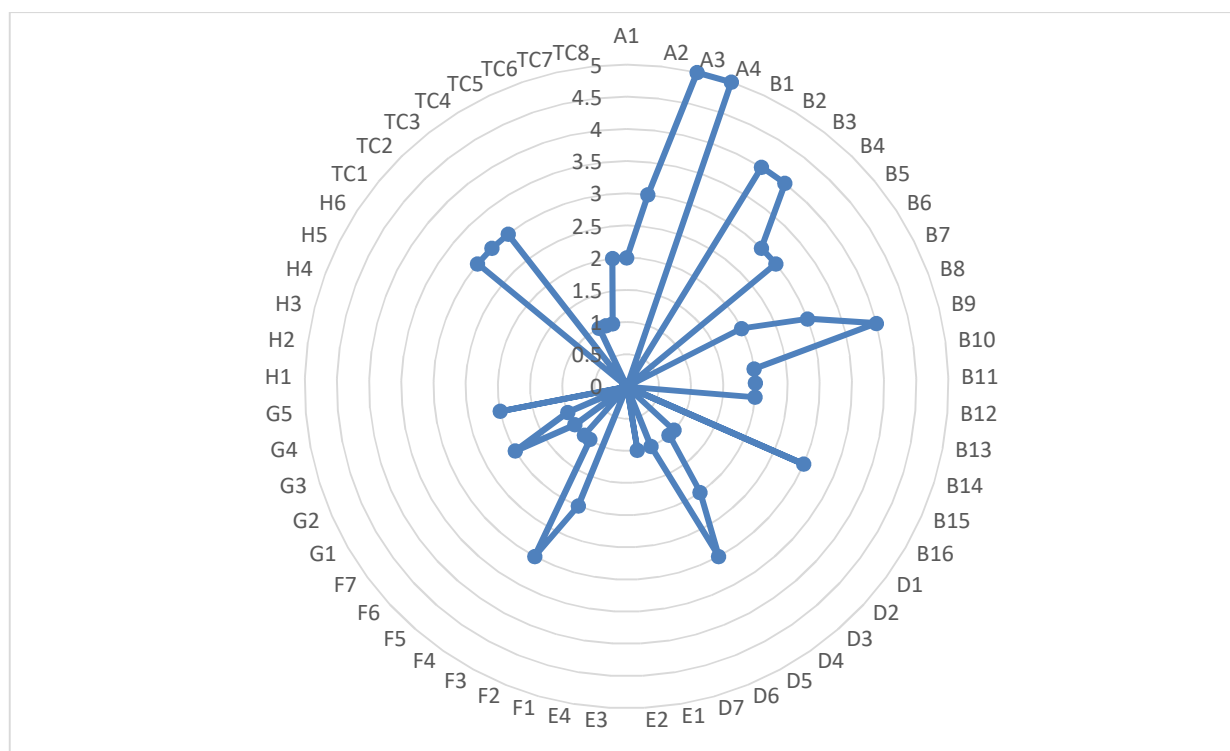


Figure 5.11 Climate-Smart Innovation Tool Section A (Curriculum, teaching approach and student-community engagements) and Section B (Plant Production) indicator score analysis for the Department of Plant Production, Case Study Two

5.3.1.2 CLIMATE-SMART INNOVATION TOOL - ANIMAL PRODUCTION DEPARTMENT

Three lecturers and one Head of Department that taught in the Animal Production Department completed the Climate-Smart Innovation Tool Booklets (Section A and Section B) for Case Study Two. The score analysis calculated from the above-mentioned reviews is summarised below. The subjects offered by Animal Production Department are listed in Table 4.2. Figure 5.12 and Figure 5.13 summarises the score analysis of the Department.

The score analysis indicates that Climate-Smart Agriculture topics are not directly taught in the Animal Production Department. Indicator Cluster C1 scored the highest at 60%. Indicator A3 and A4 scored 4, indicating the level of determination and openness to curriculum innovation and integration of the Climate-Smart Agriculture concept into the teaching and learning practices. Cluster C2 scored 20% indicating development of competencies in critical thinking (Indicator B2) and Systems thinking (Indicator B3), a sense of responsibility (Indicator B8), respect for others (Indicator B9) and creating awareness of values and ethics (Indicator B10). These indicators all scored 3. Cluster C3 score analysis indicated that the only general Climate-Smart Agriculture topics included in the curriculum are sustainable profitmaking business (Indicator D4 scoring 1) and development of entrepreneur's skills (Indicator D5 scoring 3). The score analysis indicates that there are no community engagement projects driven by the department. All indicators forming part of the Examination and Assessment (C4), Practical curriculum and research development (C5), Community engagement (C6), and Inclusion in formal curriculum (C7) clusters scored zero indicating an absence of evidence on these indicators. Section B Cluster B2 scored 25% indicating that the curriculum has relevant Climate-Smart responsive topics that are integrated to some extent. The average score analysis was calculated at 15%, which indicated a picture of the relative responsiveness of the Department.

Case Study Two: Climate Smart Responsiveness- Animal Production

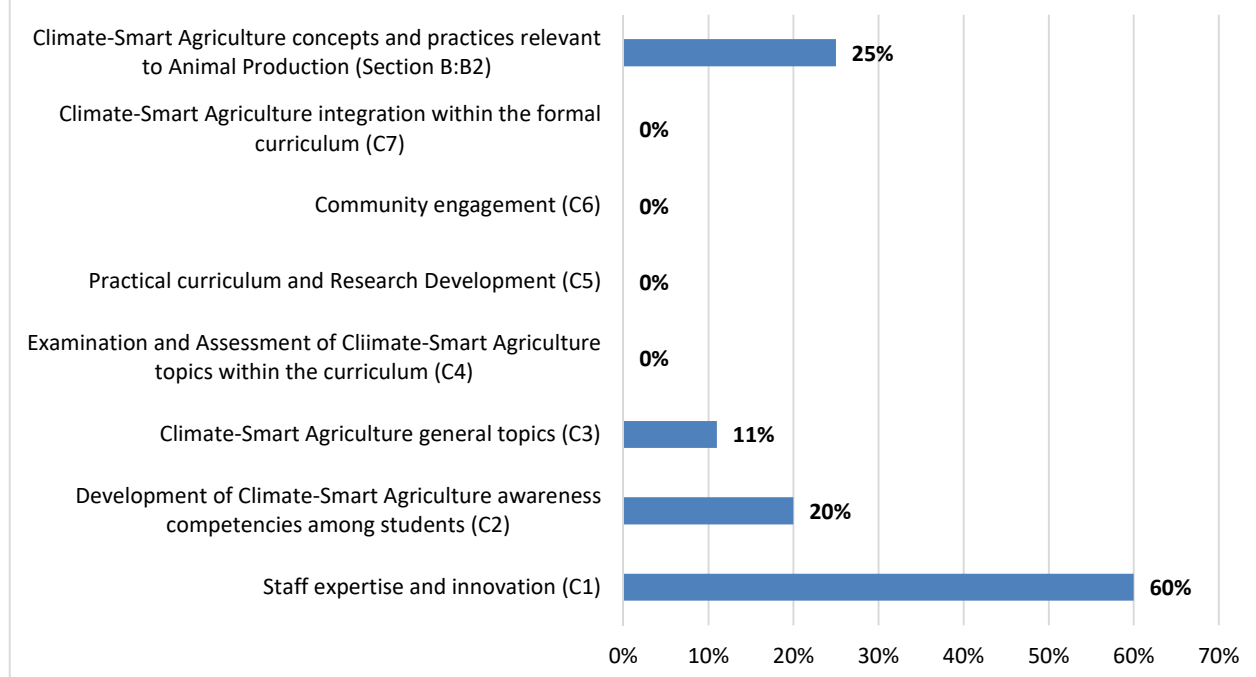


Figure 5.12: Climate-Smart Innovation Tool – Section A and Section B calculated average Indicator Cluster score analysis for the Department of Plant Production Case Study Two

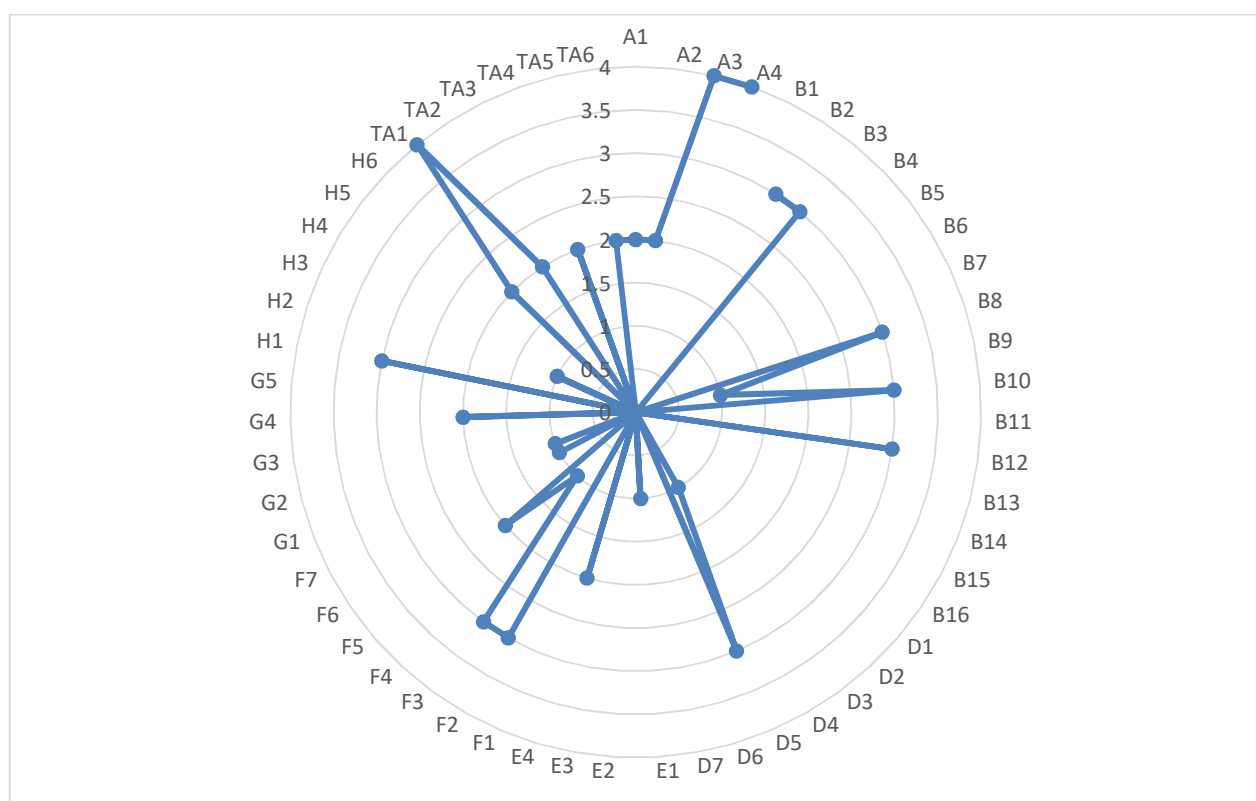


Figure 5.13 Climate-Smart Innovation Tool Section A (Curriculum, teaching approach and student-community engagements) and Section B (Plant Production) indicator score analysis for the Department of Plant Production, Case Study Two

5.3.2 CLIMATE-SMART INNOVATION TOOL – MANAGEMENT AND INSTITUTIONAL POLICY REVIEW

All research participants completed Section C of the tool, however only the tool reviews completed by the three management team members, Head of Departments, were used to generate a score analysis. The indicator codes and descriptions of the questions are listed in Table 5.5. The tool can be found in Appendix 5.1. The three reviews' answers were combined to develop a more indicative picture of the role of management and institutional policies in curriculum innovation towards a more Climate-Smart responsive curriculum.

The score analysis of the tool review indicates that Case Study Two management and institutional practices require some integration of Climate-Smart responsiveness as the scores were low in all four divisions (see Figure 5.14). Figure 5.14 illustrates the overall average calculated cluster scores of Section C for the National Diploma of Mixed Agriculture. A comprehensive score analysis of all indicators within the clusters is illustrated in Figure 5.15. Cluster P1 (Curriculum Outline Curriculum outline of the National Diploma) scored 17%. Indicator D4 (inclusion of homestead farming and food security within the curriculum) and D5 (inclusion of responsiveness to climate responsive related challenges) both scored 2. Cluster P1 focused on the extent of integration of Climate-Smart responsiveness within the general outline of the agricultural curriculum which in turn is an indicative analysis that can support the identification of challenges and possibilities for innovation.

However, the Cluster P2, (Operations and Management) scored 17%. This section allows the participant to identify the institute's performance in relation to Climate-Smart responsiveness and practices including waste reduction practices, recycling, reduction of greenhouse gas emissions, energy conservation practices, awareness of Climate-Smart Agriculture programmes and water conservation practices. Indicator O4 and O6 both scored 2 indicating that energy conservation and water saving practices are implemented on campus to some extent. No components of the Climate-Smart Agriculture approach were recorded within Cluster P3 (Student responsiveness and involvement).

Policies and written statements (Cluster P4) also scored a positive inclusion of 13% which indicates that the Institution does get some support to include Climate-Smart Agriculture concepts into the curriculum (Indicator P3 scored 2) and that there are Climate-Smart

Agriculture concepts included within the written statement of the provincial policies (Indicator P4 scored 2). This part of the tool reviews the policies and written statements of the college (or Agricultural Training Institute) and its alignment with Climate-Smart Agriculture constituents, climate responsiveness and the National Agriculture Strategic plan for Agriculture Training Institutes.

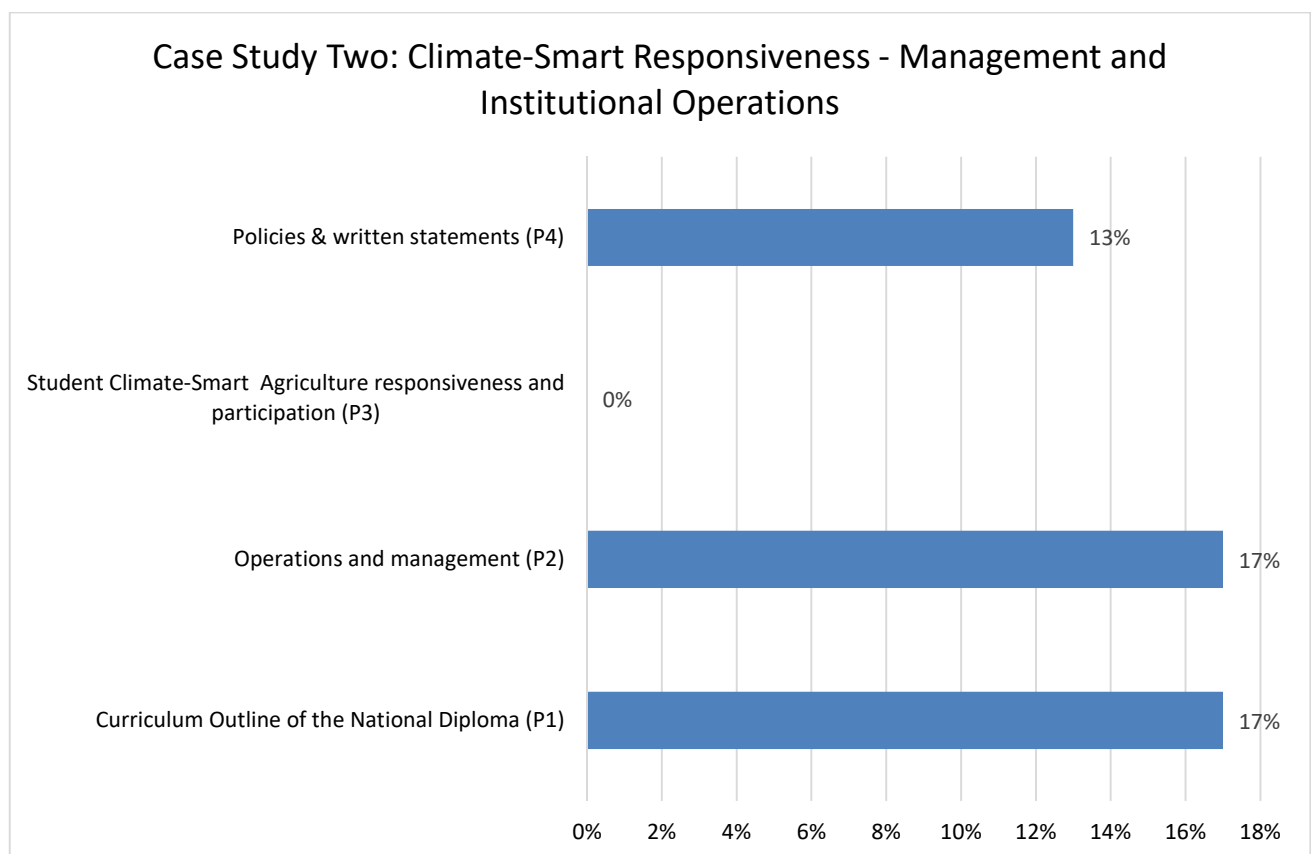


Figure 5.14: Climate-Smart Innovation Tool – Management and institutional policies calculated Indicator Cluster score analysis of Case Study Two

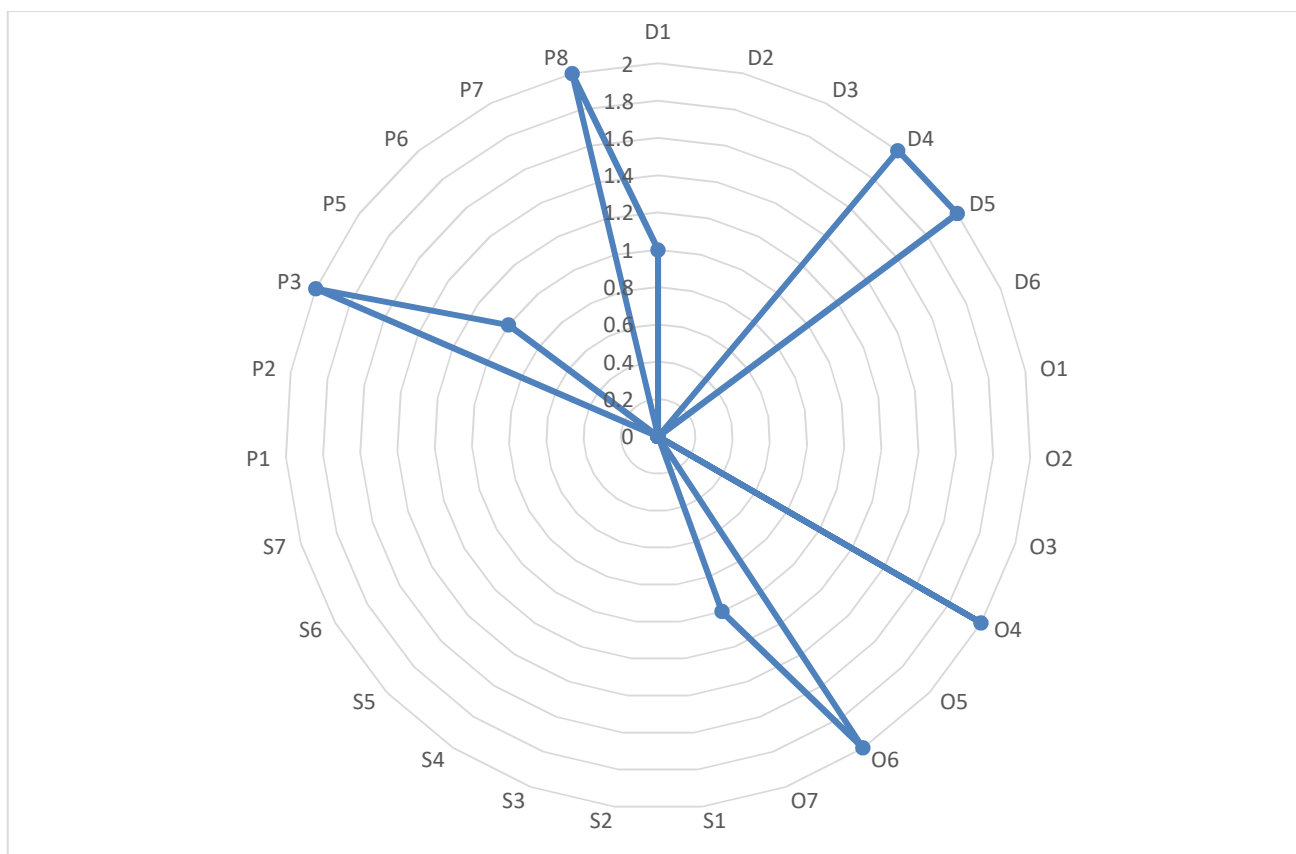


Figure 5.15: Climate-Smart Innovation Tool – Management and institutional policies indicator score analysis of Case Study Two

5.3.3 NATIONAL DIPLOMA IN AGRICULTURE – MIXED CLIMATE-SMART

RESPONSIVENESS

The indicative Climate-Smart responsiveness score analysis was derived from 11 tool reviews completed by the Departments of Crop Production (4), Animal Production (4), Agricultural Engineering and Farm Trades (2) and Agricultural Management and Computers (1). The calculated average of each Cluster for Section A and B is illustrated in Figure 5.16. The score analysis was used as mirror data during the intervention-innovation workshops in Phase 3 to initiate discussion and provide an indicative picture of the level of Climate-Smart responsiveness of Case Study Two. The tool review analysis is important as it is the views of the research participants that are mirrored back to them through inductive analysis.

The Staff expertise and innovation (Indicator Cluster C1) scored the highest at 68%. This is a clear indication of the willingness and commitment of the staff towards curriculum innovation.

Case Study Two scored 30% for Indicator C2 (the development of Climate-Smart awareness competences among the students enrolled for the national diploma). Cluster C3 (Climate-Smart Agriculture general topics) scored 17%. Climate-Smart Agriculture concepts are introduced informally to a small extent within the curriculum through discussion of sustainable agriculture. The score analysis for Cluster C4 (10%) indicates that according to the view of the research participants, Climate-Smart Agriculture topics are not generally assessed within the curriculum, but there is a marginal amount of work that is assessed in topics that are related to the approach as discussed in the curriculum content section. Cluster C5 scored 9% indicating that the integration of Climate-Smart Agriculture content within the practical curriculum and research development could possibly benefit from innovative changes. Climate-Smart Agriculture is indirectly integrated within the practical projects, teaching and surroundings. Cluster 6 (Community engagement) scored 10%. There is community engagement, but the community engagement projects do not include awareness of climate-change, food security or homestead gardening. The community engagement is more concerned with projects where crops are distributed to members of the community. Indicator Cluster C6 scored 10%.

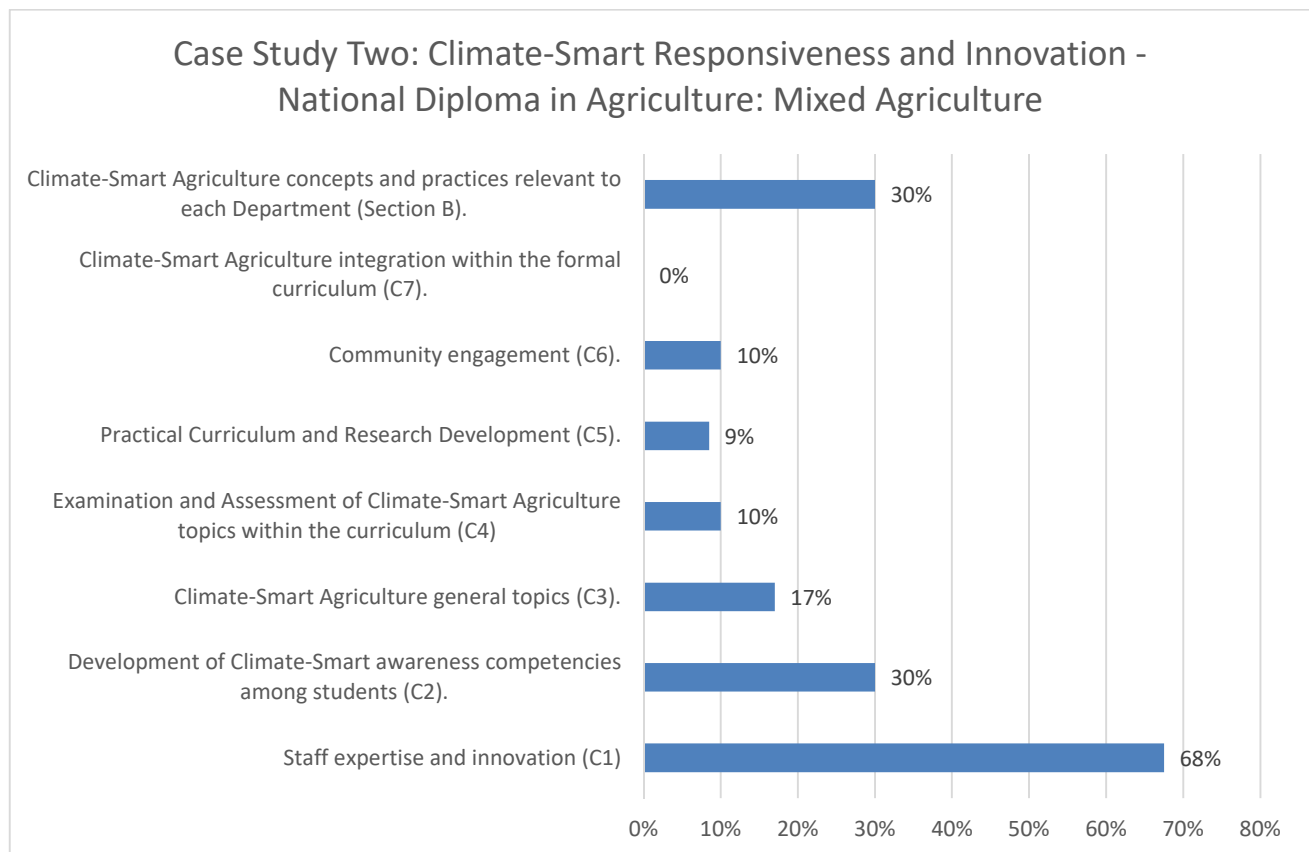


Figure 5.16: Climate-Smart Innovation Tool – Section A and Section B calculated average Indicator Cluster score for Diploma in Agriculture: Mixed Agriculture – Case Study Two

5.4 CONCLUSION

Chapter Five explored the Climate-Smart responsiveness of both activity systems through the score analysis of the Climate-Smart Innovation Tool Booklet completed by the research participants of both case studies, before the first intervention-innovation workshop. Chapters Six and Seven continue to discuss how the compiled indicative tool data was mirrored back to the research participants during the intervention-innovation workshops. The aim was to use the Climate-Smart Innovation Tool's score analysis to stimulate reflexivity and further discussion during the intervention-innovation workshop. The tool was used to initiate and support research participants during curriculum innovation within the curriculum and learning activity system towards a Climate-Smart system.

CHAPTER 6

THE ITERATIVE PROCESS OF INNOVATION SUPPORT AND TRACKING IN CASE STUDY ONE

6.1 INTRODUCTION

The insights derived from the data generated with the tool in Phase Two were used to mirror into the innovation workshops of Phase Three of the study. The participants reflected upon the data to identify and work on innovations in their specific professional field as their Climate-Smart innovation work developed. The historical analysis from the two consultative workshops (Sections 4.3 and 4.5) and the data derived from the initial use of the Climate-Smart Innovation Tool (Section 5.1) were used to model the activity systems in the respective colleges and their relation to the provincial system during the intervention-innovation workshops. This analysis enabled the participants to scope how the system was currently functioning and how it had changed over time. The insights derived from this analysis were used to identify contradictions through mirror data that surfaced and were deliberated during the intervention-innovation workshops. During the workshops, curriculum innovations were reviewed and a fuller picture of the challenges of system innovation emerged. The chapter concludes with a review of the innovation process that emerged through the three intervention-innovation workshops that initiated expansive learning. The evaluation of system tensions and contradictions illustrates the complexities of curriculum innovation towards Climate-Smart responsiveness in the college and the North West Agricultural System. These are discussed in Chapter Eight.

Appendix 3 is list of the research participants. Participants attending the intervention workshops included lecturers, members of the management team and farm managers. Due to continuous staff changes within the college, the participants at each workshop varied. Thirteen participants of Taung College attended the first consultative workshop. One representative of the college attended the Amanzi For Food curriculum innovation workshop, thirteen attended the first intervention workshop, eighteen participants attended the second intervention workshop and twelve participants attended third workshop (see Appendix 3).

6.2 THE FIRST INTERVENTION-INNOVATION WORKSHOP

The first workshop facilitated the verification of research data obtained during Phase One and Two that answers two research questions of the study namely (Also see Section 1.4):

- What Climate-Smart Agriculture elements (context, content, competencies, knowledge dynamics) are incorporated into the current National Diploma agricultural curricula content and practices, if any, at the start of the curriculum innovation formative intervention process?
- How can college staff involved in the offering of the National Diploma in Agriculture be engaged through formative intervention explore practical options for curriculum innovation utilising Climate-Smart Agriculture?

The Climate-Smart Innovation Tool score analysis (Sections 5.2 & 5.3) and the feedback from the Amanzi For Food workshop (see Section 4.7 and Appendix 6) were used as mirror data during the expansive learning cycle. Eleven lecturers and two Heads of Department attended the workshop for Case Study One.

6.2.1 OBJECT OF THE FIRST INTERVENTION – INNOVATION WORKSHOP

- To surface tensions and contradictions that arose during initial process of innovation towards responsive Climate-Smart curriculum and learning practices through the reflection of mirror data.
- To discuss the existing curriculum, use of the Climate-Smart Innovation Tool and the Amanzi for Food workshop

6.2.2 TOPICS FOR DISCUSSION

6.2.2.1 CASE STUDY ONE AS AN AGRICULTURAL CURRICULUM AND LEARNING ACTIVITY SYSTEM

The first item on the agenda was structuring and understanding the college as an activity system by identifying how the existing system functions, what has changed and what needs to change. Figure 6.2 shows four PowerPoint presentation slides used during the workshop to open the discussion on Cultural Historical Activity Theory and the college as an activity system. The college as an activity system was discussed and system component details were added by the workshop participants (Figure 6.3). The changes within the system that occurred over the last couple of decades were also discussed. Figure 6.1 represents the curriculum and learning activity system as developed with the help of the research

participants during the workshop. The subject, rules, community, division of labour and tools that were discussed during the workshop are included in Figure 6.1.

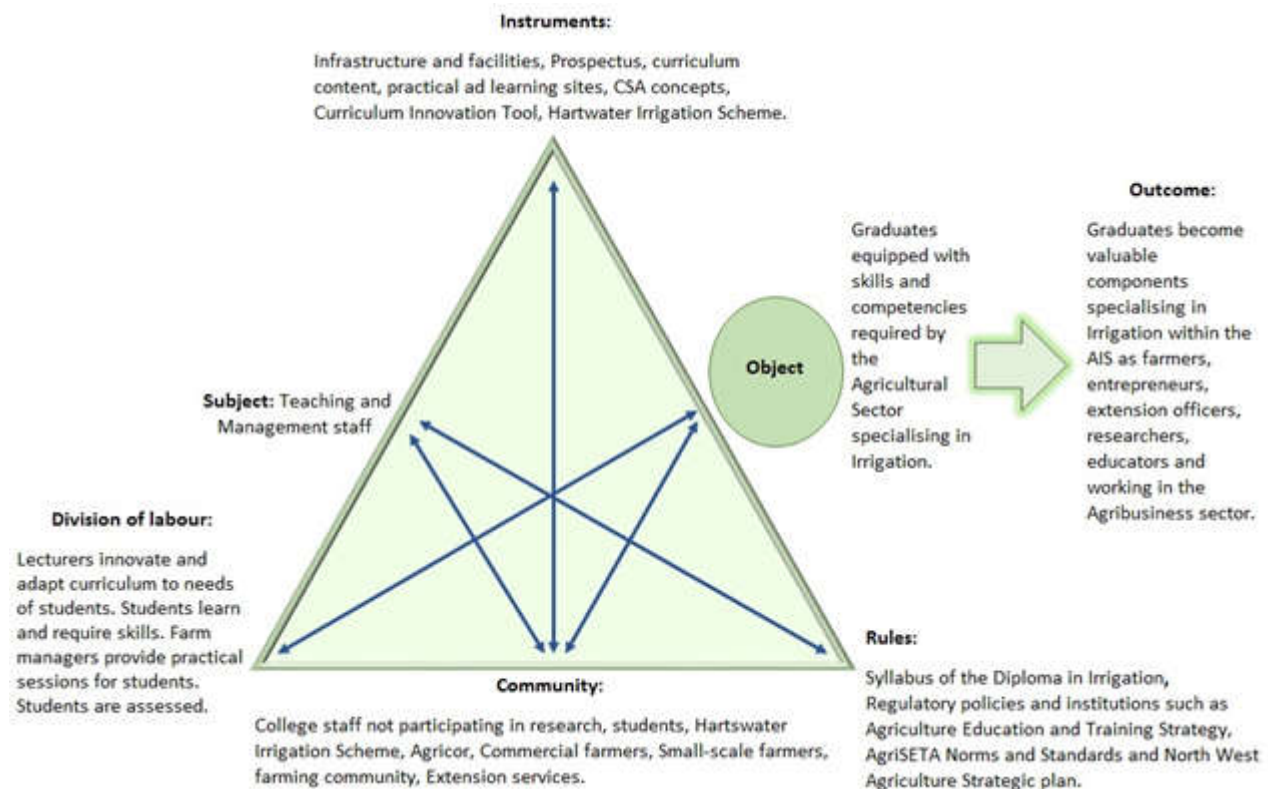


Figure 6.1: Taung Agricultural College curriculum and learning activity system

Figure 6.1 represents the curriculum and learning activity system without details of history, culture, contradictions or boundary crossings based on second generation Cultural-Historical Activity System as the primary unit of analysis. A clear picture of the system was developed with the help of the research participants during the first intervention-innovation workshop. According to Taung College's website, the college is a nationally recognised institution of excellence and a pioneer in sustainable enhanced agriculture (TAC, 2017b). A brief description of Case Study One as a curriculum and learning activity system follows.

The lecturers and management, **subject**, or **actors**, that participated in this study were the subjects. They were involved in the innovation of the activity system and acted as subjects of analysis and intervention (Engeström, 1987, p. 49). The **rules** are structured by READ and the College must also comply with all the constitutional and policy mandates that READ complies with. The activity system's courses and assessments are governed by the National

Department of Education and Department of Higher Education and Training that guides the syllabus through the South African National Qualifications Framework. Accreditation institutes that govern the accreditation of the courses presented at the College include the Council for Higher Education, Umalusi, AgriSETA, Sector Education and Training Authority (SETA) and South African Qualifications Authority (SAQA).

The **community** comprises other non-participating staff such as the farm manager, students, actors in the Taung and Hartswater Irrigation Scheme and the local farming community involved in the community projects. The small-scale farmer is an important component within the North West Agricultural System. **Division of labour** involves the lecturers that innovate the curriculum and translate content to the students through sharing of their knowledge related to the National Diploma of Irrigation. The students learn and apply new knowledge related to the course. Teaching and learning practices also prepare students to contribute to the surrounding Taung Irrigation Scheme system. Students and lecturers participate in practical sessions that enable the application of knowledge.

The **tools** are the prospectus, curriculum and study materials that assist the subjects (lecturers) to complete the object of the activity and reach the set goals of the activity system. Interactive media, practical and learning sites are tools that aid in the delivery of the object. Water from the Taung Irrigation Scheme can also be seen as a tool as can be the practical experience that students obtain from understanding and using the Irrigation Scheme. The **object** of the activity system is to provide excellent education and training that responds to the development and socio-economic needs of a dynamic agricultural sector (TAC, 2014a, p. 4). The object is also focused on training and learning of competencies valued in the irrigation sector. According to Taung's website, the college object is to provide "excellent education and training respondent to the development and socio economic needs of a dynamic agricultural sector" (TAC, 2017b).

The college also focused on the training and learning of competencies valued in the irrigation sector (TAC, 2014a). During the preliminary consultative workshops, participants in both case studies agreed upon the restructuring of their object towards climate responsiveness and curriculum innovation. The participants jointly decided that the transitioning towards a more climate responsive curriculum was required and that climate responsive approaches such as

Climate-Smart Agriculture needed to be adopted (see Section 4.6.5). The discussion turned to how this newly developed object could be achieved.

Participant 31 *Where do we start? I do not know enough of Climate-Smart Agriculture to teach my students about it or incorporate it into my subject.*

Participant 51 *Climate-Smart Agriculture is an old concept, but now the governmental policies are bringing it into the system and the integration of the Climate-Smart Agriculture principles into the college is challenging.*

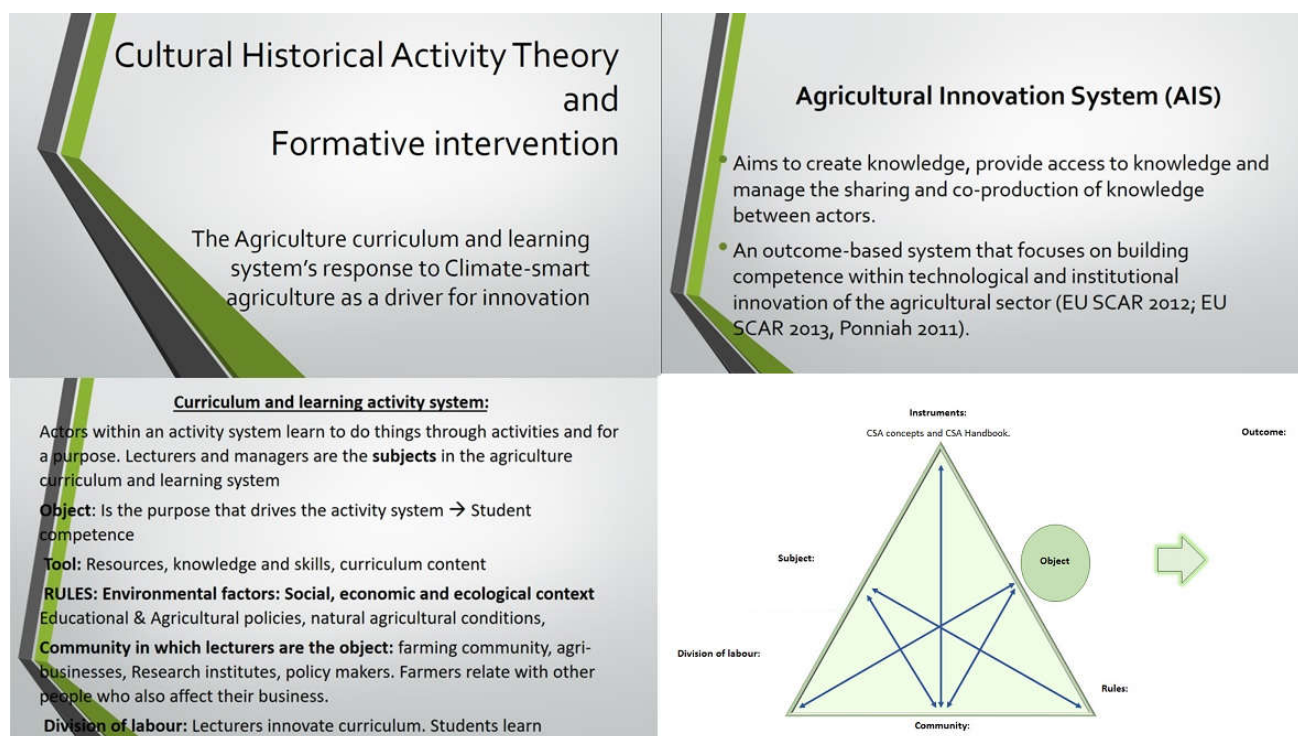


Figure 6.2: Four of the PowerPoint presentation slides used during the first intervention-innovation workshop

6.2.2.2 CLIMATE-SMART RESPONSIVENESS OF CASE STUDY ONE

The next topic on the workshop agenda was the data derived from the indicative score analysis of the Climate-Smart Innovation Tool that the research participants completed during Phase Two. The data derived from the tool allowed the participants to reflect on the Climate-Smart responsiveness of the existing curriculum. The tool analysis is discussed in Chapter Five (Section 5.2 and 5.3) and the tool can be found in Appendix 5.1. The tool findings were presented in summative and graph format on PowerPoint Slides. The figures included in Section 5.2 were shown to the research participants. The tool analysis indicated that Climate-Smart Agriculture topics were not formally included in the National Diploma of Agriculture. The Diploma obtained low scores across all indicator clusters (Section 5.2). However, the

tool was indicative of the Climate-Smart responsiveness of the college and it was intended to stimulate conversation.

The tool score analysis as mirror data suggestions of what, how and when Climate-Smart Agriculture practices and concepts should be included within the curriculum, opened new possibilities for integration. The transitioning to a more climate responsive curriculum was discussed. From this point, the participants could discuss where their activity system came from, where it currently stood and where they would like to take the activity system. During the deliberation the participants agreed that the teaching and learning practices needed to become more Climate-Smart responsive (see Appendix 6). The research participants were engaged in the innovation process and eager to integrate Climate-Smart topics into the curriculum. The next step was what, where and how to integrate the approach. The feedback from the Amanzi For Food workshop brought some light to these challenges.

6.2.2.3 FEEDBACK FROM THE AMANZI FOR FOOD WORKSHOP

The participants gave feedback on the Amanzi For Food workshop. The feedback was significant mirror data as the participants were informed on how other colleges were addressing the same climate responsive and system alignment problems. Feedback also included how other colleges are incorporating climate responsive topics into their curriculum and learning practices (see Section 4.8 and Appendix 6). The Amanzi For Food workshop materials and information on rain water harvesting and conservation methods were distributed amongst the workshop participants. The concept of developing a teaching garden was welcomed among the workshop participants. The discussion circled back to the preliminary consultative workshops and the innovation plan that was structured during that workshop. During the preliminary consultative workshop, the research participants decided that the curriculum and learning practices of the Agricultural Colleges needed to address climate change, food insecurity, subsistence farming, water scarcity and sustainable farming (see also Section 4.7 and Appendix 4). However, the action plan that the participants agreed upon did not eventually materialise and innovation towards Climate-Smart Agriculture integration seemed a more complex and challenging task than expected. The discussion moved to the tensions and challenges that arose during the process of curriculum innovation. This led to the surfacing and deliberation of the contradictions within the system.

6.2.2.4 TENSIONS AND CONTRADICTIONS THAT SURFACED DURING THE WORKSHOP

CLIMATE-SMART AGRICULTURE AS AN ABSTRACT CONCEPT VERSUS CLIMATE-SMART AGRICULTURE AS A CLIMATE RESPONSIVE CURRICULUM PROCESS

As discussed, the Climate-Smart Agriculture concept was intended to articulate across the provincial Agricultural Innovation System and the agricultural curriculum and learning practices in the college. The abstract concept needed to be taken up and translated by the lecturers, students and the management into the system. For many of the workshop participants, Climate-Smart Agriculture responsiveness was simply a stand-alone concept; it was not seen as an articulating concept within the context of the agriculture curriculum and provincial system (see Appendix 6).

The contradiction was rooted in the college staff's understanding of the concept. The contradiction was that Climate-Smart Agriculture concepts were still compartmentalised and not articulated into the system as reflected in these statements.

- Participant 51 *Climate-Smart Agriculture is an old concept, but now the governmental policies are bringing it into the system and the integration of the Climate-Smart Agriculture principles into the college are challenging.*
- Participant 30 *What would be ideal is if one could integrate this whole process around water wise and Climate-Smart using agricultural practices. Integrating sustainable practices in such a way that the student need to learn Climate-Smart Agriculture additionally during the process of all the other stuff that they need to learn. Instead of having these topics isolated. If it is not included into other subject otherwise the students will see it as something that they can ignore. I think for the start-up Climate-Smart Agriculture needs to be incorporated, but as soon as possible it must become an integral part within our text as well, our holistic approach on crop production, preparation and all the things that need to be done which takes this into account, either at small or large scale, a holistic scale that has to be incorporated as soon as possible. That it is part of the flow and the learning process and curriculum.*
- Participant 51 *We should have one module concerning Climate-Smart Agriculture, but towards the end of last year (2015), we had a review of our modules where lecturers were expected after the previous meeting to see how we can bring in the issues regarding Climate-Smart Agriculture in the modules. No one had suggestions that were suitable for implementation.*

It was considered at policy level in the North West Agricultural System. However, the concept was only partially adopted and mostly it was misinterpreted. The workshop participants were only becoming aware of the role of the college plays in preparing South Africa for the affects and challenges of climate change and water scarcity (see Appendix 6). Taung Agricultural College is situated in the Hartswater Irrigation Scheme. Water scarcity has not truly affected

the farmer in this area and therefore adjusting farming practices to include climate responsive practices has not been a priority. The research participants were unsure about what Climate-Smart Agriculture actually comprises, how it could fit into the curriculum and be utilised as a tool towards curriculum innovation.

Participant 41	<i>Climate-Smart Agriculture is not applicable to my field of Agriculture. It is more suited for Plant Production. My Department cannot implement it, but it can be integrated into Plant Production.</i>
Participant 47	<i>Water conservation can be incorporated into our first year and second year. One can then expand more in climate change as a separate short course in third year.</i>
Participant 45	<i>For now, we are trying to fit in the subject. This climatology. After introducing climatology, how can this work by spreading it out across the curriculum?</i>

Climate-Smart Agriculture was still a holistic concept for the workshop participants. How the approach could inform innovations in the existing curriculum and learning activity system was still not clearly mapped out. The possibility of the approach assisting in developing student awareness of climate change issues was also not clear.

6.2.2.5 DEVELOPMENT OF THE CLIMATE-SMART INNOVATION TOOL

The final topic of discussion before the group summarised their findings and developed an innovation plan was the Climate-Smart Innovation Tool. Positive feedback was given for the refinement of the tool (see Appendix 6). The tool was used by the participants during the initial exploratory work as a tool to surface and respond to contradictions within the agriculture curriculum content (see Chapter 4.7). The participants commented that the tool assisted them to find gaps in the curriculum and to visualise possibilities for curriculum innovation. However, the participants discussed that the tool needs to be adjusted to include Climate-Smart Agriculture topics that are relevant to their professional fields. It was also agreed that an additional column be inserted with extra references to where the user of the tool could get additional information on the topic. This would allow the user to not only learn new Climate-Smart Agriculture related topics suited to his/her specific field of expertise, but also provide a link to other websites related to the topic. The suggestion was that the tool be modified so that lecturers could evaluate their own subject content and teaching practices.

6.2.3 INNOVATION PLAN

After the contradiction was structured and the tool development was discussed, an innovation plan including the modelling of solutions was compiled. The workshop participants modelled an innovation plan for the contradiction that surfaced during the workshop. Box 6.1 is a summative report of the detailed innovation plans drawn up for the first contradiction that emerged within the system.

6.2.4 SUMMARY OF WORKSHOP OUTCOMES

During the first intervention-innovation workshop, the mirror data indicated that Climate-Smart Agriculture topics were not adequately integrated into the curriculum and learning practices of Case Study One. The campus and policies could also make adjustments to increase the college's Climate-Smart responsiveness. Not all the research participants saw Climate-Smart Agriculture as a topic that was relevant to their specific professional field's agricultural curriculum and learning practices. The approach was not perceived as a topic that could be integrated and implemented into everyday agricultural practices. The tool was used as a reflexive tool during the surfacing of contradictions. The tool should be refined into sub-tools to adjust to each department and individual's professional field.

Box 6.1: An extract of the Innovation plan that the participants in Case Study Two modelled for the first Intervention-innovation workshop

Contradiction 1: The abstract concept Climate-Smart Agriculture versus translation into curriculum context

Tensions and innovations under this contradiction

- 1) Staff are not up to date with Climate-Smart Agriculture knowledge or practices therefore training for the lecturers and other staff members is necessary.
 - a. **INNOVATION PLAN:** Train staff in Climate-Smart Agriculture
- 2) Climate-Smart Agriculture concepts and practices should be included in as a first-year subject from the 2nd semester. It should also be included in 1st year practical.
 - a. **INNOVATION PLAN:** Include Climate-Smart Agriculture practices such as rain water harvesting and conservation, indigenous irrigation methods and small-holding farming practices in the practical assessment of 1st year students.
- 3) Climate-Smart Agriculture is relevant to each field. Lecturers must bring in these practices into each specific subject
 - a. **INNOVATION PLAN:** After staff training, lecturers can use their new knowledge on Climate-Smart Agriculture to articulate the approach between the subject by integrating relevant topics into their specific subject content, teaching and learning practices.
- 4) **CHALLENGES** to consider when addressing this contradiction:
 - a. A complication is that if one includes too much new content into the existing curriculum, the college will have to reregister the curriculum. Thus, only a specific amount of new relevant content can be included.
 - b. Climate-Smart Agriculture is an old concept, but now the governmental policies are bringing it into the system and the integration of the Climate-Smart principles is challenging.
 - c. The transitioning to becoming a Climate-Smart responsive agriculture curriculum.

6.3 THE SECOND INTERVENTION-INNOVATION WORKSHOP

Eighteen participants, three managers, one farm manager, twelve lecturers and two administration and student affair representatives attended the second intervention workshop. The aim of the workshop was to deliberate further on the contradictions within the system and to discuss the innovation progress of the college towards a Climate-Smart responsive system. The workshop report is in Appendix 6. The workshop participants reported back on their individual and institutional progress and on how they had used the Climate-Smart Innovation Tool as a reflexive tool that mediated innovation. During the intervention-innovation workshop, the research was contextualised according to the study's research questions for objective 3 (see Section 1.4):

- 3.1. How do the Climate-Smart Agriculture elements change through the process of the curriculum innovation formative intervention?

- 3.2. Can significant absences within the National Diploma curricula be identified if viewed from a Climate-Smart Agriculture innovation perspective?
- 3.3. What contradictions are evident and what resolutions of these might inform the National Diploma curricula innovation process?

6.3.1 OBJECT OF THE WORKSHOP

- Feedback on the implementation of the Innovation Plan
- Feedback on the tool-supported innovation and development of the tool
- Surfacing of contradictions within the system
- Adjusting Innovation Plan and modelling alternative solutions

6.3.2 TOPICS OF DISCUSSION

6.3.2.1 FEEDBACK ON INNOVATION PLAN PROGRESS

The workshop indicated long-term innovation plan progress. The tool was refined and the participants were involved in this ongoing process. No official training in Climate-Smart topics has yet taken place. A Climate-Smart awareness campaign has been initiated on campus to make students aware of the impact of climate change and to involve students. Some of the workshop participants managed this campaign. Certain rain water harvesting and conservation methods were implemented in the practical sessions of Soil Sciences. No official integration of Climate-Smart practices, knowledge or competencies into the curriculum, policies or practices has occurred.

6.3.2.2 FEEDBACK ON TOOL DATA AND DEVELOPMENT

The further development and refinement of the innovation tools allowed the college lecturers and management to focus on their own journeys of innovation and Climate-Smart responsiveness. The main problem was that the workshop participants wanted a tool that could not only evaluate the Climate-Smart responsiveness and initiatives of the college, but also provide instant helpful feedback. The participants did not want to wait for the researcher to analyse the tool scores and then send feedback via e-mail. Therefore, the idea to turn the tool into an interactive online tool was developed. The study took these insights into account during the refinement and description of the use of the tool. After the first intervention workshop, the tool was developed from a booklet form to an interactive online review format.

The initial tool was divided into sub-tools to cater better for the specific requirements of the participants and thus it could also be utilised by other Agricultural Training Institutes (see Appendices 5.2 - 5.6).

The booklet was divided into two online tools, one for the managers and non-teaching staff, and one for the teaching staff. The group looked at an example of the Climate-Smart Innovation tool and comment on the structure and content of the tool (see Appendix 6). The online tools were welcomed and it was decided that the tool should be further refined for specific areas including Management, individual lecturers, the Departments of Irrigation, Crop Production and Animal Production. The focus of discussion was the feedback report and what needed to be included. It was decided that the tool should not only be able to provide a report on the questions that the participating reviewer answered, but it should also provide suggested resources to aid the reviewer in the innovation process. The resources should include weblinks and links to documents that could assist the reviewer with topics that were relevant to the curriculum development. During the workshop it was also suggested that the tool be used by staff to complement their yearly self-evaluation.

Participants 52 *We have a self-evaluation performance form that we need to complete. If this tool can help with that, it will be very handy, whereby questions that will be asked in the self-evaluation report, can be then evaluated through this tool. So, if this review tool, could be included in our self-evaluation report. The tool will give us the rare truth, hopefully it is not a horror story.*

6.3.2.3 THE OBJECT OF THE ACTIVITY SYSTEM

The object of the system was also discussed. No adjustments to the object of the integration of a Climate-Smart Agriculture responsive curriculum and learning practices into the system were suggested. However, the workshop participants discussed what Climate-Smart innovation was. Figure 6.3 gives a summative outline of what the researcher and research participants visualised as a Climate-Smart responsive curriculum and learning activity system. The Climate-Smart curriculum and learning activity system is founded on three pillars, namely profit through sustainable agriculture, mitigation of greenhouse gases and sustainably increased productivity and income, strengthening of resilience to climate change and variability and reducing agriculture's contribution to climate change.

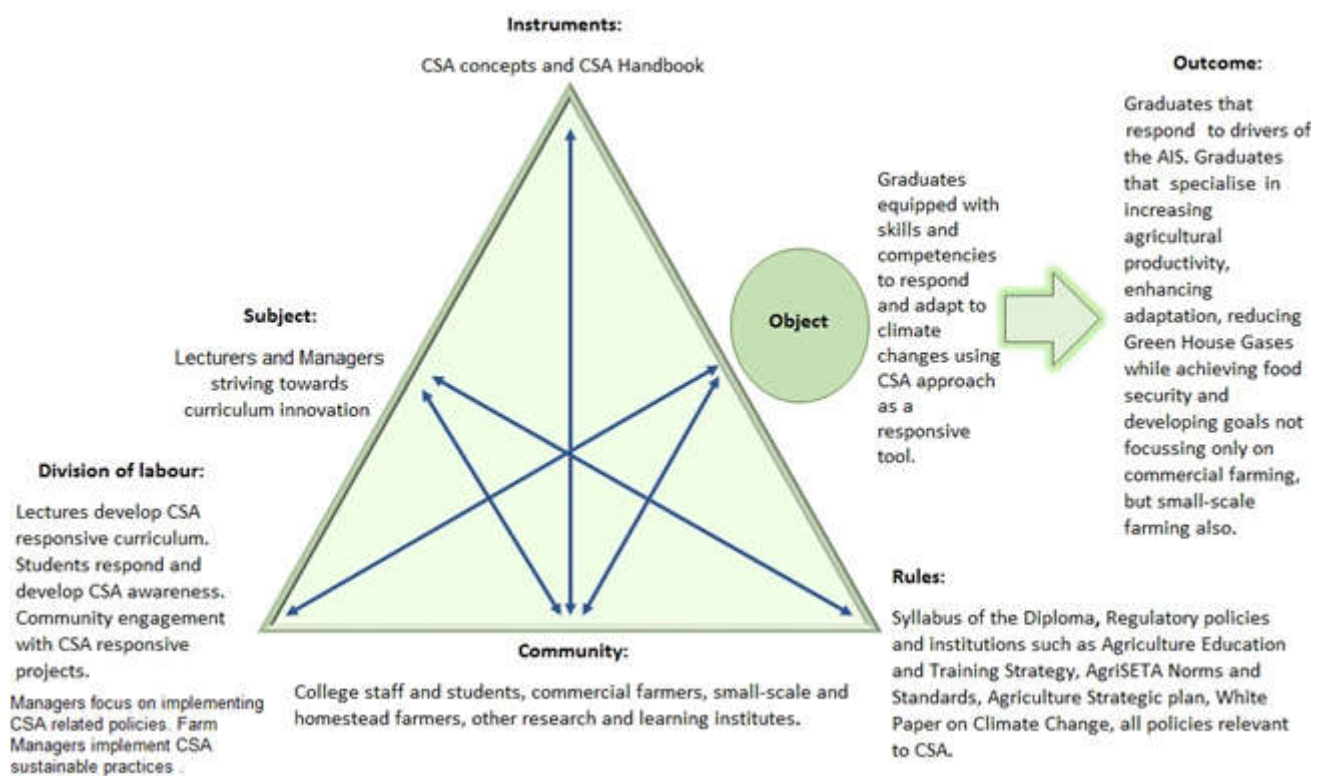


Figure 6.3: Climate-Smart Agriculture (CSA) curriculum and learning activity system

6.3.2.4 TENSIONS AND CONTRADICTIONS THAT SURFACED DURING THE WORKSHOP

Tensions arose during the workshop. In order to establish Climate-Smart awareness on campus, the campus needed to be Climate-Smart responsive. However, there are no sustainable practices implemented on campus. This raised the question of how to get the students to respond if institutional response is lacking. During their attempts to integrate Climate-Smart related agricultural practices into the practical sessions, the lecturers and farm managers had problems with the students. The lecturers commented that the students were not interested in agriculture or in the practical sessions.

From these discussions, two contradictions surfaced.

STUDENT ASPIRATIONS AND THE PURPOSE OF THE PROGRAMME AND THE LECTURERS' DEVELOPMENT OF THE PROGRAMME

Students have changed over the years and their aspirations are not necessarily met by the current programme. The National Diploma, student purpose and career needs were not in alignment. The curriculum was designed to teach knowledge and competencies for

commercial agricultural practices and future career paths specialising in Commercial Farming: Irrigation. The career opportunities for the Diploma graduates included Irrigation Farm Manager, Agricultural Extension Practitioner, Agriculturalist, Research Technician, Irrigation Technician and own business career paths (F. Klink, personal communication, May) 30, 2015). Many of the students enrolled in the National Diploma were not directly interested in agriculture and saw the programme as a stepping stone in their academic path. Students enrolled in the programme without proper career guidance and lectures were not convinced that agriculture was the correct career choice (see Appendix 6).

Participant 51 *Unfortunately, in our country at this stage, there may be one or two agricultural schools still operating, the rest of the students comes to our college due to the fact that the fees are low and that the diploma can help them to get into university to do a degree.*

Even though the cultural background of the student hadn't changed much over the years, more than half of the students were female in 2016 (see Section 4.3.3). The needs of the Agricultural Innovation System altered towards a Climate-Smart Agriculture approach oriented towards food security, homestead-gardening, small-scale farming, entrepreneurship, gender equity and poverty eradication (DAF 2008; READ, 2015b). These are areas where additional job opportunities can arise for the agricultural graduates; however if the college does not take these topics into consideration, students might not be prepared for these situations. Thus, a non-response to the system's needs can lead to graduates not obtaining the necessary competencies to fit the job market and they can then struggle with employment.

The workshop participants were unsure that the graduates were adequately prepared for work within the Agricultural System. They also felt that students did not get enough practical time, but some students did not understand the need for practical learning as the practical was not part of the formal assessments. The practical exams were written theoretically and not assessed in the field. Students needed to know the theory of the work and did not practically apply the work.

Participant 51 *We talked about it last year with our year planning and review. I think we need to look at our assessments, I think we must put more emphasis on assessing our practical side of the curriculum. The students do not want to attend the practicals because the practicals do not get assessed practically, if we don't do this they will not be motivated. I am just thinking that if we bring this in, then we need to look at the assessment criteria. We are not talking about just passing the practical because he was there, we are talking about physical assessment*

saying that a student is competent. Something that we were talking about. Assessment of competency instead of the students writing a theoretical paper on their practical side of the curriculum

It is evident that there was a problem with communication between the students and the lecturers. Some of the students did not want to attend the practical sessions and the lecturers did not know how to respond to the situation.

Participant 43 *We were just trying to put it under the table. The students that we have, especially the senior students, they are not committed to practical agriculture; they only want to do agriculture in class and on the computer, not practically. There is a huge tension between my section and the students, because we want them to go back to practical farming. The seniors have been here for too long, but at least with the first and second years we are pushing them towards that direction.*

Participant 45 *Just yesterday, the learner said 10 minutes into the practical session, "I can't do this", she said. I personally thought if you study to become a farmer you must be able to work the land. I don't get this. Then I asked them if they melt in the sun? I no longer feel the sun, I can work the whole day in the sun and not even get burned. It was about 3 or 4 of students that had the same feeling. Just yesterday.*

There was tension in the communication between the students, farming managers and lecturers.

Participant 51 *Something that I experienced a month ago, whereby there was this conflict situation between the staff and the students. Staff didn't want to give them proper tools; we ended up allocating spades and forks to students. Something that we were not aware of was the conflict between the students and the staff on the farm, but we are working on that.*

The contradiction was between the students' aspiration of the Diploma, the reality of the programme which included practical learning and the relevance of the programme in the job market. Students were not as motivated as they should be. Lecturers found it hard not only to be lecturers, but also to deal with students that did not want to do the work required to complete the programme. The students' aspirations changed. As the practical section of the Diploma was only assessed by a theoretical paper, the students did not feel they needed to do practical sessions. This in turn created tensions between the students, lecturers and farming managers.

THE COLLEGE MANAGEMENT PRACTICES AND THE PRACTICAL APPLICATION OF CLIMATE-SMART INITIATIVES WITHIN THESE PRACTICES

The contradiction was between the College Management practices and policies and the practical application of Climate-Smart initiative on the campus that should have been used as practical examples within the curriculum and learning strategies of the college.

Participant 51 *The integration of Climate-Smart Agriculture needs to be an institutional change and thus the college as a whole need to be an example of Climate-Smart responsive practical implementations. College must set an example for the students and community. It is difficult to change management practices and include the Climate-Smart Agriculture initiative.*

The green campus initiative planned during the preliminary workshop (see Section 4.6) did not materialise as there were many other projects and maintenance that were essential for the functioning of the college that required funding more (Appendix 6). The research participants wanted to incorporate Climate-Smart Agriculture into the learning practices and curriculum content but policies and principles on campus did not reflect these choices. On the researcher's visit in September 2016, the college was irrigating its lawns.

Climate-Smart Agriculture is also still seen as a floating concept in the institutional sense as it is unclear where Climate-Smart Agriculture should be prioritised and how it could fit into the policies and daily practices of the college.

Participant 52 *Sustainable agriculture is integrated in our policies. As our vision statement states: "Pioneers to sustainable agriculture". The challenge is to include Climate-Smart Agriculture at an institutional level, while still meeting all our other goals and responsibilities.*

6.3.3 INNOVATION PLAN

According to the findings of the workshop and discussions, an innovation plan to resolve contradiction two and three that surfaced during the workshop was modelled. The plan is described in Box 6.2.

Box 6.2: A summary of the Innovation plan that the participants in Case Study two modelled for the contradictions that surfaced in second intervention-innovation workshop

Contradiction 2: Student aspirations versus purpose of the programme

- ❖ Students must be able to implement knowledge that they acquired through the Agriculture Diploma outside college within the community.
- ❖ Students need proper career guidance before registering for the Diploma in Agriculture to make sure career choices are correct.
- ❖ Communication and positive attitudes between lecturers, students and farm management staff need to be established.
- **INNOVATION PLAN:**
 - Online assessment can be explored.
 - Have a day orientation where students' interest in Agriculture is explored to make sure that those that register are serious about agriculture.
 - As part of the registration process, students need to write an essay on why they want to complete a Diploma in Agriculture and which specialty they are interested in.
 - Lecturers should be an example to the students and implement Climate-Smart Agriculture policies and principles on campus and in their daily habits.
 - Invite motivational speakers, such as successful young farmers and agricultural entrepreneurs, to come and speak to the students to inspire them.

Contradiction 3: Challenges in introducing Climate-Smart Agriculture management practices into the institutional functioning of the College

- ❖ College must set an example for the students and community
- ❖ College must implement Climate-Smart Agriculture policies and principles on campus.
- **INNOVATION PLAN**
 - Incorporate different irrigation methods with irrigation demonstration sites of the rural delivery system that can assist the community.
 - Develop portions of college land for demonstration irrigation sites
 - Lecturer development such as postgraduate degree funding will be available if the project is aligned with Climate-Smart Agriculture and includes students' practicals on campus.

6.3.4 SUMMARY OF WORKSHOP OUTCOMES

During the workshop, the participants realised that the students' aspirations had changed over the years and that the existing programme might not cater for the needs of the students. The student populations changed from mostly male to more than half females. The inclusion of food security, homestead gardening, small-scale farming, entrepreneurship and other

agricultural branches such as aquaponics and agro-forestry, as listed in the Climate-Smart Innovation Tool, was also considered. Diversification of the programme might lead to a better rate of graduate employment. The necessity to include practical examinations into the curriculum to ensure that students comply with practical sessions was also realised. Tensions due to lack of communication between the lecturers, students and farm managers also surfaced.

6.4 THE THIRD INTERVENTION-INNOVATION WORKSHOP

There were twelve workshop participants, one Head of Department and eleven lecturers, that attended the workshop at Taung. However, six of the workshop participants were new lecturers at the college that had not attended the previous sessions and had worked for less than six months at the college. The new participants were welcomed and updated on the workshop participants' curriculum innovation objectives and the research goals. The third and final workshop that was part of the study helped to develop answers for the following research questions:

- 3.3 What contradictions are evident and what resolutions of these might inform the National Diploma curriculum innovation process?
- 3.4 Can the outcomes of the curriculum innovation process be used as mirror data to reflect on the systemic formative intervention to determine the barriers hampering innovation towards a Climate-Smart Agriculture system.

6.4.1 OBJECT OF THE WORKSHOP

- To evaluate the innovative progress towards Climate-Smart responsive system.
- To establish the barriers to change through the surfacing of contradictions.
- To understand the complexities hampering the process of innovation towards Climate-Smart responsive system.
- To establish the role and functionality of the Climate-Smart Innovation Tool during the iterative innovation process.

6.4.2 TOPIC OF DISCUSSION

Below is a summary of the discussions during the third intervention-innovation workshop. The workshop report (Appendix 6) provides further detail and evidence.

6.4.2.1 FEEDBACK ON MEDIATED INNOVATION PLAN

Participant 51 used the online tool for Management. Two lecturers used the Climate-Smart Innovation Tool – Irrigation, sub-tool; two lecturers used the Climate-Smart Innovation Tool – lecturers; three lecturers completed the Plant/crop Production sub-tool and two lecturers, the Animal Production online tool. Feedback was positive (see Appendix 6). Figure 6.4 shows the data from Participant's 51 online tool. No training in Climate-Smart Agriculture topics was scheduled. There was not enough time and many personnel changes occurred between intervention-innovation workshops Two and Three (note Section 6.4). The practical component of the Diploma was not included in the formally assessed programme. It was said to be difficult to prioritise the matter due to time constraints and lecturers' responsibilities. The farm managers assisted students with practical sessions. The lecturers were not always involved and some newly appointed lecturers did not have the necessary practical agricultural expertise or experience to be of assistance (see Section 6.4.3.3).

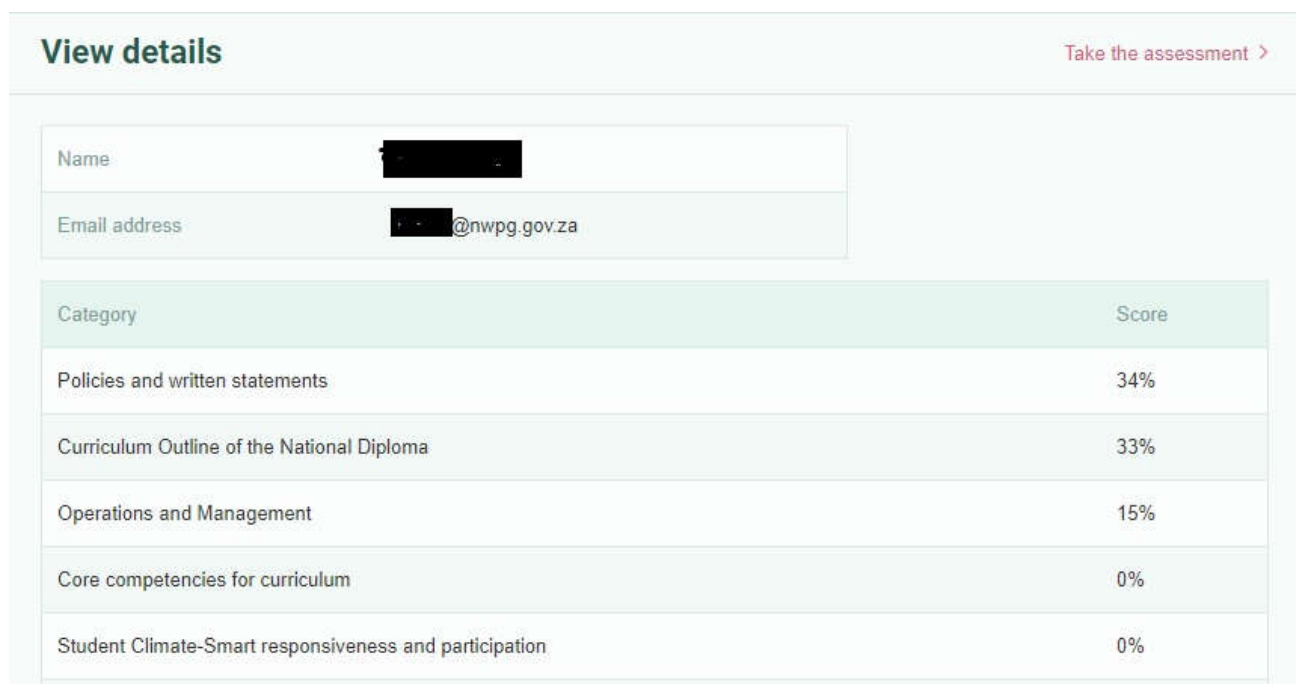


Figure 6.4: An example of the Online summative session statistics for Climate-Smart Innovation Tool – Lecturer

6.4.2.2 FEEDBACK ON THE CLIMATE-SMART INNOVATION ONLINE TOOLS

Some of the participants used their smartphones to complete the online tool and for some questions, the reviewer had to scroll down on the phone screen to choose an option. This made it inconvenient for the reviewer and sometimes the reviewer was unaware of an option

below the screen view. The necessary layout and format for tool changes were noted so that the tool could also be smartphone user-friendly. Suggestions to open the tool for other Agricultural Training Institutes to use were also discussed. The workshop participants were satisfied with the feedback reports and commented that the links and attached documents did help them to establish a bridge to the Climate-Smart knowledge they still required. Examples of these online reports are available after each example of the online Innovation Tools in Appendix 5.2 to 5.6.

6.4.2.3 TENSIONS AND CONTRADICTIONS THAT SURFACED DURING THE WORKSHOP

Questions that were discussed during the workshop regarding formalising an approach to respond to the tensions and contradictions within the Agricultural Curriculum System are listed in Box 6.3. Through the answering of these questions, the research participants reflected upon the existing tensions and contradictions within the surface and developed insights into other contradictions relating to the practical component of the programme and the perpetual changing system that were not previously discussed in detail.

Box 6.3: The questions that were discussed as part of the approach to surface the continued tensions and contradictions within the system

- 1) What are the policies that govern Climate-Smart Agriculture innovation and curriculum change within the North West Province?
- 2) How does the change in policies affect the Agriculture curriculum development?
- 3) How does the College position itself amidst the time of institutional flux and change while dealing with the floating concept of Climate-Smart Agriculture within the context of the curriculum?
- 4) How do we change what we are doing for better alignment between the agricultural college curriculum and Climate-Smart Agriculture and Agricultural Education Training policies?
- 5) What are the implications of Climate-Smart Agriculture for the Management Practices of the college?
- 6) How do teaching practices cover better alignment with changing seasonal cycles?
- 7) How are the students being taught about adapting to the changing dynamics of seasonal cycles in the surrounding biotope?
- 8) Do the colleges see themselves as Centres of Excellence (Agricultural Training Institutes in Higher Education) in practical application of modern commercial agricultural theory that is transitioning to Climate-Smart Agriculture?
- 9) How is Climate-Smart Agriculture included in the disciplines within the centre of excellence?
- 10) What is the relationship between the curriculum and students' purpose and needs?

Is Climate-Smart innovation possible within the system that is in flux?

CONTRADICTION BETWEEN THE DEMANDS OF THE ACADEMIC PROGRAMME VERSUS THE INCLUSION OF RELEVANT PRACTICAL COMPONENTS

Lecturers stated that students needed more practical time (50:50 ratio to theory and practical) to be prepared for the outside world. At the workshop a timetable was considered with 60% theory and 40% practical. However, even with this schedule, the practical component was difficult to uphold.

Participant 45

The practical component of the programme needs to become more necessary and the focus must shift to the competencies in practical components.

The practical component of the Diploma is of utmost importance, but the practical aspects of the Diploma were assessed theoretically through a written examination with no practical component as mentioned earlier. The students do not practically have to show that they have

attained the acquired knowledge and developed the necessary competencies, they just needed to be able to explain the practical process during a written exam. The lack of practical assessment within the Diploma also leads to students lacking the motivation to attend or participate during practical sessions, as mentioned. Lecturers were not only teaching, but also preparing practical sessions. The preparation of practical sessions was time consuming (see Appendix 6). This developed into stressful situations as the lecturers' struggled to complete the practical component of the curriculum, whilst also having to struggle with lack of participation of the students.

Participant 47 *We are trying to encourage the younger students to do practicals. But, on the other hand our curriculum on theory in class, is very huge. They will have to do overview on some work and not in depth, so there is enough time to do practical component.*

Participant 53 *We have basically registered the programme, 60% theory, 40% practical. But at this stage, I don't think we are getting to that point. I think this is something that we will have to correct. I think we spend too much time on theory in class and not enough on practicals. I think the majority of staff was also not so fortunate to have that practical farming experience.*

Within this contradiction, the transformation of Agricultural Colleges to Agricultural Training Institutes is also a tension. The college is a centre of excellence (Agricultural Training Institute in Higher Education) in practical application of modern commercial agricultural theory specialising in Irrigation. The college is shifting to higher education; once that happens the college will no longer report to DAFF and will instead be accredited by the Department of Higher Education (DHE). The college staff also expressed their concerns that the shift can lead to less focus on the practical component of the Diploma and more theoretical components.

CONTRADICTION BETWEEN THE CURRENT STATE OF FLUX: INSTITUTIONAL DEVELOPMENT VERSUS INNOVATION

It was noted that the college activity system is undergoing structural (the expected change from Agricultural College to Agricultural Training Institute) and rule changes (policy shift to include Climate-Smart Agriculture as a climate response) that affected the character and relevance of the object of the system. The system needs required the curriculum and learning practices to support adaptive change to the Climate-Smart responsive approach with a solid relevant object and outcomes. Once Climate-Smart Agriculture was identified as a provincial response to climate change, the college realised that they also needed to integrate these policies and approaches as reported in Section 2.3.5. The proposed object of innovation

stood in contrast with the existing ways of developing curriculum in an institutional context that was in continuous flux. The activity system in Case Study One had undergone various changes in the last five years as reported in Section 4.3.5 and Figure 4.4. The whole National Diploma programme changed in 2014. The North West Agricultural Strategic Plan has also included new strategies and policies that need implementation and adaptation within all the sub-systems within the provincial Agricultural System. The head of campus has changed three times since 2013 (TAC, 2014a) and the Principal of the colleges in the North West resigned in 2016 and was replaced in 2017. Many staff changes occurred (six new lecturers joined the team, see Section 6.4) during the study and most of the new lecturers do not have the practical agricultural experience to maintain this component of courses.

Participant 51 *The problem is that many of the lecturers themselves do not have any practical farming experience and come from universities of other institutions with no farming background.*

The immanent transformation of the Agricultural Colleges to Agricultural Training Institutes (ATI), had an influence on the curriculum and curriculum innovation during the study. Along with the associated institutional restructuring (see Section 4.3.5 and Figure 4.4). The Agriculture Training Institutes (ATI) are the country's unique key to integrate the agricultural practical and theoretical sides. The Institutes focus on developing scarce practically oriented knowledge and competencies (DAF, 2008). There are direct objectives for the college to follow to develop into an Agricultural Training Institute. These include:

- *Within its earmarked field of specialisation each ATI should be developed and capacitated to become a Centre of Excellence. This implies that it will develop a pool of staff with specific expertise in the functional field;*
- *it will establish and develop its infrastructure, facilities and equipment to world class standards within the functional field;*
- *it will offer a range of programmes that caters in the needs of all farming sectors in the field (from short courses aimed at emerging farmers to highly specialised courses for the commercial sector);*
- *it will undertake applied research in the functional field; its programmes will also consider upstream and downstream (agribusiness) opportunities in the field, it could render a farmer consultancy service within the field, etc.* (DAF, 2008, p.196)

The continuous changes within the components of the system including policy changes, curriculum content changes, staff changes, system driver changes, leadership changes and

student aspiration changes lead to the fragmentation of the system and the object of the system became fluid and unclear (see Appendix 6). Within this state of flux, the lecturers' role was also changing and more responsibilities outside the perimeter of education and training were expected from the lecturers. The college is assisting with other departmental projects (see Appendix 6).

Participant 37 *I think the contradiction that we are dealing with here is exciting and worrying at the same time, we used to be the teacher in the college, but now we are also project manager in an institute. So, the question is how does the college get the balance between practical teaching college and a development agency, to research and supporting developmental projects, including students.*

Participant 51 *Instead of having four different departments, one needs to say let's have a Head of Department for academics. Clearly indicate that you have your Head of Department in academics, and then you have a Head of Department or manager for these other projects. We were not really involved in the project, but now we are and the project is running. And I mean, you get calls 24/7 from the Chief Director.*

Time also became an issue, as there is not enough time to complete all the tasks and fulfil all the roles expected of the subjects.

Participant 45 *There is not enough time to do practical sessions.*

Participant 51 *We are currently overloaded and overworked. Now they are pushing us all the way, because they want this thing done.*

The contradiction is embedded in the system towards innovation versus system in flux. An innovation plan for contradiction five was difficult to compile for the workshop participants as how do you model a plan to innovate a system if the system is in flux? From these contradictions, the main question that developed was:

- What curriculum and institutional innovations towards climate-smart responsiveness are necessary and possible within Case Study One's activity system within a state of flux?
- From this point, the participants compiled an innovation plan that could guide them towards Climate-Smart responsive curriculum and teaching practices. Box 6.4 is the innovation plan that the Case study participants formalised for the college staff, practical components of the curriculum and the students.

6.4.3 INNOVATION PLAN

An innovation plan for contradiction four was modelled (Box 6.4), but workshop participants were unsure how to devise a plan to deal with the realities of institutional flux they were experiencing. For that reason, an innovation plan for Contradiction 5 was not developed

during the third workshop and instead a general “the way forward” Innovation Plan was structured that outlined the object for the staff, the practical components of the curriculum and the students (Table 6.1).

Box 6.4: The Innovation Plan structured for contradiction four during the third intervention-innovation workshop

<u>Contradiction 4:</u> Contradiction between the demands of the academic programme and the inclusion of relevant practical components	
❖	Presently the time table is 60:40, but that practical component is even difficult now to uphold. More practical is required in the program (50:50 ratios to theory and practical).
❖	Practical component of the program needs to become more necessary and focus must shift to competencies on practical components.
❖	<u>INNOVATION PLAN:</u> ➤ Practical components of the Diploma need to be practically assessed. ➤ 3rd year students can be first year tutors at the practical components. Gives students a sense of achievement and contribution. Introduce a system of mentoring the first years.

Table 6.1 The Innovation Plan modelled during the third Intervention-innovation workshop of Case Study One

Staff	Train staff in Climate-Smart Agriculture. Lecturers should articulate Climate-Smart Agriculture between the subjects by integrating relevant topics into their specific subject content, teaching and learning practices. Lecturers must be the example to the students and implement Climate-Smart Agriculture policies and principles on campus. Provide postgraduate degree funding for projects aligned with Climate-Smart Agriculture.
Practical components of the curriculum	Include Climate-Smart Agriculture practices in the practical assessment of 1st year students. Incorporate different irrigation methods with irrigation demonstration sites with the rural delivery system that can assist the community. Practical components of the Diploma need to be practically assessed.

Student aspirations and alignment with curriculum	Career counselling Have a day orientation to make sure that the students that register are serious about agriculture. As part of the registration process, students need to write an essay on why they want to complete a Diploma in Agriculture and which specialty are they interested in. Invite motivational speakers, such as successful young farmers and agricultural entrepreneurs, to come and speak to the students to inspire the students. 3rd year students can be first year tutors at the practical components.

6.4.4 SUMMARY OF WORKSHOP OUTCOMES

As the “the way forward” Innovation Plan was discussed, the conversation turned to the fact that little Climate-Smart curriculum innovation had occurred within the system in the past two years. The workshop participants who had been participating since the preliminary consultative workshop felt that during each workshop, solid innovation plans are developed, but never initiated or applied. However, there were specific changes that had occurred during the two years, namely:

- Participant 47 included rain water harvesting and conservation into the practical component of his subject.
- Many of the workshop participants are involved in the *Food in Developmental State* project of DAFF.
- Participant 51 is establishing learning networks between the college lecturers, farmers, community media, extension officers and students to support students in developing sustainable agricultural practice.
- The Climate-Smart awareness programme was established again as part of the learning network development.
- The Irrigation Department included Climate-Smart Irrigation methods into the practical component of their courses.
- Use of the Climate-Smart Tool gave the workshop participants a better grasp of climate concerns and the agricultural practices associated with this approach in an Agricultural Innovation System.

- Communication between the Colleges and other agricultural organisations was established through the Amanzi For Food workshop.
- Most of the participants attended the Intervention-innovation workshops and remained engaged in the curriculum innovation process despite setbacks and challenges.
- Online Climate-Smart Innovation Tools were developed to assist the lecturers to review individual lecturers, management and Departments' Climate-Smart responsiveness and the tool was utilised as a reflexive tool that provides additional opportunities of self-development of knowledge and competencies.

These findings indicated that even though institutional change was difficult, many workshop participants initiated or were involved in some sort of innovation during the expansive learning cycle over the three intervention workshop sessions. The tool was also a functional mediated tool that assisted the workshop participants during the expansive learning process and individual Climate-Smart innovations.

6.5 REVIEW OF THE ITERATIVE PROCESS OF INNOVATION SUPPORT AND TRACKING THROUGH EXPANSIVE LEARNING CYCLES IN CASE STUDY ONE

The review and tracking of the supported innovation process enabled the researcher to build a picture of the complexities of systems innovation and the challenges of a transitioning process to a Climate-Smart system of innovation. Here follows an overview of this process.

6.5.1 IDENTIFYING THE SHARED OBJECT

The participants aimed to adapt to the new policies and objectives of the provincial Agricultural Innovation System and understood the importance of climate change awareness. Thus, the object was identified as the development of a Climate-Smart responsive curriculum and learning system. This object was also shared with Case Study Two as the colleges were combine during Phase Two (see Section 4.6.2).

6.5.2 ANALYSIS OF CONTRADICTIONS

The outcomes of the use of the initial Climate-Smart Innovation Tool and profile research were used as mirror data to surface contradictions during intervention-innovation workshops. The tensions and obstacles within the activity system surfaced and were then deliberated.

Possible solutions to these problems and tensions were discussed. The main tensions circled around how to develop Climate-Smart Agriculture approach as a tool to stimulate the practical and learning activities of the system towards climate responsiveness. Sub-tensions surrounding this contradiction included the lack of knowledge on the topic, how to get the students involved and the implementation of a climate smart systems approach on an institutional policy level.

6.5.3 MODELLING OF SOLUTIONS

After the contradictions were structured and discussed, an action plan and modelling of solutions were developed during each expansive learning cycle that followed.

6.5.4 SOLUTIONS AND INNOVATION PROCESS

During the third intervention-innovation workshop, a review of the activity system revealed that little institutional innovation has occurred. The innovation plans structured in Phase Three of the research had not been effectively implemented. The main reason was that many of the participants that were crucial to the implementation of these plans were not working at the college anymore or were engaged in other projects. Seven new members of staff attended the final workshop. A new DAFF project had also taken up a lot of the staff's time (see Section 6.4.3.3). At an institution level, the activity system was in flux and innovation towards Climate-Smart responsiveness had not been progressing as expected. Participants were somewhat demotivated when they looked at the innovations achieved since the start of the programme in July 2015 until 2017. However, some kind of innovation within individual subject, teaching practices and practical applications of Climate-Smart within subjects did occur (Section 5.4.5). The participants also discussed the role of the Climate-Smart Innovation Tool. The tool helped the participants to review their own Climate-Smart responsiveness and they then had the opportunity to learn more about Climate-Smart Agriculture topics that were related and implementable within their speciality. One participant mentioned that after completing the survey on his report page he chose a link to Amanzi For Food website where water conservation methods such as tillage was illustrated. A participant implemented some of the rain water harvesting and conservation (RWH&C) methods into his teaching practical. It was also indicated that management is trying to focus on saving water even though water is available freely. Thus, the innovation that occurred was not the institutional innovation expected, but more on an individual level working towards the shared object during a time of flux.

6.5.5 THE EXPANSIVE CYCLES OF INNOVATION

The iterative process of expansive learning cycles of Case Study One is outlined via the phases of the study in Chapter Three. Figure 6.5 is a summative diagram of the research process seen as an expansive learning cycle. During each Intervention-innovation workshop, the expansive process continued until Learning Action 4; however, during the second and third workshop, it was clear that there was little progress between examining the new model and implementing the new model. The participants fell back to Learning Action 2 where contradictions were outlined again and new more realistic solutions were debated. During the expansive learning cycles, the Climate-Smart Innovation Tool was developed not only as a mediating tool, but as a tool that could support and track innovation within the system.

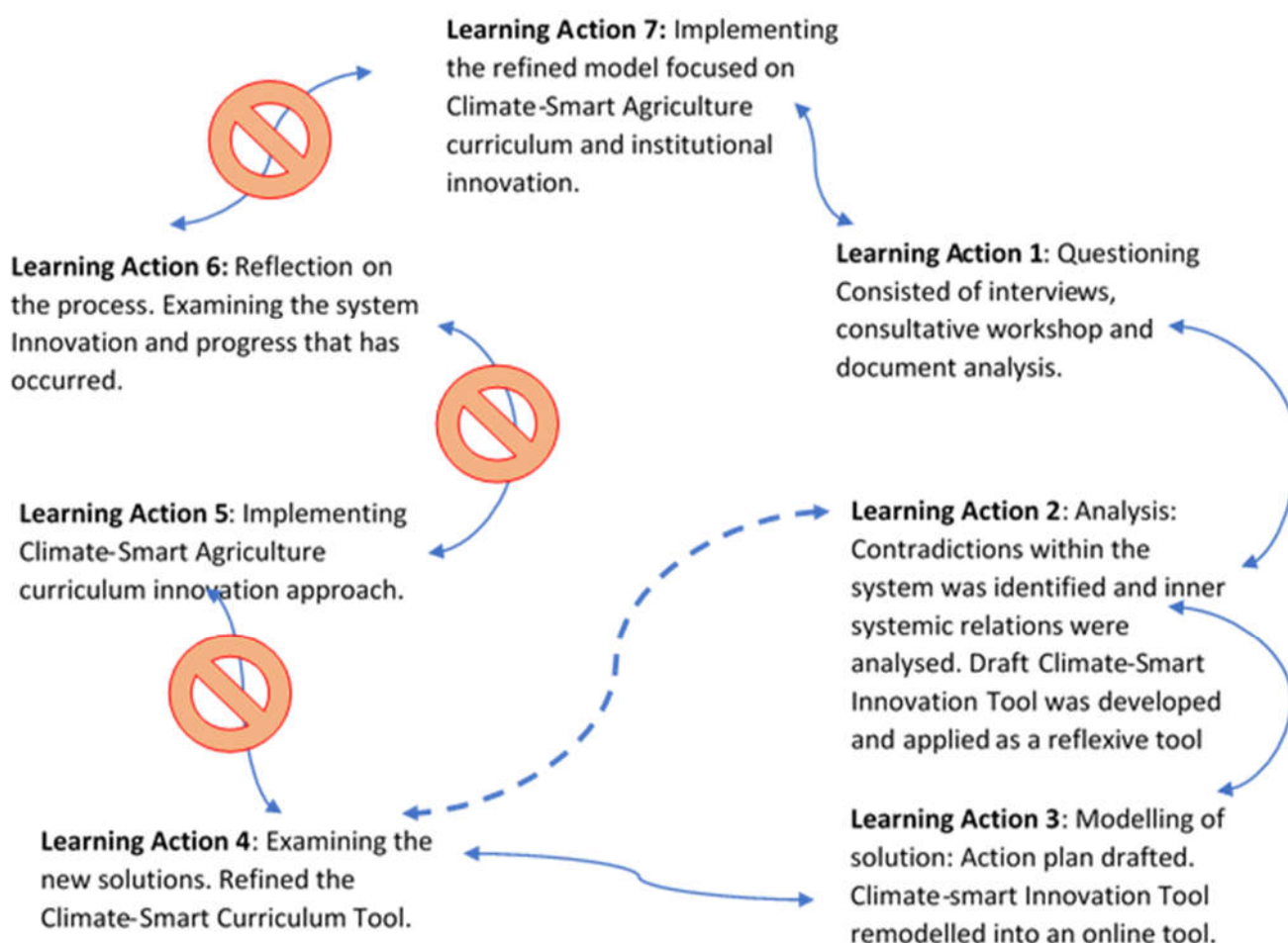


Figure 6.5: The steps completed during the expansive learning process in Case Study One

The main accomplishments during the expansive learning process was the identification of the contradictions within the system and the tensions these contradictions formed. Participants could discuss these matters and realised that many of the frustrations and

obstacles they were experiencing were also being experienced by other participants. The development of the Climate-Smart Innovation Tool acted as a double stimulus tool and later as a tool for self-reflection by individual participants reviewing their specific curriculum and learning practices. Many obstacles were encountered that hindered the process of innovation towards a more Climate-Smart responsive curriculum. Institutional change such as staff changes and the role changes of the participants were also challenges that the expansive learning process tried to overcome. Even though the expansive learning process has not undergone the full cycle through evaluation, reflection and adjustments, the innovation process is still moving forward as the researcher and research participants plan to continue the process further during 2018.

6.6 CONCLUSION

Chapter Six has comprised a narrative of the review and tracking of the supported innovation process that enabled the researcher to build a picture of the complexities of systems innovation and the challenges of a transitioning process to a Climate-Smart system of innovation. Five specific contradictions surfaced during the expansive learning process.

Contradiction One consisted of Climate-Smart Agriculture as an abstract concept versus Climate-Smart Agriculture as a climate responsive tool utilised within the curriculum. The contradiction is a primary contradiction as it is between the exchange value and use value of Climate-Smart Agriculture. Contradiction Two is founded in the student aspirations and the purpose of the programme and the lecturers' development of the programme. It is a secondary contradiction between the object and tools or the subject and object. Contradiction Three is between the College Management practices and the practical application of Climate-Smart initiatives within these practices. This is a secondary contradiction as it is between the rules of the activity system and the division of labour. Contradiction Four is the demand of the academic programme versus the inclusion of relevant practical components. It is a secondary contradiction between the tool (or goal) and the division of labour. Contradiction Five emerged due to the current state of flux within the system and exists between Institutional development and Institutional Innovation. It is a primary contradiction as it is between the goals of the activity system or quaternary contradiction as it only develops after the other contradictions were developed and it occurs due to the neighbouring activity systems and Agricultural Innovation System response to climate change. During the

expansive learning cycles, the Climate-Smart Innovation Tool was developed into online sub-tools which either departments or individual lecturers could review and track their own Climate-Smart responsiveness (Appendix 5). The further development of the tool and the review of the accumulated innovation experience allowed the researcher and participants to get a better grasp of some of the current barriers to Climate-Smart Innovation. Chapter Seven continues with the iterative innovation process of support and tracking within Case Study Two. The barriers to change and complexities hampering the processes of transitioning to Climate-Smart responsive system are discussed in Chapter Eight.

CHAPTER 7

THE ITERATIVE PROCESS OF INNOVATION SUPPORT AND TRACKING IN CASE STUDY TWO

7.1 INTRODUCTION

Chapter Six discussed the innovation-intervention workshops and expansive learning that occurred in Case Study One. As both case studies are situated within the same Agricultural System, both experienced similar contradictions with slightly different views of the contradictions and outcomes of the expansive learning process. Chapter Seven continues to mirror the insights derived from the tool-based data generated in Phase Two in the subsequent innovation-intervention workshops held as part of Case Study Two.

Appendix 3 list the details of the participants that participated during this study. Potchefstroom and Taung were combined for the first two contact sessions. However, the third contact session was held separately. Attendees consisted of eight lecturers and three managing staff that also lectured at the college. The following workshop was attended by six participants and four participants attended the third intervention-innovation workshop. A total of two attended all the workshops. The third intervention-workshop was intended to be an intervention workshop discussing feedback, however only two of the original participants were able to attend the workshop and the other attendees had other engagements at short notice. After the contact session, an online mirror data workshop was developed for the participants that would like to give feedback on the innovation process.

7.2 THE FIRST INTERVENTION-INNOVATION WORKSHOP

The first workshop facilitated the verification of research data obtained during Phase One and Two that answers two research questions of the study namely as listed in Section 1.4 and 6.2. The Climate-Smart Innovation Tool score analysis (Sections 5.2 & 5.3) and the feedback from the Amanzi For Food workshop (see Section 4.7 and Appendix 6) were used as mirror data during the expansive learning cycle. Eleven lecturers and two Heads of Department attended the workshop for Case Study One. Intervention-innovation workshop One was a college initiated process of expansive learning focused on the integration of the Climate-Smart Agriculture approach into the curriculum and learning practices of Case Study Two.

Mirror data in the form of the Climate-Smart Innovation Tool analysis (see Section 5.3) and feedback from the Amanzi For Food Workshop (see also Section 4.7 and Lotz-Sisitka et al., 2016) were reflected upon during the intervention-innovation workshop. Eight lecturers and three Heads of Department attended the workshop at Potchefstroom College of Agriculture (see Appendix 3).

7.2.1 OBJECT OF THE FIRST INTERVENTION– INNOVATION WORKSHOP

- Establish the Climate-Smart responsiveness of the curriculum through data obtained from the Climate-Smart Innovation Tool.
- Discuss the tensions and challenges that the workshop participants experienced in integrating Climate-Smart Agriculture into the system since the first contact session (see Section 4.6).
- Review the Climate-Smart Innovation Tool's functionality and discuss the Amanzi For Food workshop (see Section 4.7 and 4.8).

7.2.2 TOPICS FOR DISCUSSION

7.2.2.1 CASE STUDY TWO AS AN AGRICULTURAL CURRICULUM AND LEARNING ACTIVITY SYSTEM

The workshop opened with a discussion on the structure and functionality of the college as a curriculum and learning activity system. The same four PowerPoint presentation slides presented to participants in Case Study One were shown to the workshop participants to stimulate conversation (Figure 6.2). A system analysis on how the college has changed indicated that the curriculum structure and object has stayed the same for three decades. The most important change was the transferral in object from commercial farming to the inclusion of small-scale farming, sustainable agriculture and Climate-Smart Agriculture concepts and practices. This was seen as a positive realisation as the staff were experts in their field speciality focused on mixed agriculture in the Highveld Region (see Section 4.5.4). Figure 7.1 shows the activity system outlined as developed with the help of the research participants. The object of the existing activity system was to provide academic and practical training to meet the needs of prospective commercial mixed farmers in the Highveld region and the agricultural sector. The newly developed object was a shared object with Case Study One as both were interacting systems within the Provincial Agricultural Innovation System supporting Climate-Smart integration through systems innovation.

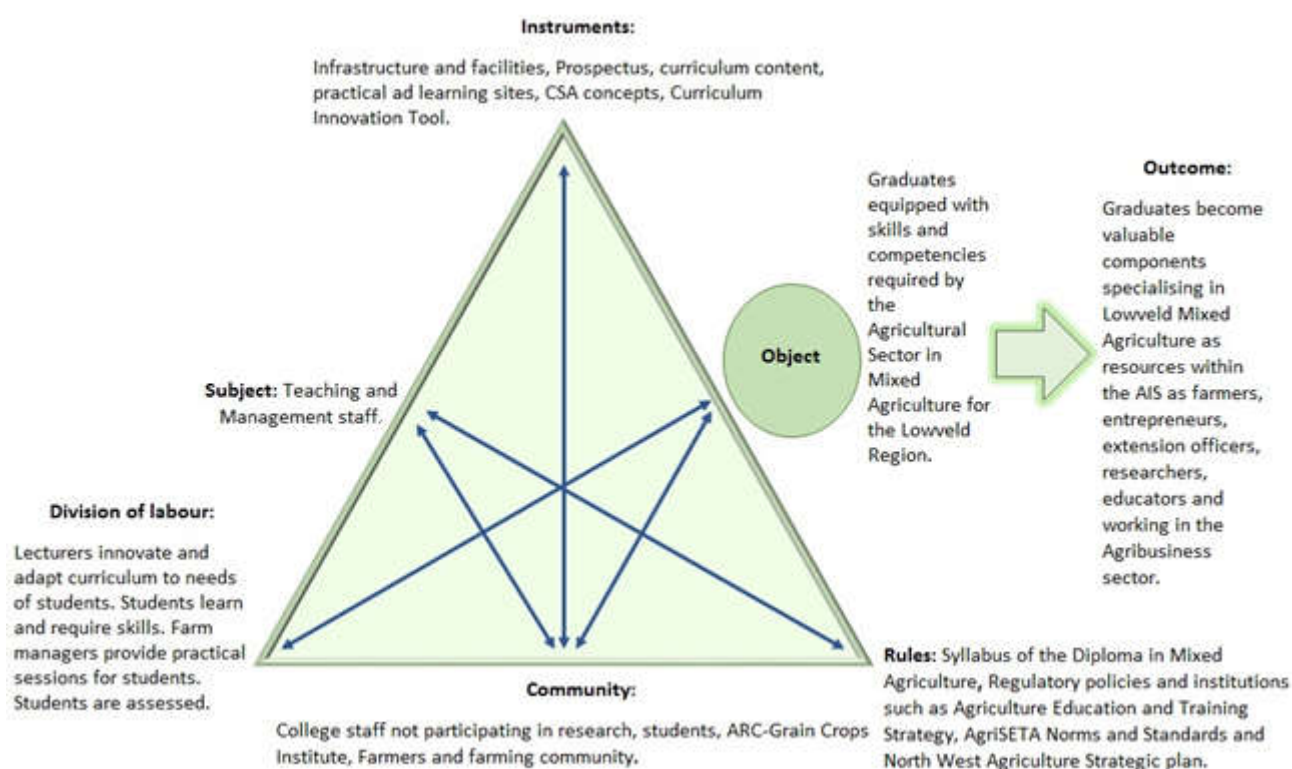


Figure 7.1: Potchefstroom College of Agriculture’s curriculum and learning activity system within the North West Agricultural Innovation System depicted in Figure 1.1

7.2.2.2 MIRROR DATA

The next topic on the agenda was the Climate-Smart responsiveness of Case Study Two. The Climate-Smart Innovation Tool was used to generate mirror data that allowed the participants to reflect on their Climate-Smart responsiveness. The tool findings were presented summatively and in graph format on PowerPoint Slides. A comprehensive scope of the case study’s Climate-Smart responsiveness is discussed in Chapter Five, Section 5.3.

The participant that attended the Amanzi For Food Workshop explained to the other workshop participants what the workshop was about and how what he had obtained could be implemented at the college (see Appendix 6). This discussion lead to tensions within the college.

7.2.2.3 TENSIONS AND CONTRADICTIONS

CLIMATE-SMART AGRICULTURE AS AN ABSTRACT CONCEPT VERSUS TRANSLATION INTO THE AGRICULTURAL COLLEGE CURRICULUM CONTEXT

During 2015 and 2016 the North West experienced drought. Unlike Taung, Potchefstroom does not rely heavily on irrigation and the drought affected the agricultural system dramatically. This also made the college aware of its responsibility to teach the students to cope under such drastic and difficult conditions as farmers.

Participant 2 *Due to the changes in the environment and climate change we need to teach our students how to survive a drought and use other methods of irrigation that save water.*

As the Climate-Smart approach was taken up at policy level within the province, the college also decided to look into this approach as a climate responsive curriculum process that can initiate innovation.

Report for July 2015's workshop states (Appendix 3):

The balance of the day consisted of interactive small group discussions which *discussed* the major gaps within the agricultural college's curriculum in relation to Climate-Smart Agriculture. A curriculum transitioning approach towards Climate-Smart Agriculture was also discussed. Participants prioritised the integration of Climate-Smart Agriculture therefore curriculum revision is required. Colleges felt that they need assistance to develop a Climate-Smart Agriculture curriculum. Lectures emphasised the need for training of trainers to carry this knowledge over to the students and community.

However, the decision to support curriculum innovation through the Climate-Smart approach and the actual process of innovation were more challenging than expected. The contradiction was between Climate-Smart Agriculture as a floating concept that the college adopted to integrate into the system and the Climate-Smart approach as a responsive tool that lecturers need to visualise and become familiar with.

Participant 17 *We understand the concept, but we do not have any idea about climate change and how to implement the topic. The student also does not have any idea about climate change. There should be a continuous awareness campaign to make the lecturers and students aware of Climate-Smart Agriculture. Through awareness, the college can become open for change to include these topics. We, as lecturers need training to understand the importance of the topic.*

Lecturers emphasised the need for training of lecturers to be able to translate the knowledge to the students.

7.2.2.4 DEVELOPMENT OF THE CLIMATE-SMART INNOVATION TOOL

The final topic of discussion before the group summarised their findings and developed an appropriated innovation plan was the Climate-Smart Innovation Tool. The refinement of the tool was discussed. Some of the research participants were still unsure how Climate-Smart Agriculture knowledge and practices were relevant to their own professional fields. It was agreed that refining the tool to include specific content relating to specific agricultural fields could assist the participants to frame their professional fields within Climate-Smart Agriculture (see Appendix 6).

7.2.3 INNOVATION PLAN FOR INTERVENTION-INNOVATION WORKSHOP ONE

Through the emergence of the contradictions and understanding of the existing system's functionality and shortcomings, an innovation plan was developed. The participants developed a five-step plan that was structured to achieve their goal of curriculum innovation towards a Climate-Smart System. Figure 6.2 is visual representation of that plan according to the components within the curriculum and learning activity system (see Appendix 6).

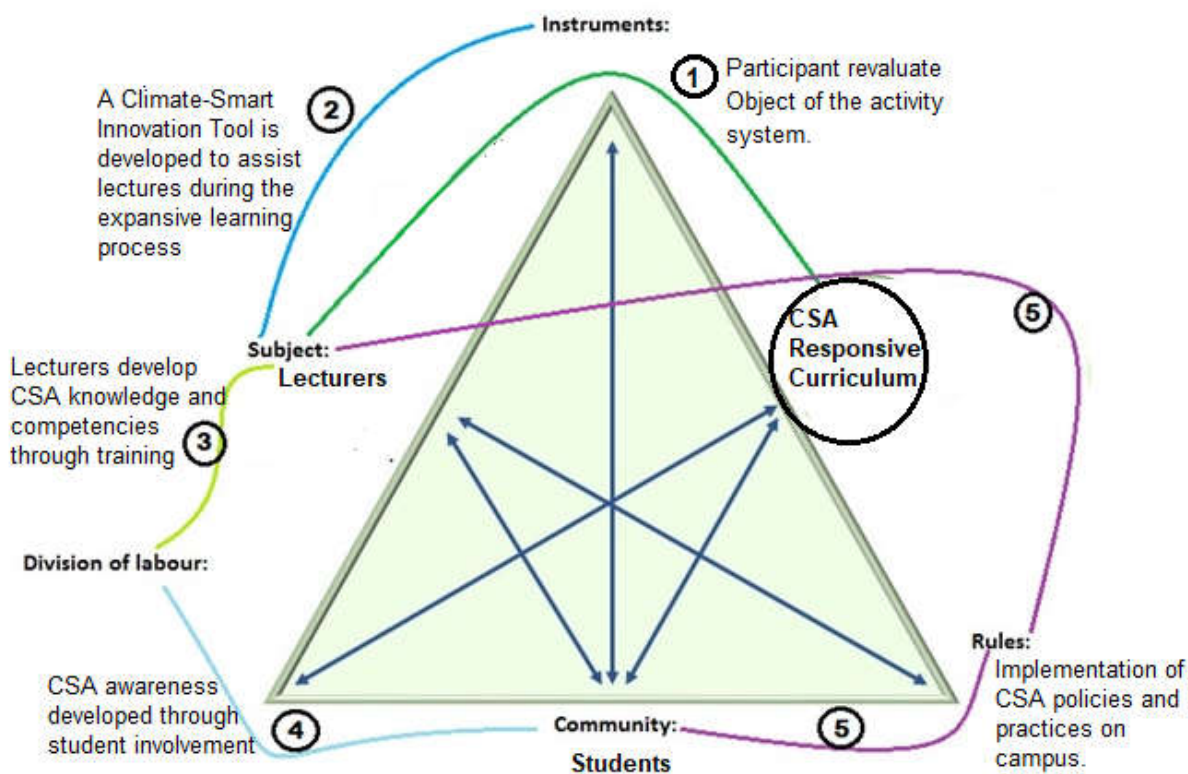


Figure 7.2: The mediated innovation plan of Case Study Two

7.2.4 SUMMARY OF WORKSHOP OUTCOMES

A five-step innovation plan was developed during the first workshop. The plan included revaluations of the system, development of reflexive tools, training, creating awareness amongst students and implement policies and practices. The tool analysis showed that Climate-Smart Agriculture is not presented in the curriculum and learning practices of Case Study Two (also see Section 5.3). The research participants acted on the process of Climate-Smart integration by developing an innovation plan and deciding to implement a teaching garden. Green campus initiatives have not been implemented.

7.3 THE SECOND INTERVENTION–INNOVATION WORKSHOP

Eight participants and one Head of Department attended the second intervention workshop. The aim of the workshop was to surface the contradictions that existed in the system and model solutions for these contradictions. The feedback of the workshop participants on their own curriculum innovation progress and challenges were helpful to conceptualise the existing system contradictions. The data obtained from a student survey of 57 third-year students were also used as mirror data to reflect back the contradictions within the system (see Section 6.3.2.3).

7.3.1 OBJECT OF THE WORKSHOP

The workshop's object was structured around the main aim of discussing the contradictions within the system and modelling solutions. The implementation of the Case Study Two's mediated Innovation Plan and the support provided by the tool was also discussed.

7.3.2 TOPICS OF DISCUSSION

7.3.2.1 FEEDBACK ON INNOVATION PLAN PROGRESS

- The revaluation of the object, step one, was successful.
- Step two of the plan is in progress as the development of the tool is an ongoing process. Workshop participants were involved in this process by suggesting format and structure changes to the tool.
- No progress in step three as no official training in Climate-Smart Agriculture or related topic was undertaken by the workshop participants

- Progress in step four was positive. A stand-alone Climate-Smart Agriculture three-day course was held for the third-year students in June 2016 (also see Section 6.3.2.4).
- Progress in step five was also recorded. Towering Gardens, a sustainable homestead gardening practice, was used by the first-years during the Enterprise practical teaching as part of sustainable agricultural practices (no evidence or photographs could be obtained).
- No other official integration of Climate-Smart practices, knowledge or competencies into the curriculum, policies or practices.

7.3.2.2 FEEDBACK ON TOOL DATA AND DEVELOPMENT

After the Intervention-innovation workshop two in Case Study One, the researcher drafted an online version of the tool as suggested. During the workshop, the adjusted Climate-Smart Innovation Tool Booklets were distributed and the comments from Case Study One were also discussed. The draft online version of the tool was shown to the workshop participants. Research participants were invited to use the online tool as soon as possible and to comment at the end of the assessment. There is a “question and comment” section at the end of each online sub-tool that allows the reviewer (participant) to comment on the tool (see Appendix 5.2, question 23). Figure 7.3 shows the summative data (session statistics) the researcher received after Participant 2 completed the Online Climate-Smart Innovation Tool – Lecturer.

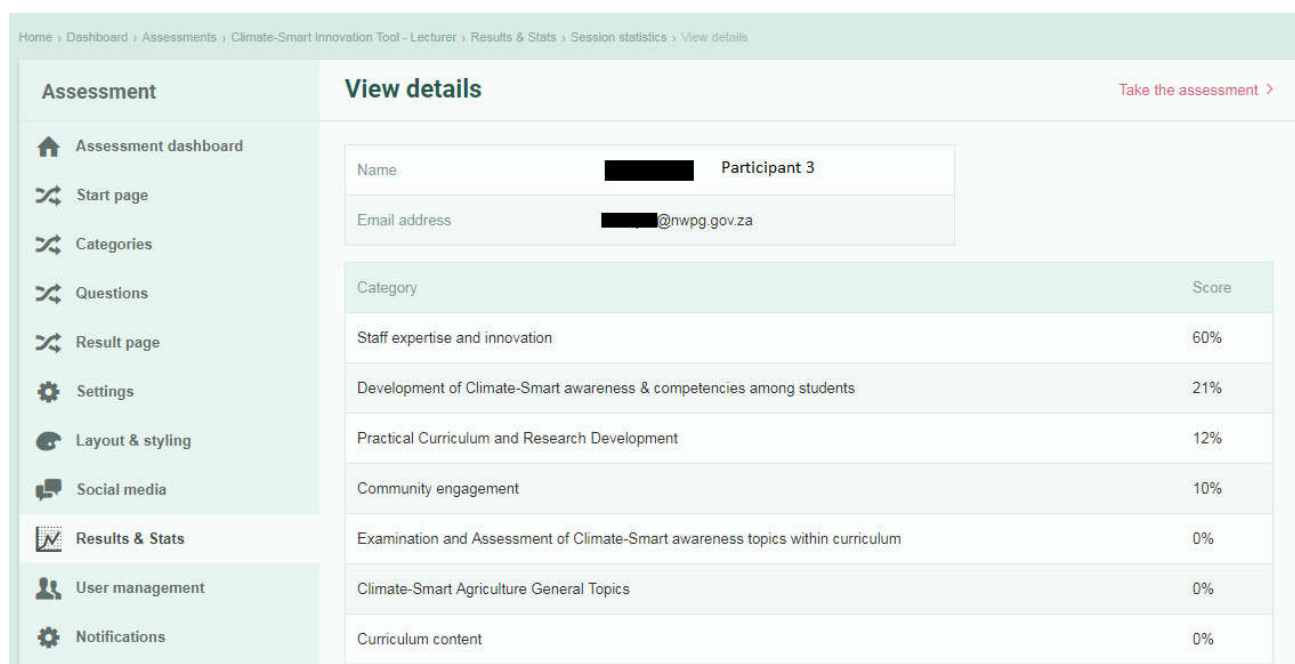


Figure 7.3: An example of the Online summative session statistics for Climate-Smart Innovation Tool – Lecturer (also see Appendix 5.2 to 5.6)

7.3.2.3 FEEDBACK ON STUDENT SURVEY

The independent student survey conducted by the researcher during a visit to Potchefstroom (1 June 2016) aimed to understand the role of the students and their Climate-Smart responsiveness, awareness and participation. The survey obtained data on the students not from the subjects' (participants/ lecturers) point of view but from the students themselves. The results of the student surveys were also used as mirror data to show the participants another version of the activity system from the students' point of view. The survey aimed to understand the role of the students and their Climate-Smart responsiveness, awareness and participation. A total of 54 Diploma in Agriculture third-year students completed the Climate-Smart innovation survey for students.

To summarise the results, a total of 7% of the students acknowledged that some career counselling towards sustainable agriculture and environmental careers was provided by members of staff. Of the 54 students, 13% knew of recycling bins on campus to dispose recyclables. Two percent of the students participated in a voluntary community service programme. The promotion of climate change awareness and agriculture sustainability by the college and staff was acknowledged by 7% of the students participating in the survey. Prior to the course, 9% were involved in projects which involved the Climate-Smart Agriculture concept on any level such as food security, poverty upliftment, sustainable agriculture and all the other side branches of Climate-Smart Agriculture discussed in detail in Chapter 2 (Section 2.3). Forty-four percent of the students said that they have considered a career in environmental conservation and sustainable development. During the survey, the students were asked about their future and why they were studying the Diploma in Agriculture at the college. One student aimed to work at the Department of Agriculture, Forestry and Fishery and another wanted to go into agricultural research. Four percent of the students aimed to become lecturers at an educational establishment. Thirteen students were undecided. Of the remaining students, only 35% wanted to farm after graduation and the other 44% students saw the Diploma as a stepping stone for acceptance at other educational institutes to further their studies at, for example, primary B Tech degrees or for veterinary qualifications. The surveys are listed under Case Study Two's Case Record information. The student survey analysis is illustrated in Figure 7.4.

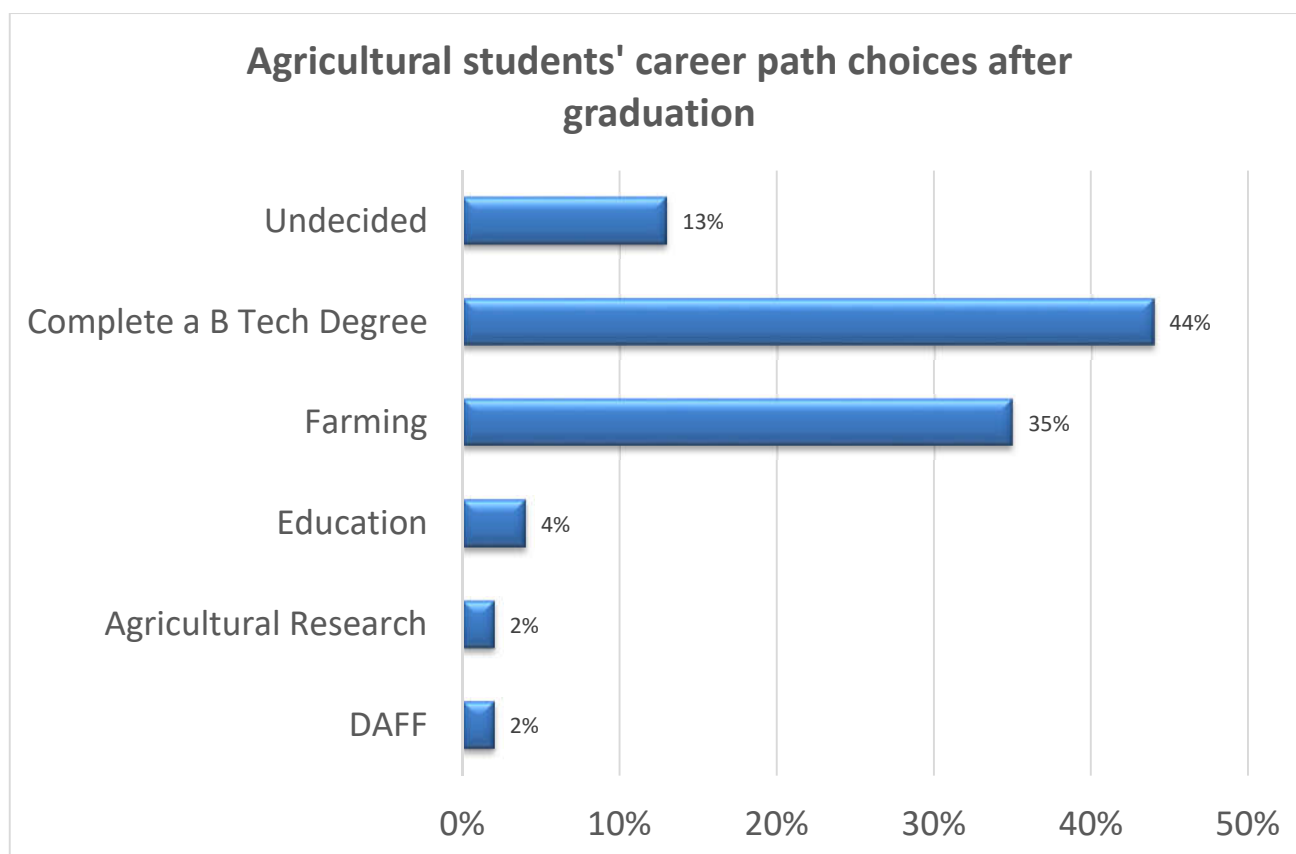


Figure 7.4 Third-year student aspirations after graduation

7.3.2.4 CLIMATE-SMART AGRICULTURE THIRD-YEAR WORKSHOP

The three-day workshop was held on 1 - 3 June 2016. The course was an introduction to Climate-Smart Agriculture components and practices. Topics included:

- Climate Change
- The implications of Climate Change for the Agriculture sector of South Africa and North West province
- Climate Change & Agriculture
- Climate-Smart agriculture: Concept and interpretation
- Competencies of Climate-Smart agriculture. Why Climate-Smart agriculture?
- Homestead gardening – water saving
- Homestead gardening – water harvesting
- Homestead gardening – mixed cropping and seed saving

The students had three theoretical tasks to complete on the last day of the workshop.

7.3.2.5 TENSIONS AND CONTRADICTIONS THAT SURFACED DURING THE INTERVENTION-INNOVATION WORKSHOP TWO

CHANGES IN THE ASPIRATIONS OF THE STUDENTS VERSUS CURRICULUM AND LEARNING PRACTICES

There has been a change in students enrolled to obtain knowledge and competencies to manage a commercial farm, to students that were considering other options of career paths within the agricultural sector (also see Section 7.3.2.3).

Participant 23 *Our students have changed over the years. They do not come from farming backgrounds anymore and most of them did not complete high school at an Agricultural School.*

The students that enrolled in the college until the early 2000s were mostly white students that had attended agricultural schools and grown up on a family farm. Most of the students presently enrolled at the college have no agricultural background or previous knowledge of farming practices. A sixth of the 53 third-year students in 2016 had a family farm or had attended an agricultural school before enrolment. The curriculum was developed for students that had acquired foundational agricultural knowledge and competencies before enrolment. As basic knowledge is often lacking today, lecturers must spend time on developing the foundation required by the curriculum. The practical side of the programme that was based on students with a solid agricultural foundation now has to cater for students with no agricultural background. There has been a change from students that became commercial farmers to students that might follow the extension officer career path, enrol in another qualification or become an entrepreneur. These career paths require other tools to assist in the development of competencies around these needs of the students and community. The students' needs have shifted from commercial farming to attaining knowledge and developing competencies to adapt to climate change and its effect on the agricultural sector to ensure future sustainability and food security (also see Section 4.5.5 and Figure 4.7) Student enrolment has also changed from mainly males to equal ratios of females/males.

COMMERCIAL FARMING TEACHING PRACTICES VERSUS CLIMATE-SMART RESPONSIVE TEACHING PRACTICES

The National Diploma in Mixed Farming focusses mainly on commercial agriculture. However, key challenges for agriculture that the government has been focussing on for the

last decade include sustainable agriculture, land care, food security, rain water harvesting and conservation (RWH&C) and rural wealth creation.

Participant 20 *The college and lecturers needs to adapt with times. Things need to change. We need to include climate change and sustainability in the curriculum.*

It is important to incorporate these components into the syllabus. A career in extension service after graduation is an option. However, the extension officers mainly focus on smallholder farmers and not commercial farmers. The college graduates' knowledge on small-scale farming systems is not adequate to fill these positions as the curriculum focuses mainly on commercial farming.

Participant 2 *Our programme mainly focusses on commercial agriculture and not smallholdings. However, the programme has entrepreneurs as a subject.*

CURRENT STATE OF FLUX: INSTITUTIONAL DEVELOPMENT VS POLICY IMPLEMENTATION

Since 2000 there has been talk about transitioning to an Agricultural Training Institute (also see Section 2.4 and 4.3.1). However, no fixed changes have been made. Staff and management changes during the last couple of years have also affected policy implementation (see Appendix 3). The contradiction arises that many policies are in place for institutional innovation, however within a state of continuous flux, implementing policies is not occurring as quickly as was expected.

Participant 4 *There was talk about Agricultural Training Institute in early 2000. Management initiated the process and people from Potchefstroom University were here to assess the situation. However, we decided to not do it as we would lose more than what we would gain. We were also worried about the practical side of our course.*

7.3.3 INNOVATION PLAN ADJUSTMENTS

- Step 1: To achieve the object of the system Climate-Smart Agriculture approach needed to be integrated into the curriculum. A curriculum review should be scheduled with the necessary stakeholders.
- Step 2: The workshop participants should use the online tools to review their own Climate-Smart responsiveness and send feedback via e-mail to the researcher.
- Step 3: Training possibilities will be scheduled for the following year. In the meantime, the online tool's suggested links should be used to develop the workshop participants' knowledge and competencies.

- Step 4: Students needed to become more involved in the practical component of the programme. Therefore, the practical component of the programme will be assessed. A teaching garden approach will also be used to incorporate Climate-Smart practices into the practical component of the programme. Student group leaders will be appointed to communicate with lecturers and farm managers during arrangements for practical contact sessions.
- Step 5: The Climate-Smart awareness campaign will continue. A recycling area will be established and the college will focus on saving water on campus.

7.3.4 SUMMARY OF WORKSHOP OUTCOMES

The data of the student survey provided another perspective and clearer picture of how the students experience Climate-Smart agriculture and also provided mirror data for research participants to reflect upon. A total of 7% of the students acknowledged that some career counselling towards sustainable agriculture and environmental careers had been provided by members of staff. The promotion of climate change awareness and agriculture sustainability by the college and staff was acknowledged by 7% of the students participating in the survey. During the survey, the students were asked about their future and why they were studying the Diploma in Agriculture at the college. There was tension in the curriculum alignment between the Agricultural Educational Training Strategy and student aspirations.

7.4 THE THIRD INTERVENTION-INNOVATION WORKSHOP AT CASE STUDY TWO

Only four participants attended the third intervention-innovation workshop, due to short notice training for the college staff. However, an online intervention-innovation workshop where the absent research participants could participate in the expansive learning cycle was developed. The online workshop provided the absent participants with an opportunity to engage in the feedback process and also comment on the contradictions and modelling of the innovation plan. Two participants completed the online mirror data feedback workshop. The data derived from the feedback opportunity including the comments of the participating participant were kept in mind and used to complement the already existing contradictions and innovation plan. Figure 7.5 indicates the participants that completed the online workshop and Table 7.1 contains the data exported from the online workshop including the questions and answers of the two participants.

Climate-smart curriculum innovation mirror data online workshop > Results & Stats > Session statistics

Session statistics

Take the assessment >

Delete selected sessions

Displaying 1-2 of 2 results:

Select	Start	Name	E-mail	Finished	
☐	Mar 27, 2017 4:55 PM	[REDACTED]	[REDACTED]@nwpg.gov.za	Yes	View Details
☐	Mar 6, 2017 7:29 AM	[REDACTED]	[REDACTED]@nwpg.gov.za	Yes	View Details

Figure 7.5: List of participants that completed the Online workshop.

<https://www.onlineassessmenttool.com/climate-smart-curriculum-innovation-mirror-data-online-workshop/assessment-61969>

Climate-smart curriculum innovation mirror data online workshop

[Start Online mirror data workshop](#)

Good day,

In March 2015 READ collaborated with Amanzi for Food (WRC & Rhodes University) with the aim to track the implementation of the Climate-smart agriculture integration within the Agricultural Education system within the North West Province as specified in the North West Agricultural Strategy for 2016 to 2020 published in 2015.

As part of this collaborate team I gathered data on Potchefstroom College of Agriculture through workshops, interviews and document/policy analysis. This online workshop is an opportunity for the **LECTURERS and MANAGEMENT TEAM** to be informed and to give feedback on the tensions and contradictions within the system by using the mirror data which have been gathered through this expansive learning process.

Your feedback will then be send to the Head of Campus and the co-coordinator of the collaboration. Once all participants have completed this feedback online-workshop session I will compile a report on the college's action plan and feedback. The report can be utilised as a tool towards the innovation of Climate-smart agriculture within the curriculum and learning practices.



Figure 7.6: The introduction page of the online mirror data workshop

Table 7.1: The questions and answers of the online mirror data workshop assessment

Question Number	Assessment ID	61969	61969
	Assessment Title	Climate-Smart curriculum innovation mirror data online workshop	Climate-Smart curriculum innovation mirror data online workshop
		Participant 18	Participant 2
	Start	2017-03-06 07:29:22	2017-03-27 16:55:57
	End	2017-03-06 08:14:30	2017-03-27 17:20:08
	Finished	Yes	Yes
	The mirror data indicated that one challenge for the lecturers was to translate the abstract concept of Climate-Smart Agriculture into the Agricultural College curriculum context. How, if possible would you address this issue and include Climate-Smart Agriculture within the college context?	Either as a course on its own, covering all the different subjects, or to incorporate sections to different linking subjects (soil, agronomy, horticulture, cultivated and natural pasture	Somehow climate change issues are addressed in different agricultural production courses but not as a stand-alone course
1	The mirror data showed that the students' aspirations and the purpose of the programme might be in contradictions. Do you think the needs and skills development of the student have changed? How do you suggest addressing this change in student aspiration alignment with the curriculum?	At Potchefstroom I don't think that the students have enough, if any insight nor exposure to CSA. Introduction workshop, to make students aware of the importance and need of CSA in South Africa, showing practical implementations thereof, and then working with management to incorporate CSA as a module, subject or part of different subjects' curriculum	The College is in the process of applying and engaging more on this and aligning into the curriculum
2	What do you suggest the college does to get better alignment between the Agricultural College management practices and Climate-Smart Agriculture?	All starts with a positive attitude and open mind from management towards CSA. A positive and driven management can drive CSA with the support of CSA workshops and continuous inputs and subject material	We only need to understand the concept better, apply the practices and have a workshop on how best the College sees this principle included in the curriculum
3	Contradiction between the demands of the academic programme and the inclusion of relevant practical components were evident (institutional innovation – institutional flux) What curriculum and institutional innovations are necessary and possible to address this contradiction?	I don't think a lot of innovations are needed, only a positive and driven outlook towards CSA from both management, lecturers as well as technicians. Then the college must decide how they want to include CSA into their curriculum (subject or fragments in different subjects). Training of relevant lecturers and providing of study material is also important. Maybe the lack of realising the importance of CSA and lack of knowledge as to how to implement CSA into our curriculum are of the major factors	Climate Smart Agriculture addresses issues as sustainable agriculture but perhaps a different approach. Climate Smart Agriculture could also be introduced and be a requirement by CHE for ATIs to comply with climate change issues into the different agricultural production courses as an option of conserving natural resources

4	How are the students being taught about adapting to the changing dynamics of seasonal cycles in the surrounding biotope?	In pasture we only touch on the general changes in growth cycles of trees and grasses, Also on the influences, dangers and adaptations to severe climate changes due to long term droughts and floods. They are taught how to prevent overgrazing during droughts by decreasing the stock numbers, preventing fires, Prevent bush invasion and encroachment. There is also a module on soil erosion.	That is included in different modules as teaching material is updated annually or semester based according to changes in agriculture and challenges faced of future water availability and high temperatures but at the same time ensuring profit maximising and disease control. Currently the College has invested in biogas facilities as a way of introducing students to renewable energy source and a pioneer student is trialling Biogas production using manure.
5	In your opinion how and what type of institutional innovation towards Climate-Smart responsiveness is necessary and what innovations are actually possible?	Positive attitude. Not a lot of innovations, only incorporation	A stand-alone course through guidelines or as a unit standard according to set standards

7.4.1 OBJECT OF THE WORKSHOP

The workshop objectives were to evaluate the innovative progress towards Climate-Smart responsive system and to establish barriers that hamper the progress. The workshop purpose was also to establish how innovation occurred, the role of the Climate-Smart Innovation Tool and to plan the next step towards innovation.

7.4.2 TOPIC OF DISCUSSION

7.4.2.1 FEEDBACK ON MEDIATED INNOVATION PLAN

The impact of the third-year Climate-Smart Agriculture short course was discussed (see Section 7.3.2.4). One of the participants felt that the course might not have been as successful as expected as it was a stand-alone course and the knowledge did not articulate into the rest of the curriculum. This was an important comment to take into consideration when developing a Climate-Smart short course or a related subject. Otherwise, it was not clear if innovation had occurred or if any progress was made in the implementation of the innovation plan as most of the participants involved in this process were not present. However, arrangements for future contact sessions and discussions were arranged.

7.4.2.2 THE OBJECTIVE OF THE ACTIVITY SYSTEM

The existing objective was still mainly focused on commercial farming. Slight progress towards adopting the Climate-Smart system objectives was visible.

7.4.2.3 FEEDBACK ON THE CLIMATE-SMART INNOVATION ONLINE TOOLS

Feedback on the refinement of the tool from e-mails and from the “comments and questions” section of the online tools was positive and the development of the online sub-tools were seen as a positive outcome of the expansive learning cycles (see Appendix 6).

7.4.2.4 TENSIONS AND CONTRADICTIONS THAT SURFACED DURING THE WORKSHOP

Many of the participants were not present. However, through discussions, the tensions and contradictions emerged within the existing curriculum and learning activity system.

BETWEEN TIME AND RESOURCES ALLOCATED FOR SUPPORTING CURRICULUM INNOVATION TOWARDS CLIMATE-SMART RESPONSIVENESS

The Diploma programme is very full and lecturers also have other responsibilities. Time to develop the curriculum is restricted and lecturers allocate their time to more urgent matters than how to develop their subject to become more responsive to climate change. During the workshop, the participants expressed their concerns on the integration of Climate-Smart Agriculture as time and resources were limited.

Participant 2 *I think time is always a challenge, there is not even time really for a lecturer to sit down and develop their subject or practical component. We need to get to a point where you value a person itself and actually have time to improve on the curriculum that we have.*

Participant 17 *We need time for the lecturers and students to adopt Climate-Smart Agriculture and understand climate change. It is a life change that needs to occur. We need time to include it into our curriculum and time to train our lecturers. However, Mixed Agriculture is a great programme. I think there might be too much information crammed up into the programme as it has to cover such a fast range of topics There is almost not enough time to cover all the content and practical.*

The contradiction is embedded in time and resource tension. Time to develop and integrate Climate-Smart into the activity system and time for the lecturers, management and students to adopt the Climate-Smart as their own. Time was said to be the limiting factor.

THE ARTICULATION OF SOCIAL-ECOLOGICAL AND ECONOMIC PRACTICES VERSUS THE CHANGING DYNAMICS OF SEASONAL CYCLES IN THE BIOTOPES OF NORTH WEST PROVINCE.

Climate change including the recent drought, changes in rainfall and frost timing is affecting the farming practices in the North West by altering seasonal cycles. Climate change is reducing the predictability associated with rain-fed crops. The social-ecological and earth system changes influenced by climate change results in challenges in the farming system that overflow into the curriculum and learning system. The contradiction is generated between the social-ecological and economic practices taught by the college and the change in relevance due to climate and seasonal changes.

Researcher *Are the students taught about climate change and weather changes within the surrounding biotopes?*

Participant 17 *We teach the students about seasonal cycles and how climate change is affecting rainfall. Students have to work out the predicted rainfall by looking at the last 20 years' rainfall recorded.*

Participant 19 *I try to teach some indigenous knowledge, but it doesn't fit into the practical curriculum.*

Participant 17 *In pasture we only touch on the general changes in growth cycles of trees and grasses, Also on the influences, dangers and adaptations to severe climate changes due to long term droughts and floods. They are taught how to prevent overgrazing during droughts by decreasing the stock numbers, preventing fires, Prevent bush invasion and encroachment. There is also a module on soil erosion.*

Also see Table 7.1 for comments on articulation social-ecological and economic practices.

7.4.3 INNOVATION PLAN AND WORKSHOP OUTCOMES

The modelling of solutions and surfacing of the contradiction process did not follow the exact path and methodology as Case Study One. Due to the inconvenience of absenteeism, the innovation plan was developed through a set of structured questions. The process allowed the participants to reflect on the activity system's current position, the tension that they experienced and the way forward. The combination of this question, tension and modelling approach was incorporated into the intervention-innovation feedback online workshop for the participants to provide feedback and comment. Table 7.2 is the rough plan drawn up according to the research participants' answers during the workshop and the online workshop. The feedback was used to redefine the innovation model towards change.

The innovation model was adapted to include the following steps:

- To train the lecturers to be able to implement Climate-Smart Agriculture practices and knowledge in the curriculum;
- To use the Climate-Smart Innovation sub-tools to assist the participants in reviewing the curriculum and learning practices of the activity system;
- Develop the curriculum content to include climate responsive topics;
- Implement Climate-Smart policies and practices at an institutional level; and
- Revise the programme and include climate responsive topics on a practical basis.

According to the revised innovation plan, the innovation will occur through the subjects and division of labour, where the subjects will undergo training. Figure 7.8 illustrates the newly developed innovation plan from workshop three and online feedback. Figure 7.8 also illustrates the components within the activity system that is affected by the model. Step one focusses on training. The next step focused on developing further reflexive tools or mediating tools to support the innovation process. Thereafter, the Rules and Regulations that govern the activity system will be adjusted followed by revision of the programme during the annual curriculum revision.

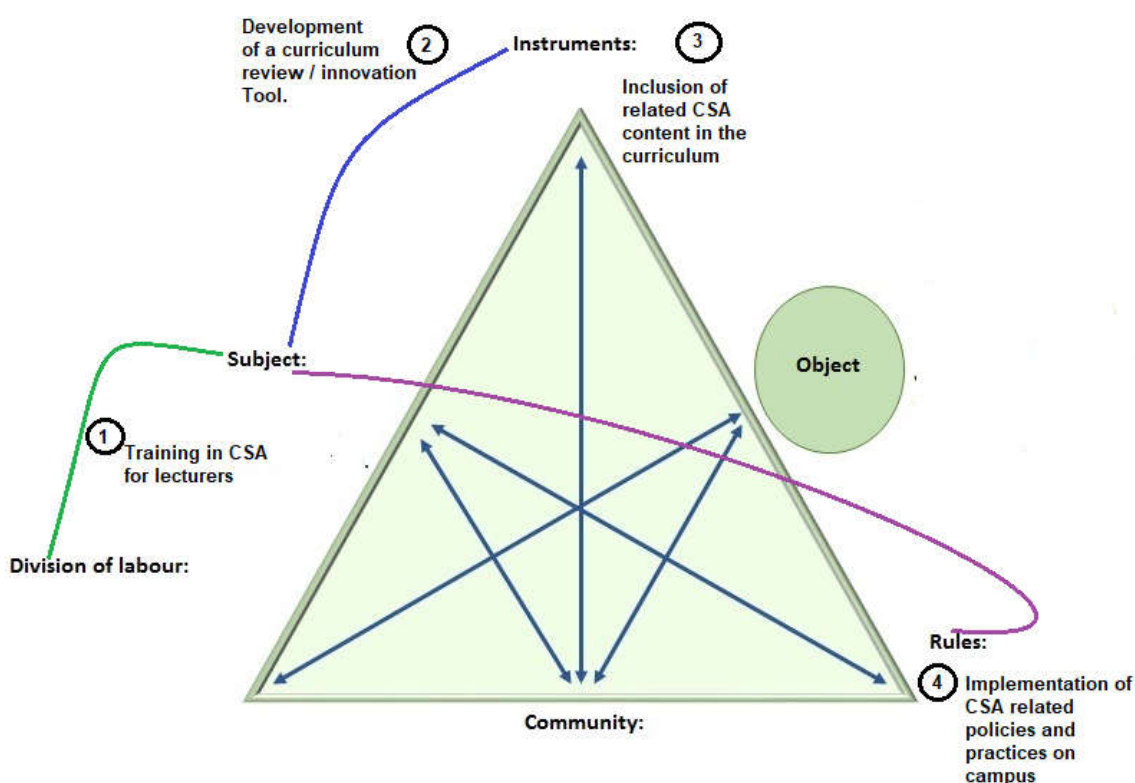


Figure 7.8: Case Study Two's steps outlining the modelled solutions developed through the expansive learning process

Table 7.2: Questions used to develop an innovation plan

WHAT ARE WE, THE STAFF, DOING NOW AT THE COLLEGES?		
Current Position	Problem	Action Plan
There are specific subjects that have some information regarding water conservation and climate change.	The curriculum content does not clearly address the problems surrounding water conservation. Review of indigenous knowledge in our curriculum is needed.	Include these topics in curriculum.
IS THERE A NEED FOR A SEPARATE NEW COURSE ON CLIMATE SMART AGRICULTURE AND WATER CONSERVATION?		
Current Position	Problem	Action Plan
No course content covering specific topics of Climate-Smart Agriculture.	There is a need for a course that covers Climate Change and Water Conservation.	Short courses covering specific components of Climate Change and Water Conservation can be presented in the third year. Develop a first-year module on Climate-Smart Agriculture topics.
CAN CLIMATE-SMART AGRICULTURE BE INTEGRATED INTO EXISTING SUBJECTS AND ARTICULATED OVER THE WHOLE CURRICULUM?		
Current Position	Problem	Action Plan
Some subject content includes topics such as Water Conservation.	Integration of Water Conservation and Climate Change within existing subjects is essential. Suggested subjects for integration of climate change topics include: Horticulture; Water irrigation management; Natural resources; Crop management; Livestock management; Soil science; Irrigation subjects at Taung; Pasture management	Inclusion of these topics in curriculum

WHAT ARE THE COLLEGES TRANSITIONING APPROACHES TOWARDS THE WHOLE INSTITUTION APPROACHES SUCH AS GREEN CAMPUS ETC.?		
Current Position	Problem	Action Plan
No official actions in place	Campuses do not practise rain water harvesting and conservation methods. No green campus incentives	Lecturers must be more engaged with these topics and involve students. Colleges will implement rain water harvesting and conservation around the campuses
WHICH PARTNERS OR STAKEHOLDERS WILL ENGAGE IN THE TRANSITIONING OF THE CURRICULUM TOWARDS CLIMATE-SMART INNOVATION THROUGH THE INCLUSION OF TOPICS SUCH AS CLIMATE CHANGE AND WATER HARVESTING AND CONSERVATION METHODS?		
Current Position	Problem	Action Plan
Learning network needs development	Inclusion of students, Surrounding agricultural businesses, farming communities and research institutes	The curriculum must be designed in such a way that knowledge flow will infiltrate the community. College must collaborate with the Agri-Grain Institute next door.
IS THERE A NEED FOR TRAINING?		
Current Position	Problem	Action Plan
Most lecturers know something about Climate Change and Water Conservation.	Lecturers feel that their knowledge is unorganised and that the lecturers need training to carry this knowledge over to the students and community and to be able to use available information within their courses.	Lecturers needs to be trained in Climate-Smart Agriculture concepts such as rain water harvesting and conservation.
Course Design and development for curriculum revision	Climate change integration can occur in practical parts of the courses. The course design must change to include Climate change and water conservation topics.	Curriculum revision is required and must be updated.
WHAT CLIMATE RESPONSIVE PRACTICES CAN BE IMPLEMENTED AT THE COLLEGE?		
Trap rainwater runoff from buildings etc.; Reuse grey water from hostels; Put up JoJo tanks; Create an underwater catchment area for runoff water that can be pumped using windmills or a solar powered pump; Establish an earthworm farm.		

7.5 REVIEW OF THE ITERATIVE PROCESS OF INNOVATION SUPPORT AND TRACKING THROUGH EXPANSIVE LEARNING CYCLES IN CASE STUDY TWO

7.5.1 IDENTIFYING THE SHARED OBJECT

The object, as discussed in Section 7.2, was shared with Case Study One as interacting activity systems within the Provincial Agricultural Innovation System. The other contact sessions were held separately to allow the researcher to study the innovation process of both case studies separately.

7.5.2 ANALYSIS OF CONTRADICTIONS

The results of the consultative workshops discussions, initial survey (Appendix 1) and Climate-Smart Innovation Tool (Appendix 5) completed by the participants were used as mirror data during the first intervention-innovation workshop. The expansive learning process allowed the lecturers, through engagement, to surface the contradictions within the system.

7.5.3 MODELLING OF SOLUTIONS

During the workshop, participants surfaced various contradictions relevant to the new object. Through engagement, the contradictions were analysed. Specific suggested solutions were discussed. The participants of Case Study Two focused their attention mainly on how to incorporate policy into practice and integrate Climate-Smart Agriculture concept and practices into the curriculum content. The participants discussed the role of the college in responding to climate change issues as an educational institute. The participants followed by analysing the needs, gaps and possibilities for change within the curriculum focussing on a curriculum transitioning opportunities (see Appendix 6).

7.5.4 SOLUTIONS AND INNOVATION PROCESS

After the first intervention-innovation workshop, the management of the college held a three-day Climate-Smart awareness and application short course for the third-year students. During the second intervention-innovation workshop, the lecturers commented on the course, but were unsure if a course out of context of the curriculum was the way to go. Due to many changes within the management structures and staff, tracking innovation was continued.

During the study, three management changes occurred during which the study had to be reintroduced to the management to acquire cooperation. Management was, however, always supportive and cooperative.

7.6 THE EXPANSIVE LEARNING PROCESS OF CASE STUDY TWO

Learning Action 1 consisted of the consultative workshop and gathering of background information of the activity system. The contradictions, part of Learning Action 2, were structured during Workshop 3 and modelling of solutions in the form of an action plan was developed by the participants (Learning Action 3). Case Study Two was also actively involved in the development and refinement of the Climate-Smart Innovation Tool. During the second intervention-innovation workshop, the progress of the tool was discussed. The adjustments to the tool and development of sub-tools occurred during Learning Action 3. However, in the third intervention-innovation workshop, it was clear the due to many constraints the expansive learning process did not take its course as expected. Discussions on the contradictions identified in previous sessions and the way forward were held during the third workshop. Due to attendance difficulties the researcher developed an online intervention-innovation feedback workshop after the third intervention-innovation workshop. The participants that could not attend the workshop in person could therefore still interact and give input. A request with a description of the objectives of such an online workshop was emailed to each participant

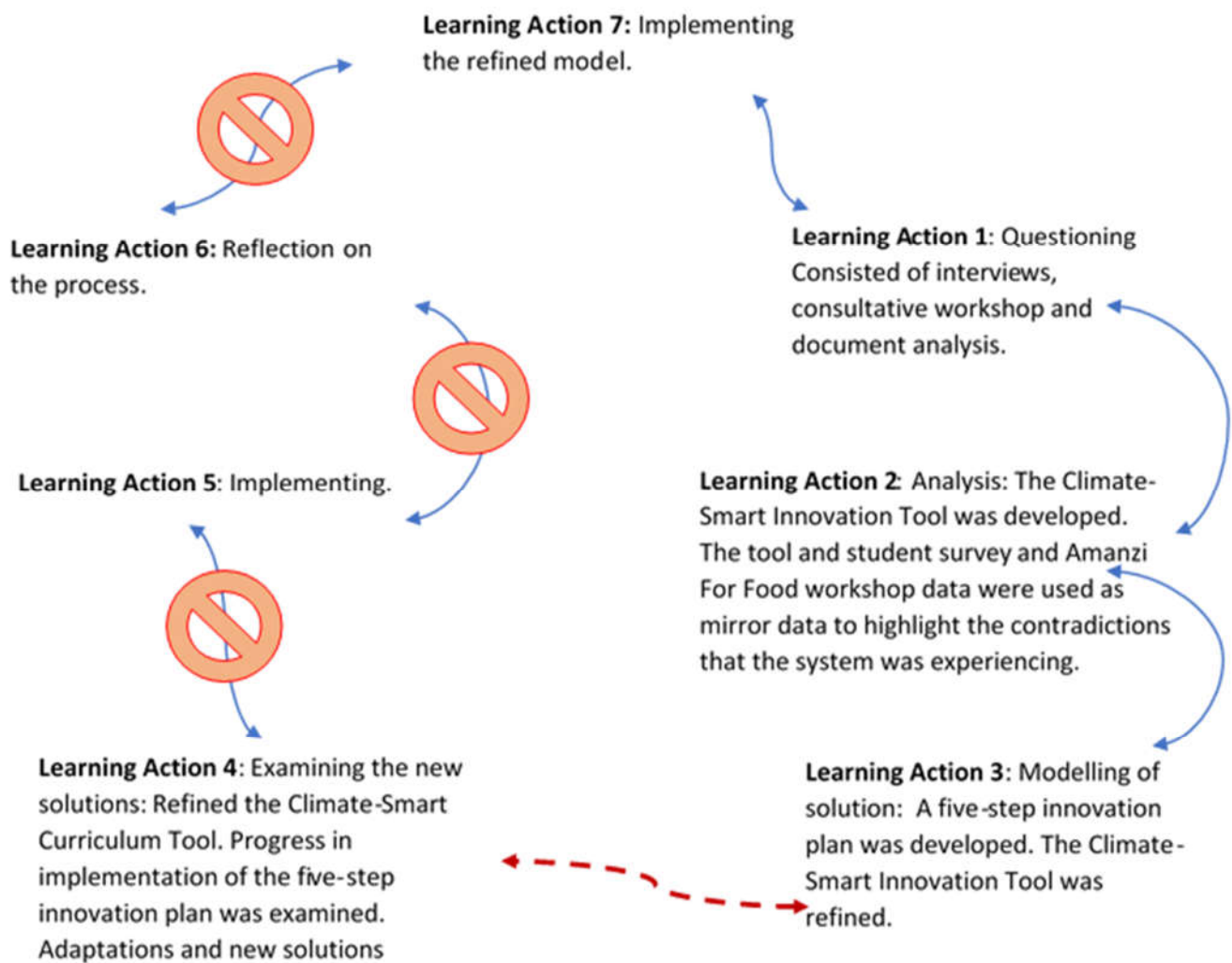


Figure 7.9: The steps completed during the expansive learning process of Case Study Two

7.6.1 TOOL AS A DRIVER OF INNOVATION

The initial Innovation Tool was used to gather mirror data from the participants. The Climate-Smart Innovation Tool was discussed and the tool was developed to function for other purposes too. The lecturers felt a need to develop their own Climate-Smart Agriculture knowledge and assess their own subject for themselves without having to write down many answers and wait for the researcher to translate the answers. Thus, the Climate-Smart Innovation Tool was developed before the first intervention-innovation workshop, during Phase Two, and the use of the tool was assessed during the workshop, during Phase Three. Lecturers then utilised the tool online to review their own subjects. After the completion of the review, a report was provided to the participants. The report also included links to information that the participants might find useful during his or her journey towards Climate-Smart

Agriculture innovation. It became clearer that there was a need for specification as the participants had specific specialities. The participants suggested sub-tools that cover specific areas of the curriculum for Climate-Smart responsiveness. Thus, during Phase Three sub-tools were developed and utilised by the participants online. Reports for the online sub-tools are listed in Appendix 5.2 to 5.7.

The innovation tool, utilised as a second stimulus, was used as an instrument in the design of a new conceptual model of the activity system that the participants were trying to innovate (Engeström, 2016). The tool assisted as mirror data that served as a stimulus for triggering questions and analysis during Learning Actions 1 and 2. The aim of the tool was also not only to review the Climate-Smart responsiveness of the system but also to serve as an informative reflexive tool and a way to track innovation of the system and individual components of the system. Thus the Climate-Smart Innovation tool served many purposes during the expansive learning process but will also be able to be used by individuals and other activity systems.

7.7 CONCLUSION

Chapter Seven continued to discuss the review and tracking of the supported innovation process that enabled the researcher and research participant to build a picture of the complexities of systems innovation and the challenges of the transitioning process to a Climate-Smart system of innovation.

Contradictions emerged and were addressed during the expansive learning cycles. The first contradiction was between time and the resources allocated for supporting curriculum innovation towards Climate-Smart responsiveness. The contradiction was a primary contradiction within the Tools of the activity system. The second contradiction arose between Climate-Smart Agriculture as an abstract concept and the approach as an innovation responsive tool that can mediate action within the system. It is a primary contradiction within the tools. The contradiction is between the subjects, lecturers understanding Climate-Smart Agriculture as an innovation responsive tool and Climate-Smart Agriculture as an abstract concept. There is a secondary contradiction between Subject and Tools. The third contradiction arose due to the stress developed through external drivers: the articulation and of social-ecological and economic practices versus the inclusion of practices responding to the changing system dynamics due to driver changes within the Agricultural Innovation System. The level of the contradiction is Quaternary as it includes the influence of an external

system. As a secondary contradiction, it is between the rules and norms and the current teaching practices, division of labour. Another contradiction involved the students' aspirations versus the object and goal of the activity system. This is a secondary contradiction between the object and the community. What about division of labour? Another contradiction emerged between the commercial agricultural teaching practices versus the innovative sustainable teaching practices responding to the agricultural sector's needs and challenges. This is a secondary contradiction between the norms and standards and the division of labour. The final contradiction emerged between the current state of flux versus the policies that require implementation.

Chapter Eight continues to report on the insights and limitations of the iterative process of innovation and the role of expansive learning during this process within a system of flux. The chapter discusses the innovations within the system and concludes with recommendations on how a Climate-Smart innovation process might best be supported with reflexive tools within a curriculum and learning system during a time of institutional flux.

CHAPTER 8

TOOLS, TIME AND LEARNING IN A STATE OF INSTITUTIONAL FLUX

8.1 INTRODUCTION

The purpose of this study was to track innovation within the North West Provincial Agricultural Innovation System. The focus was on the embedded curriculum and learning activity system and responses to social-ecological and earth system changes influenced by climate change. In response to these challenges, the Agricultural System adopted the Climate-Smart Agriculture approach at policy level which resulted in the process of accepting and integrating the climate responsive approach within the system and its sub-systems. The Agricultural Training Institutes within the province responded to the changes by also adopting the Climate-Smart Agriculture approach. This provided the context for the study to track the innovation process of transitioning towards Climate-Smart responsive curricula and learning practices within the system.

The study was based in North West Agricultural Innovation System during a time of system changes and where responses to these changes were necessary and inevitable. The study is meant to inform the curriculum and learning system by examining the processes of innovation and how these processes occur. It provides a formative insight into the functioning of the Agricultural Innovation System during a process of supporting and enabling curriculum innovation towards Climate-Smart responsiveness. The approaches, insights and innovation tools shaped by the study can be employed to provide guidance to any Southern African Agricultural Training Institute during curriculum and learning innovation processes.

The study drew upon systems theory and Cultural Historical Activity Theory to support the research into curriculum and learning innovation. The theoretical framework enabled the research participants to review the context, identify matters of concern and contradictions and to initiate change before examining how their initiatives were developing an expansive learning and innovation process within the system. Chapter Eight now discusses the insights, findings and recommendations emerging from this study of systems innovation.

The chapter first discusses the innovations that occurred within the system. It then examines the barriers and processes hampering the curriculum and learning innovation within the system towards Climate-Smart responsiveness. Significant processes associated with the abstract Climate-Smart Agriculture concept as well as more concrete contexts of curriculum innovation are examined. The double stimulation tools developed during this study to assist with the micro-level innovation of the curriculum and learning system are also discussed. Finally, developing insights and recommendations for the way forward are discussed to inform the curriculum and learning system within the colleges and in the broader Agricultural System responding to climate change.

8.2 OVERVIEW OF THE ITERATIVE PROCESS OF INNOVATION

As reported, Climate-Smart Agriculture was adopted at a provincial policy level (see Section 4.3.5). The preliminary consultative workshop framed the study and allowed the research participants to develop a provincial object and adopt Climate-Smart Agriculture as a response tool at a provincial level (Chapter 4, Section 4.6). The Amanzi For Food workshop which representatives of the case studies attended set the arena for network building and a supportive structure for the colleges to develop provincial climate responsiveness. A reflexive tool was developed and tested to establish the climate responsiveness of the system.

Phase One and Two of the research focused on Objective 1 and 2 of the study (see Section 1.4), namely:

- To develop a tool to aid in the support and tracking of curriculum innovation as a reflexive tool that reviews the Climate-Smart responsiveness of an Agricultural College or Training Institutes informed by a Climate-Smart Agriculture system framework.

- To engage college staff involved in the offering of the National Diploma of Agriculture to explore practical options for curriculum innovation within a Provincial Agricultural System undergoing Climate-Smart innovation through an iterative process of expansive learning.

During Phase One, research questions 1.1 to 1.3 were answered. Research Question 1.1 (How are the current National Diploma of Agriculture curricula constituted?) was discussed in Sections 4.2 to 4.5 (also see Sections 1.2.3, 1.2.4, 2.3.5 and 2.4). Research Question 1.2 (How can a reflexive tool be developed for review, support and tracking of curriculum innovation towards Climate-Smart responsiveness?) and Question 1.3 (Are there examples of curriculum innovation tools for sustainability that can be adapted for climate smart responsiveness? If so, how can this be done?) initiated the development of the Climate-Smart

Innovation Tool. Through document analysis and research, these questions were answered and the USAT Tool was adapted to develop the reflexive tool during this study (see Sections 3.3.1.1 and 4.7; also see Section 5.1).

Research Question 2.1 (What Climate-Smart Agriculture elements are incorporated into the current National Diploma agricultural curricula content and practices, if any, at the start of the curriculum innovation formative intervention process?) was explored during the preliminary consultative workshop (Section 4.6), participant survey (Appendix 1) and more in-depth through the data obtained from the Climate-Smart Innovation Tool at the end of Phase 2 (see Chapter Five). Research Question 2.2 (How can college staff involved in the offering of the National Diploma in Agriculture be engaged through formative intervention explore practical options for curriculum innovation utilising Climate-Smart Agriculture?) was the focus of Chapter Four.

Phase Three focused on Objective 3.

To work with the outcomes of the curriculum innovation process as mirror data to reflect on the systemic formative intervention to determine the barriers hampering the innovation process towards a Climate-Smart system.

The expansive learning process was initiated during the first intervention-innovation workshops. During these workshops, the participants reflected on their progress to fulfil the systems object (Section 4.6). The Climate-Smart Innovation Tool mirrored back the responsiveness of each curriculum. This reflection allowed the participants to develop a clearer picture of the tensions and contradictions within their system. The prevailing curricular systems were not responsive to climate change. How to articulate Climate-Smart Agriculture as an abstract concept into the curricula as a climate responsive curriculum process was identified as a crucial factor to be addressed. An innovation plan was structured in both case studies focussing mostly on staff training, integration of Climate-Smart Agriculture into the curriculum and learning practices and developing student awareness. The tool was utilised as a Climate-Smart responsive indicator.

During the second intervention-innovation workshops, it became clear through reflection that only micro-level innovation occurred within the system. The tool was refined to incorporate different departments and subject specialities. The contradictions that could possibly initiate change were discussed. A communication gap between student and lecturers was identified

and this led to a discussion on the students' aspirations. The gap in student foundational knowledge was a crucial point that surfaced (Section 6.3.2.4 and 7.3.2.5). Reasons for why change was difficult surfaced through conversation. Between workshops 1 and 2 there were staff and responsibility (division of labour) changes (see Appendix 3). Frequently leadership changes also made enacting decisions difficult. The research project had to be repeatedly reintroduced to management during this time, due to changes in management. The revised innovation plans included institutional change and integration of the Climate-Smart Agriculture concept on campus (Sections 6.3.3 and 7.3.3).

The planning and attendance of the third intervention-innovation workshop in Case Study Two was problematic. The research project had to be reintroduced due to management changes. However, the project was welcomed and supported. Due to the last-minute training session, only four research participants could attend the workshop.

Half of the initial workshop participants of Case Study One were no longer working at the college. Thus, the project was reintroduced to the new attending participants (see participant list in Appendix 3). It also became clear that many lecturers at Case Study One had attained new responsibilities that disrupt their normal teaching time due to a project initiated by DAFF within the province (see Section 6.4.3.3). It became evident that the case studies were functioning in a system of continuous and perpetual flux. The conversation addressed how to function and initiate change within a system in flux. The tool was developed into an online tool that assisted the participants to review their own Climate-Smart responsiveness and initiative success. During Phase Three, Research Questions 3.1 to 3.3 were answered.

- 3.1 How do the Climate-Smart Agriculture elements change through the process of the curriculum innovation formative intervention?
- 3.2 Can significant absences within the National Diploma curricula be identified if viewed from a Climate-Smart Agriculture innovation perspective?
- 3.3 What contradictions are evident and what resolutions of these might inform the National Diploma curricula innovation process?

At the provincial level, awareness of the inclusion of climate responsive policies and practices was acknowledged (READ, 2015b). The research participants were aware of the urgency of inclusion of climate responsive topics within the teaching and learning practices and that the system had to adjust to a Climate-Smart system. The lecturers and Heads of Departments, with support of the Campus Managers, were engaged in an expansive learning process

towards innovation. However, with all the continuous changes, the activity system's staff (subjects), leadership (community), responsibility changes (division of labour) and policies (rules of the activity system), it became almost impossible to initiate change. In a system of continuous flux, all changes are on a fundamental basis and the subjects within the system (the lecturers and management) focus on achieving some form of functioning within the system. Due to the continuous state of perpetual flux, innovation did not occur as planned.

The research participants had access to the Climate-Smart Innovation Tool that not only assisted with reporting on the responsiveness of the curriculum, but was also used as a reflexive, knowledge engagement tool. A well-structured innovation plan was developed in both case studies and participants were engaged in this process. However, innovation as planned did not occur. To summarise, the research participants recognised an absence in their curriculum, the absence of Climate-Smart Agriculture. Their objective was to work with this concept in the concrete (see Section 3.2.3, 6.2.2.4 and 7.2.2.3) while trying to make changes. Their agency was limited to the changes they could make. This is not uncommon as Agbedahin (2016) pointed out: "The manner and extent to institutional policy or curriculum changes possible by agents is dependent on their position-practice system and associated sphere of influence (p.178).

There were absences in the system, such as absence of curriculum structure, a stable environment and administration stability. The Climate-Smart Agriculture Tool stimulated people to be reflexive through Cultural Historical Activity Theory that also allowed the researcher to analyse the system and surface contradictions with research participants over a period of time. The contradictions were addressed during the three intervention-innovation workshops through a process of working with people that allowed the understanding of the complexities of making change in a context of flux to surface. Thus, the expansive learning cycles supported people to initiate agency towards change in the context of flux. Through the iterative process towards an innovative system, it became clear that micro innovation had occurred. It became clear that when trying to innovate a system, the institutional flux needs to be considered and that conventional research and expansive learning methods might need adjustment to compensate for these drivers and constraints towards innovation. Agents are influenced by structure; however, individuals have the ability to modify the structure (Chapter Three, Section 3.2.4). Thus, during Phase Four, Research Question 4.1 (Can the Climate-Smart Innovation Tool be used as a reflexive tool to support and track the processes of

curriculum review and innovation?) was answered and through reflection on the whole study, the main fundamental research questions were addressed:

How can an Agricultural Innovation System functionally foster the necessary knowledge and competencies for transitioning to a climate responsive system of curriculum and learning innovation within a system of flux?

Section 8.3 continues to discuss the innovation which occurred during the expansive learning process towards a Climate-Smart System.

8.3 INNOVATIONS WITHIN THE AGRICULTURAL SYSTEM

The study developed from a system analysis of the two case studies (see Sections 4.2, 4.3, 4.4 and 4.5). The review and tracking of the supportive innovation process enabled the research to shape a picture of the complexities of systems innovation and the challenges of the transitioning process to a Climate-Smart system. The system tensions and contradictions are outlined in Chapter Six (Section 6.6) and Seven (Section 7.7). Section 8.3 summarises the innovations within the two co-existing streams of research that occurred within the system during the study. The expansive learning-based research stream was informed by the reflexive tool as a double stimulus tool and the tool-based research stream that was developed and refined during the expansive learning cycles. The tool-based innovations and expansive learning-based innovations are summarised in Tables 8.1 and 8.2 respectively. The summary is based on the evidence of innovation during the expansive learning cycles structured in Chapters Six and Seven.

8.3.1 CLIMATE-SMART INNOVATION TOOL-BASED INNOVATIONS

Initially the tool was developed to analyse the Climate-Smart responsiveness of both cases. The tool data were then used to surface the contradictions that were carried into the intervention-innovation workshops. The tool enabled the research participants, lecturers and representatives of the management team, to not only look at the Climate-Smart responsiveness of the system, but also the institutional functioning within the system. The tool was refined and online sub-tools were developed. The tool developed from being only a double-stimulus tool to a reflexive knowledge disseminating tool (Appendix 5). The reviewer could either review his or her specific professional field, a department, the management practices or the institutional policy responsiveness. Research participants could track their own innovation progress by reviewing their teaching and learning practices periodically. The

tool also provided information through further suggested readings and website links (see Appendices 5.2 to 5.6). This enabled the reviewer to obtain information on the sections which scored the lowest. Thus, the tool stimulated change within the system when the workshop participants and I (the formative interventionist researcher) used its data as mirror data to surface the contradictions within the system.

The tool was reflexive as the online tool provided a report page where the reviewer's data was presented with comments. It was further used to not only reflect on the Climate-Smart responsiveness of the individual research participant's curriculum and learning practices, but also on their innovation progress. The tool also functioned as a knowledge engagement tool and source of knowledge (see examples of the end of review reports and websites links in Appendices 5.2 to 5.6).

The tool supported the participants during their iterative process of innovation towards a more Climate-Smart system as a double stimulus tool that surfaced the system contradictions, as reflexive tool that reflected on systems innovations and as a knowledge engagement tool being a source of valuable information on Climate-Smart Agriculture. To summarise, the lecturers' routine actions had been teaching the existing agriculture curriculum. No one was thinking about Climate-Smart Agriculture, however the tool functioned as a de-routiniser that steered the routine action of the workshop participants towards Climate-Smart responsiveness towards agency for change (Archer, 1995). The tool supported change of the routine action within the system. The tool-based innovations are summarised in Table 8.1.

Table 8.1: Tool-based innovation within curriculum and learning system of North West Province

	Tool-based system innovations
Lecturer based innovation	Data derived from tool was used as mirror data during expansive learning process (see Sections 6.2.2.2 and 7.2.2.2) and as a reflexive tool by research participants to reflect on individual course based climate responsiveness (Sections 6.3.2.2; 6.4.2.1; 6.4.3.2 and 7.4.3). Tool also used as a knowledge engagement tool to capacitate lecturers (Section 6.4.3.2; 6.4.5; 7.2.2.4 and 7.3.3).
Student based innovation	The tool allowed the research participants to become aware of how their teaching and learning practices affect the students' awareness and perceptions of the world. The student awareness section in the tool indicated to the staff what Climate-Smart knowledge and competencies the students require to competently be climate responsive (Sections 5.2.1, 5.2.3, 5.3.1 and 5.3.2).
Course based innovation	The tool assisted lecturers to identify what topics were relevant to the subject under review and the Climate-Smart responsive status of the subject (Table 5.4, Appendices 5.2 to 5.6).
Policy based innovation	The tool outlines the policy and institutional Climate-Smart initiatives that can lead to innovation (Table 5.5, Appendix 5.3).

Table 8.2: The expansive learning based innovations

	Expansive learning based innovations
Lecturer based innovation	Through internal conversation during the intervention innovation workshops, the object of the activity system became more climate responsive. There was identification of contradictions and discussing solutions to the tensions. Lecturers were attempting to develop new Climate-Smart Agriculture knowledge and practical competencies. Lecturers' awareness shifted to climate responsiveness (Sections 6.5 and 7.5).
Student based innovation	Students were informed of Climate-Smart Agriculture during a third-year workshop presented in 2016 (Section 7.3.2.3). A student awareness campaign was initiated (Case Study One; Section 6.3.2.1). The workshops surfaced the communication problems between the students and lecturers (Section 6.3.2.4). Awareness led to modelling of ways to develop communication links (see Table 6.1).
Course based innovation	A Climate-Smart Agriculture awareness workshop for the third-year students was presented in 2016 in Case Study two (Section 7.3.2.3). Practical climate responsive components have been included in the course such as tower gardening. Climate-Smart Agriculture topics have been included informally into subjects by individual lecturers (Section 6.2.2.4).
Policy based innovation	No formal policy or institutional innovations occurred (Sections 6.4.3.3 and 7.3.2.5).

8.3.2 EXPANSIVE LEARNING CYCLES TOWARDS INNOVATION

Based on the evidence summarised in Tables 8.1 and 8.2 derived from the expansive learning cycles documented in Chapter Six (Figure 6.5 and Figure 7.9), micro innovation occurred within the activity systems. Even though system change was not evident at a macro level, micro innovation occurred through individual participants. Climate-Smart Agriculture was incorporated in specific subject practical components, a student awareness programme was initiated and mostly the research participants were willing to engage in the expansive learning led innovation. Through the support of the Climate-Smart Innovation Tool, the research participants could reflect and further develop their own individual curriculum and learning practices. Through the small changes within the system, the Climate-Smart approach is cyphering through the system by small steps and actions.

During the expansive learning process, various barriers were encountered. Thus, the participants that were engaged in the process of innovation did not necessary focus on the institutional change, but more on how they could innovate their own curriculum and learning practices. The Climate-Smart Innovation Tool (Chapter Four, Section 4.6) and expansive learning cycle analysis (Sections 5.5 and 6.5) indicated that little institutional innovation occurred during the study. No policy innovations were documented.8.4 Barriers and processes hampering the process of innovation towards a Climate-Smart responsive system

Through interaction with the research participants during workshops, interviews and informal feedback discussions, it became clearer that to innovate the Climate-Smart approach into the system is a difficult process. The analysis of the system (Chapter Four) and the addressing of the contradictions that surfaced within the system (Chapters Six and Seven) enabled the researcher and research participants to use the data as a 'mirror' to reflect on and understand why innovation was not progressing. Even though the Provincial Agricultural System initiated Climate-Smart Agriculture into the system and the colleges adopted the approach towards a Climate-Smart System, supported change did not occur. Supported systemic change was difficult.

The Cultural Historical Activity Theory approach allowed the researcher and research participants to map out the activity systems. Through the activity system analysis, contradictions surfaced. The contradictions enabled the innovation process. But the

continued modelling of the activity system allowed the research participants to discuss the barriers and processes hampering innovation. This also allowed for the analysis of the barriers of innovation within different levels at the curriculum and learning practices and at the provincial level.

8.4.1 POLICY AND PRACTICE

Changes within the policies over the last century have influenced the drivers and functioning of the agricultural curriculum and learning activity system. As the agricultural sector's needs leaned more towards sustainable agriculture, water conservation, and food security, so did national and provincial policies adapt to include these challenges. The agricultural and environmental policies that influence the North West Province's Agricultural Innovation System is discussed in Chapter Two, Section 2.3.5. The system is driven by the policies and strategies set out by the national and provincial departments. Climate-Smart Agriculture was adopted as a responsive approach towards sustainable agriculture during this time of climatic changes and water scarcity. The approach functioned within the wider climate compatibility development, resilience, adaptation, mitigation framework which is included in the South African National Climate Change Response White Paper (NCCRP, DoA, 1995). These drivers embedded the NCCRP impact and innovated the agricultural sector.

The sector's changes in policy and strategic plans shape and drive the Agricultural Innovation System at a national and provincial level that in turn affects the sub-systems (READ, 2015b; AgriSETA, 2014; DoA, 2005b). A policy shift of the Agricultural Education and Strategic plan to fulfil the need to move from the almost exclusive focus on commercial agriculture to a more rural development and poverty eradication orientation also influenced the innovation pathway of the system (DoA, 2005a, 2005b; AgriSETA, 2014).

The Provincial Agricultural Strategic Plan contradicts itself. READ is developing new irrigation projects and other facilities that require a tremendous amount of water within the North West Province. This is in contradiction with the acknowledgement of the water crisis and climate change adaptation issues also addressed within the same Strategic Plan (Chapter Two, Section 2.3.5). In the short term, the development of the irrigation projects will boost the agricultural production and increase food security. This is not a long-term solution as it doesn't

train the farmers to develop sustainable agricultural practices and does not prepare agriculture for the province's main climate vulnerability which is water scarcity (Section 2.3.5).

The data derived from the Climate-Smart Innovation tool indicated that there is a lack of structural alignment between policy and practice. At provincial level, the policies are in place; however the implementation of these policies at a sub-system level is not clear. This study was based on policy innovation as the case studies brought Climate-Smart Agriculture into the colleges. However, even though the research participants were actively engaged in and initiated Climate-Smart integration, the research indicated that at college level, adequate alignment at a policy level, including the Agricultural Strategic Plan of the North West Province, was not achieved. All the institutional changes have created a situation of flux so the synergies and coordination between the provincial imperative to innovate for Climate Smart Agriculture and the college based imperative to function as a Climate-Smart system is not aligned.

8.4.2 AGRICULTURAL TRAINING INSTITUTE FUNCTIONING AS AN INNOVATION SYSTEM WITHIN THE AGRICULTURAL INNOVATION SYSTEM DURING INSTITUTIONAL FLUX

Initiating innovation within a stable system, in theory, should be relatively easy. However, numerous studies have shown that often innovation is not easy (Agbedahin, 2016; Chakeredza et al., 2009; DAFF, 2010 & Engeström, 2016). This study has shown that if the system is in flux, the innovation process becomes more difficult and complicated. The North West Agricultural System is in flux and initiating change in this situation is challenging. A state of flux refers to the constantly changing components within the agricultural system that creates a sense of uncertainty regarding what should be done. The flux within the North West Province's Agricultural System that surfaced during the innovation process of the study can be summarised as follows.

8.4.2.1 COLLEGES OF AGRICULTURE TRANSFORMATION TO AGRICULTURAL TRAINING INSTITUTES

The transformation of the colleges of agriculture to Agricultural Training Institutes which aims to revamp and restructure the Institutes towards becoming Centres of Excellence is a factor that influences curriculum and learning innovation. The long-awaited shift from provincial governance to the incorporation as Agriculture Training Institutes at a national level affects

innovation within the system (ASSAf, 2017). The uncertainty of what will happen to the colleges affects decision-making and progress of development within the system. This transfer is likely to bring about change to the agricultural curriculum and learning system. The most evident concern in the study was how the change will affect the practical component of the curriculum and the day-to-day functioning of the colleges (Section 6.4.3.3). This in turn will affect the functioning of the Agricultural System as responsibility of the curriculum and training required for the functioning of the system will then be transferred to another system (DAF, 2008). The shift can also deepen the divisions between the agricultural sector's needs and the agricultural education system as the direct line of communication will then be lost (ASSAf, 2017). Presently, the two colleges are still functioning under READ within the Agricultural System; however, after transitioning, the two colleges will fall under the Department of Higher Education within the educational system. It is already a struggle to align agricultural education with the agricultural sector's needs. How will the shift to another system unrelated to agriculture affect the articulation between the agricultural education and the agricultural sector? This question remains open for further research.

8.4.2.2 Leadership in a situation of flux

The leadership changes within the system are also a barrier to innovation. With the management and staff changes, the system structure and objectives are altered. Even the division of labour is affected as system changes are implemented. During the study, the principals of both colleges resigned in 2016 and were replaced in 2017. The Campus Head in Case Study Two was also replaced during the time of research. Case Study One has had three Campus Heads in the last seven years. Academic staff have also left the colleges and some have moved between the colleges. At the third intervention-innovation workshop in Case Study One, five of the lecturers attending the workshop had been lecturing at the college for less than six months (Section 6.4). Changes in the management and academic staff made following the innovation plan structured by the research participants difficult and thus affected the ability of the system to function and strive towards innovation (Sections 6.4.3.3 and 7.3.2.5).

8.4.2.3 KNOWLEDGE AND COMPETENCIES OF ACTORS WITHIN THE SYSTEM INCLUDING THE ACADEMIC STAFF, MANAGEMENT AND CURRICULUM DEVELOPERS

Knowledge and competencies relating to agriculture within the agricultural system is of utmost importance. Over the years, the need within the curriculum has developed and changed. For the implementation of new knowledge and practice within the curriculum and learning practices, the educators within the system need to be trained in the new learning and teaching topics and practices (DoA, 2005a, 2005b; DAF, 2008). The academic staff do not always have access or time to the new agricultural developments and research as the colleges are not research institutes. Newly appointed staff do not necessarily have an academic background in agriculture or practical experience, a finding also reported in the Eastern Cape, especially when it comes to new areas of study that have not previously been included in the agricultural college curricula such as rainwater harvesting and conservation practices (Lotz-Sisitka et al., 2016) and climate change. To observe transformative agency processes in learning, the agents need to be fully engaged in the action of learning (Archer, 1995). However, if the lecturers and curriculum developers do not have the necessary competencies, knowledge and tools, transformative agency to initiate innovation towards Climate-Smart System is not possible or at best very difficult, as also reported in Togo (2009) and Agbedahin's (2016) studies on sustainability in Higher Education. In such a context, professional development programmes for academics become important, but there are often too few of these available, especially in new areas of study such as Climate-Smart Agriculture, as was also found in this study.

8.4.2.4 TIME AND SPACE CONFIGURATION

Time was identified as one of the most central elements in determining the curriculum innovation and integration of Climate-Smart responsive concepts. Lecturers do not have time to incorporate the practical side of Climate-Smart Agriculture such as rain water harvesting and conservation practices into the curriculum. A key and repeated issue raised across this study was that there was not enough time for students to master the practical techniques and the other practical aspects that they need to understand as there is not enough time allocated for these sections in the already overloaded timetable (Section 6.4.3 and Section 7.4.2.4). This is also reported in other agricultural education contexts (Lotz-Sisitka et al., 2016; ASSAf, 2017, DAF, 2008; DAFF, 2010). It takes time to change attitudes and perceptions regarding the incorporation of Climate-Smart responsive components into the curriculum (Section

6.4.2.4). It takes time to build a relationship with the community and time to participate in community projects. It takes time to incorporate the concepts into the curriculum. It takes time to train the trainers in how to incorporate the concepts into the curriculum.

8.5 DRIVERS INFLUENCING THE CLIMATE-SMART RESPONSES OF THE CURRICULUM AND LEARNING PRACTICES WITHIN THE PROVINCIAL AGRICULTURAL INNOVATION SYSTEM

The system drivers discussed in this section are depicted in Figure 1.1 (Chapter One) as influences and drivers in the Provincial Agricultural Innovation System. This section's findings are based on the data that was obtained through the completion of the Climate-Smart Innovation Tool by the research participants and the discussions and comments made by the participants during the consultative and intervention-innovation workshops. The tool data highlighted that Climate-Smart concepts such as climate change, food security, water conservation, adaptation and building resilience to climate change are not directly part of the curricula of the North West Colleges of Agriculture (Sections 5.2 and 5.3). Section 8.5 explores how critical challenges within the system affected its alignment and responsiveness towards Climate-Smart innovation. It is important to consider the broader contextual factors which affect the curriculum responsiveness and innovation to fully understand the cultural historical influences on innovation towards responsiveness and alignment.

8.5.1 THE GEOGRAPHICAL AND ENVIRONMENTAL SETTING OF THE COLLEGE

The agriculture curriculum is driven by the geographical setting and agricultural activities of the region in which the college is situated. The colleges tend to focus their practical knowledge and competencies developed in the agricultural activities that take place in their region, therefore the geographical setting of the colleges plays a role in the curriculum development of the college. Case Study Two focuses on mixed farming as carried out in the Highveld and adjacent regions and Case Study One focuses on irrigation as it is situated in the middle of the Taung Irrigation Scheme (see Sections 4.2 and 4.4). This is in accordance with the Department of Agriculture (DoA, 2008) recommendations for ATI's to develop specialist knowledge relevant to the local farming practices. What is not contained in these recommendations is what support should be provided to Agricultural Training Institutes (ATI's) for cross-cutting issues such as climate change responsiveness or/ Climate-Smart Agriculture, and how they manifest in the areas of specialisation in the ATIs. As shown in this

study, this is quite a specialised process in itself and it requires specialist research support with implications for the agricultural innovation system and how it is structured (ASSAf, 2017)

8.5.2 SOCIAL AND CULTURAL BACKGROUND OF STUDENTS

The social and cultural background of the students plays a role in curriculum innovation and curriculum development. There has been remarkable progress removing racial and gender disparities during the last 23 years. Policy and other support measures are geared to facilitate and enhance the access of students from previously disadvantaged communities and population groups. In 2008 100% of the students in Case Study One were black and 65% of the students in Case Study Two. At both colleges there are approximately an equal amount of male and female students. The knowledge-based background of the students themselves has changed. The students were traditionally from farming families and grew up on farms with the aim of becoming commercial farmers after their studies in Case Study Two (Section 7.3.2.4). At both colleges, in the past students would have matriculated from an agricultural school. Now most of the students do not have an agricultural background and have not studied at an agricultural school. Therefore, the students' knowledge base has also changed over the years. College students' knowledge base, social and cultural background plays a vital role in the development of the curricula. The knowledge and competencies that the students require to become successful after graduation are not the same knowledge and competencies that the students of 20 years ago required (Sections 6.3.2.4 and 7.3.2.4). The data (Section 7.3.2.3) indicates that only a small percentage of students wanted to become commercial farmers after training. Many students are considering working as extension officers, entrepreneurs, in research or other careers within DAFF (Section 7.3.2.3). Therefore, the curriculum and learning practices need to cater for these different aspirations of the students as well as the needs of the agricultural sector.

8.5.3 DEMANDS OF THE AGRICULTURE SECTOR, ENVIRONMENT AND ECONOMY

The focus of the agricultural sector has shifted away from commercial farming to the inclusion of small-holding farmers and homestead gardening. This has affected the way farmers and other members of the sector see farming. Challenges that the sector needs to overcome include racial disparities, climate change, food insecurity, water scarcity and unemployment (DAFF, 2010; READ, 2015b).

8.6 THE ROLE OF THE EXPANSIVE LEARNING DURING THE PROCESS OF INNOVATION WITHIN A STATE OF INSTITUTIONAL FLUX

Expansive learning plays an important role in supporting innovation within a system in perpetual state of flux (Mukute, 2010). During this study, the expansive learning process was adapted for the needs of the research participants. The questioning phase of the system allowed the workshop participants to ask what they wanted to achieve and change within the system. The questioning showed that the system required a shift in object, tools to help with the innovation process and a functional structured way to guide the innovation process and develop innovation plans (Sections 6.5 and 7.5). The expansive learning cycle through intervention-innovation workshops provided that functional structure to follow, as has also been modelled in other studies in southern Africa (Mukute, 2010; Pesanayi, 2016; Mukute & Lotz-Sisitka, 2012).

The Climate-Smart Innovation Tool was developed and used as a reflexive tool during the system analysis learning actions. The tool was also utilised as an analytical tool to observe the relationship between transformative learning and transformative agency (Lotz-Sisitka et al., 2016). Thus, the tool was not only used to support the expansive learning cycles, but also to track innovation and emergence of transformative agency. The analysis allowed the research participants to surface and examine the tensions and contradictions. The modelling of solutions gave the workshop participants the sense that they were acting on changing their system; even though it was known to be complex and difficult to achieve larger scale systemic change, there were some signs of change at the individual practice level.

As a system within institutional flux, the modelled solutions could not be instantaneously implemented as there are many mechanisms (structural, cultural and agentic) (Archer, 1995) that hamper the innovation process (see Section 8.4) with some of these also being enabling. The research participants were able to use their agentic powers to develop well-structured innovation plans and solutions in both case studies. The implementation of these plans did not occur as intended due to structural and institutional history and cultural factors which reflect the complex process of agentic action to which Archer referred (1995). The research participants could not progress within the expansive learning process to the next step of reflection and finally consolidation of the new practice (Sections 6.5 and 7.5). Thus, the expansive learning process was reflexively adjusted to allow the participants to innovate even

though learning actions 1-7 were not followed or completed. This is not unusual in complex transformation processes. Mukute (2010) showed in his research that modelled solutions are not always achieved the first time they are articulated (see also Engeström, 2016). The research participants analysed their system, examined the contradictions that they decided were most relevant to achieving their objective, modelled solutions, adjusted the innovation plans and assisted in the development of reflexive tools. In this way, even though change did not occur at a macro level as might have been expected, the participants still had the opportunity to enact their micro innovations and change the system within their own context in the time allocated. Mukute's (2010) research shows that this is nevertheless an important 'step' on the pathway to transformative agency and with continued support over longer periods of change, more complex forms of change can occur. The Eastern Cape Amanzi For Food case study, which is in its fourth year of operation, is beginning to show more substantive institution level impacts in terms of curriculum innovation and practice, all of which also started with the smaller steps found in this study's expansive learning process (Pesanayi, in press).

Thus, expansive learning processes allowed the research participants within a system of institutional flux to still analyse the system and model solutions. It allowed the research to focus on long-term change and micro innovations focussing on knowledge engagement, network building and tool development instead of focussing on institutional change at a macro level. It allowed the workshop participants to focus on what they could change, how they could develop their own competencies and how to work around the continuous changes that hamper productive macro innovations: Through the expansive learning cycles, the research indicated that the catalysing of the curriculum and learning system required specific tools, time and the understanding of the importance of micro-level innovation. Thus, in a state of flux, the support of the innovation process should focus on developing tools, provide enough time for developing and implementation of innovation plans at a micro-level as an important starting point for more macro-level changes that may occur over longer time periods. Lindley's (2014) expansive learning study showed how important it was to give attention to these micro-processes in expansive learning research as these tend to become catalytic towards more substantive changes.

8.7 THE SIGNIFICANT PROCESSES ASSOCIATED WITH THE DEVELOPMENT OF THE ABSTRACT CLIMATE-SMART AGRICULTURE CONCEPT INTO A CONCRETE CURRICULUM INCORPORATED APPROACH

In research, one must contemplate to what extent the data derived from the expansive learning cycles are sustainable and whether data could be regarded as usable knowledge and applicable to other systems during their transitioning process towards Climate-Smart responsiveness (Virkunnen & Newnham, 2013). To understand how the abstract concept of Climate-Smart Agriculture has embedded itself into the curriculum and learning system, the process of coming into being within the system needs to be considered.

The process of contextualising Climate-Smart Agriculture as a climate response tool was initiated through expansive learning cycles. There were, however, numerous barriers and challenges (Sections 8.4 and 8.5). The concept was adopted at provincial level and the colleges were expected to implement the concept as a climate response tool. However, there was no guidance on how to implement the policy or integrate Climate-Smart Agriculture into the system. The research participants had to develop their own way of learning and understanding of the concept. The case studies utilised and adopted Climate-Smart Agriculture to compensate for the absence within the system to make change possible. A policy implementation guide or tool was absent. The expansive learning process initiated by the colleges came into place in an attempt to implement Climate-Smart Agriculture into the system.

The routine actions of the research participants were to teach commercial farming. The imperative to include Climate-Smart Agriculture into the system at a policy, institutional, curriculum and learning practices level de-routinised the routine actions of the participants, which Archer (1995) would refer to as changing the cultural generative mechanisms in agency formation. The Climate-Smart Innovation Tool was developed and refined to assist in the innovation process (transformative change) allowing for transformation of cultural generative mechanisms such as 'routinisation' of practice, and agentive generative mechanisms such as lecturers' knowledge and values. Thus, the tool help to de-routinise the research

participants' actions towards Climate-Smart responsiveness and thus make the abstract concrete.

Research on resilience indicates that individuals play key roles in bringing about transformative change within a system (Westley, 2002; Folke, Hahn, Olsson & Norberg, 2005). This was also witnessed during this study. It was found that agency formation as described above via the expansive learning process played an important role in the innovation. When the research participants came together and discussed climate change responses and the integration of Climate-Smart Agriculture as a response tool, they exercised their agency in the conversation. This initiated the possibility for change. However, in the situation of flux, the research participants had much working against them, especially at the level of more deeply situated institutional and historically constituted structural factors, which are also known to impede, but not necessarily completely constrain agency for change (Archer, 1995; Mukute, 2010; Lindley, 2014).

The abstract concept of Climate-Smart Agriculture ascended into the system as a conceptual tool in different ways. Through initial mobilisation of this partially fragmented new scientific concept being promoted by policy, a new tool to address curriculum relevance in times of climate change was introduced. This catalysed an ongoing situated and critically reflexive engagement with an expanded range of proposals for addressing emerging contradictions, as well as expanded technical and social knowledge of the concept as reflected in previous chapters. As noted by Engeström, Nummijoki and Sannino (2012), the formation of concepts is often regarded as “primarily a textual and language bound process”. Engeström et al. (2012) explained that:

A theoretical concept is initially produced in the form of an abstract, simple explanatory relationship, a ‘germ cell’. This initial abstraction is step-by-step enriched and transformed into a concrete system of multiple, constantly developing and expanding manifestations. In other words, the initial simple idea is transformed into a complex new form of practice. (p. 2)

The change in policy and climate initiated the lecturers to think and change their routine actions based on the introduction of the concept of climate smart agriculture, which as reflected earlier, was initially a ‘foreign’ concept with little local relevance. The changes in action and reflexive understanding were supported by the use of the tool and via participation in its iterative refinements, resulting in transformatory action at the micro-level, as reported on above. Even though the research participants had little power due to institutional flux,

regulations and management structures, it was still possible for directed iterative change to cause systemic shifts through micro innovations. However, the micro innovations were not simply the product of a single individual de-routinisation, but were also part of a wider systemic shift through the supported innovation expansive learning process and tool development. The tool supported each individual to reflexively capacitate themselves and innovate their curriculum towards Climate-Smart Innovation. Through discussion, the micro innovation was discussed amongst participants to possibly generalise these innovations. Thus, from this it is possible to see that the Climate-Smart Innovation Tool was utilised as a reflexive, double stimulus, knowledge engagement tool providing information on Climate-Smart Agriculture, which allowed the concept to ascend into the system. Engeström et al. (2012) noted that concepts 'ascend' from the abstract to the concrete as they gradually become realised via and into practice. At the point of finalising this study, the concept is yet to be fully embedded at an institutional level, but through tool-supported micro innovations, the concept is slowly being adopted and is no longer seen as a foreign non-relevant concept, but rather one that requires ongoing engagement.

8.8 SUMMARY OF FINDINGS

This study was centred on supported Climate-Smart curriculum innovation and how this articulates within a provincial system of responsive climate change innovations. The reductive narrative of education as a rational objective giving effect to change was accompanied by the ideal of innovations giving effect to change that could be measure empirically. Here follows a summary of the research findings discussed in Sections 8.1 to 8.7 derived from the data documented in Chapters Four to Seven. Findings across the study presented in Section 8.8 are clustered into two main categories namely, tool-based findings and expansive learning based innovations.

8.8.1 SYSTEMIC FORMATIVE INTERVENTION PROCESS

As indicated in earlier chapters, the study was supported by the systems thinking and systems innovation process model. Significant to this study's findings is that the recent Academy of Science South Africa (ASSAf, 2017) study – which is a nationally strategic study developed via the Department of Science and Technology to review the direction of agricultural education and training in the country – also makes strong recommendations to locate agricultural education change within an agricultural systems innovation perspective.

During the research the Agricultural Colleges were seen as part of the Agricultural Innovation System driving towards becoming a Climate-Smart responsive system (Figure 1.1). ASSAf (2017) noted the importance of education and research in the innovation system and also recommended adoption of a farmer-centred approach to innovation. As noted earlier, READ included Climate-Smart Agriculture as a responsive tool to reduce the problems of climate change within the North West Province Agricultural Innovation System. As shown in this study, this kind of systems thinking and the inclusion of Climate-Smart Agriculture as a responsive tool can produce innovative solutions. However, systems thinking can be an ideology that policy makers, researchers and agricultural scientists can visualise but the ideal might not work in practice nor produce the justice and sustainability that the nation needs, hence the need for engaged expansive learning, deliberation and 'sense making' around such idealistic concepts as put forward in policy and scientific thought. Popkewitz (2017) has traced how systemic technologies came to be expressed in benchmarking systems as models of process for innovation. Here, referring to benchmarking measures in education systems (of which agricultural innovation systems discourse could be one) Popkewitz (2017, p. 1) noted:

The promise of a better future is tied to standards expressed in the benchmarks. "Benchmarks" are the technologies to optimise the qualities and characteristics for the nation to function efficiently and achieve prosperity. The elixir to actualise the promise is number that provide the true, efficient and effective empirical evidence to chart national change. The salvation themes of the future, however, are a particular kind of utopic thought: they embody cultural principles about people and society as a collective space of belonging that the benchmarks and empirical evidence enable for the future.

As Popkewitz explained, the benchmarks placed within the Agricultural Innovation System included the Climate-Smart Agriculture approach. It was expected that the agents, as part of the institute (society) within the system, would utilise Climate-Smart Agriculture to become climate responsive. As noted earlier, it seems that micro innovation was more likely within the system than institutional changes and, as shown in this research, this process also required substantive support and ongoing reflexive engagement. Thus, while people are part of society and idealistically framed concepts are part of this reality (e.g. Climate-Smart Agriculture within an Agricultural Innovation System), there is need for people to also initiate their own individual innovations within the system to make sense of these wider concepts and benchmarks referred to by Popkewitz. Archer (2007) rightly suggested that structures cannot be reflexive per se, as reflexivity is a property of humans not structure. Even though the Climate-Smart Innovation Tool supported the research participants during the curriculum

innovation process, it was the gradual learning, reflexivity and emergent agency of the research participants that made the innovation begin to happen or be realised in practice. In a discussion on the attributes of people and structural systems of education, she noted:

... just as no system can possess the reflexivity, intentionality and commitment of the agents whose actions first produced and then continuously sustain these forms of state education. (Archer, 2007, p. 38)

While this is important to realise (i.e. the power of the individual agent), it is also important to note Agbedahin's (2016, p. 178) finding which emerged from a large study focussing on academics in institutions of Higher Education (using similar reflexive tools for change as those produced for this study). She noted:

The whole institutional change cannot depend on individual participants and co-participants. ... Participants without concrete and continuous institutional support struggle alone when they get back to their institution and sometimes give up.

From this, it is evident that innovations are linked to individual agents, but without the necessary support from the institution and society, innovation becomes less likely to be initiated and sustained. Thus, during a system of flux, the agents end up with systems that are supposed to work but do not necessarily function optimally to support the changes that are required for system-based changes. Within the system of flux, supportive structures are not always in place to support the individuals (agents) to realise their ambitions or commitment to innovative processes as was also shown to be the case in part in this study. This study showed that changes in management, policies and division of labour can cause a state of flux that decreases the structural support the agents within the system require for innovative action (transformation). The nexus of people in/and social systems has raised questions related to the complex intermeshing of 'structure and agency' that has been a longstanding contention in the contemporary social sciences. Both are clearly at play in society where, according to Archer (2007, p. 38) "we the people shape it, whilst it re-shapes us as we go about it or maintain it, individually and collectively", a point also made clear in Agbedahin's study (2016) which focussed in on the importance of fully understanding the 'position-practice' system that influences individual agents of change in higher education institutions.

Ahier, Beck and Moore (2003) theorised that with the advent of complex risk and with an attendant redrawing of existing bounded practices to resolve this, modernity has become reflexive. The emergence of the reflexive changes that Ahier et al. (2003) have identified

might best be read as hopeful illustrations that humans, working reflexively within prevailing social structures, are seemingly able to effect evaluative critical work and initiate change within learning environments that have become better to support participants to enact reflexive change. As noted in Agbedahin's (2016) study, and as also repeatedly called for in this study by participants, professional learning opportunities, as well as supportive structural conditions, are crucial for supporting this change process over time.

It is evident that to initiate institutional change, the agents need to be supported by the management and other supporting institutes in striving towards change. Through the analysis of the data, it has become clear that better support is required for Climate-Smart innovation processes within the curriculum and learning system during a time of institutional flux. It is concluded that the catalysing of the curriculum and learning system required specific tools, time and the understanding of the importance of micro innovations. Thus, even though the systems thinking approach is a functional framework to support innovation, the agents (individuals) within the system also need to be focused on and supported in order for innovation to occur. Section 8.10 recommends ways to support innovation within a system of flux.

8.8.2 REFLEXIVE TOOL TO REVIEW, SUPPORT AND TRACK CURRICULUM INNOVATIONS

One of the objectives of the study was to develop a reflexive tool that could review, support and track curriculum innovations. Presently, there are no Climate-Smart Agriculture assessment tools that can be compared, thus other institutional assessment tools for sustainability in higher education were used for comparison as reported in Section 3.3.1 (especially Phase 2.2) and Section 4.7 (also see Lotz-Sisitka et al., 2015; Yarime & Tanaka, 2012; Shriber, 2012). It is from this platform that I adapted and co-created the Climate Smart Agriculture curriculum innovation tool for this study. Shriber (2002) stated that ideal assessment tools identify the most important attributes of an institute's sustainability, are calculable and comparable, can measure more aspects than only eco-efficiency, assess processes and motivations and are comprehensible multiple stakeholders. Yarime and Tanaka (2012) completed a study on 16 Sustainability Assessment Tools for Higher Education Institutes (USAT tool was not amongst these tools). Their findings included:

The sustainability assessment tools reviewed focus mainly on the environmental impacts of university operation and issues related to governance. Aspects of education, research and outreach activities are not well addressed by these tools. As activities for sustainability at higher education institutions increasingly involve inter-/trans-disciplinary cooperation and close collaboration with diverse stakeholders in society, it will be of

critical importance to develop and implement concepts and methodologies for conducting comprehensive, long-term and integrated assessment of research, education and outreach on sustainability at higher education institutions. (p. 1)

The Climate-Smart Innovation Tool does not only focus on the operation and governance (Section C of the tool, see Appendix 4.1), but Section A mainly focusses on education, research, student awareness and community engagement, modelled from the USAT tool which was specifically developed for use in African Higher Education institutions in response to a lack of systemic engagement in curriculum innovations for sustainability (Togo, 2009; Togo & Lotz-Sisitka, 2009). Togo (2015) reported using the USAT tool in 35 countries in Africa and Asia and noted that the in-built flexibility of the tool, as well as its adaptability for specific purposes are strengths that allow for local level reflexivity and adapted use of the tool. She remarked that the tool was particularly successful in allowing participants to identify 'change projects' that were of relevance to their institutional development pathways, as was also found to be the case in this study, where I adapted the USAT tool substantially to suit the agricultural education context and the focus on Climate-Smart Agriculture. As reported in this study, very specific adaptations of the tool were called for to accommodate differences in practice and agricultural focus, which also facilitated further reflexivity and professional learning.

Thus, during this study, it became clear that not only should a reflexive tool that reviews the Climate-Smart responsiveness of a higher education institute be based on the relevant concepts and policies, it should also include a methodology and process for conducting comprehensive reviews of all aspects of the curriculum and learning system. This study also showed the importance of supporting use of the tool via ongoing reflexive and participatory iterations in which the tool can be refined for improved use. For the tool data to be successfully used as reflexive "mirror data" it has to be subjective and not only based on the reviewer's (assessor's) opinion; it must therefore be mainly 'indicative' and not overly prescriptive, especially when it comes to interpretation of the tool's results. This is important for maintaining open-ended engagements with the results of the tool within the overall reflexive learning process. As shown in this study, for the tool to be functional and user-friendly it has to be developed in co-operation with the reviewers, in this case, the research participants who were College teaching and management staff. Through the suggestions of the research participants or agents, the tool was developed to not only provide direct feedback (online), but also to function as an access point to related knowledge that can

support micro innovation of teaching and management staff. The potential exists to further develop the tool with students, especially to support their reflexive participation in practice-based learning, as was done by Currie (2015) at the Nelson Mandela University, a process which catalysed significant practical engagement by students in sustainability activities on their campus, helping to improve the wider institutional culture for sustainability related programme implementation.

8.8.3 THE EMERGENCE OF CLIMATE-SMART AGRICULTURE AS A RESPONSIVE TOOL FOR CLIMATE CHANGE

As shown in this study, Climate-Smart Agriculture has only recently been introduced into the Agricultural Innovation System i.e. for a very short period, since 2015. It is therefore not surprising that significant Climate-Smart Agriculture absences within the system were identified. These absences included the absence of policy alignment and implementation, the absence of climate change responses, the absence of institutional stability and structure, the absence of climate responsive knowledge, the absence of time to conduct sufficient practical sessions with the students amongst others. Absence is, according to Bhaskar (1993) the 'great loosener' as it can help to identify pathways to transformative agency and praxis. Thus, identifying such absences can be a positive movement for change, especially if processes are put in place to 'absent the absences' (Lotz-Sisitka et al., 2016) via expansive learning processes as was the case in this study. Cultural Historical Activity Theory and expansive learning is a dialectical theory of learning which engages people in confronting contradictions. In a related climate change response study in the agricultural sector in Mozambique, focussing on community-based irrigation system management processes and expansive learning, Baloi (2017) argued that Cultural Historical Activity Theory can be strengthened with a focus on absence and expansive learning can be oriented towards 'absenting the absences'. Mukute (2016), Baloi (2016) and Pesanayi (2016) all argued that giving attention to absenting absences in Cultural Historical Activity Theory can enhance the transformative agency potential of the expansive learning process as it helps participants to articulate the directionality of the transformative agency pathways they are on and to reflexively review their agency development on such pathways. This study has 'opened' the space for such expansive learning pathways to emerge in the agricultural education and training system in South Africa, as part of the wider system of agricultural innovation which is also envisaged by policy makers (e.g. DAFF, 2010, 2013a, 2013b, 2015a, 2015b) and ASSAf (2017) for this

system. As noted in Chapter One (Section 1.6.1) and Chapter Two (Section 2.3), climate change is a critical issue that needs to be confronted in the agricultural sector, and as shown in this study, the Agricultural Training Institutes are only recently beginning to confront the implications of this and their role within this system. Further clarification of these absences can therefore potentially help to make the transformative agency pathways that are necessary more visible and clear within the system.

As shown in this study, the Climate-Smart Agriculture approach can be used as a functional response to climate change and can help to lead engagement with the absences identified above. As the approach covers all the components and aspects of the Agricultural Innovation System it can potentially be adopted and adapted into the system as shown in this study. This study also indicated that the approach is not too complex to understand and participants showed a willingness to engage with the approach once the initial introduction was completed. The Climate-Smart Innovation Tool was shown to be a useful tool for surfacing contradictions and identifying absences and thus for charting out the start of reflexive learning and change processes that are needed to support the incorporation of climate responsive knowledge into the system.

8.9 REFLECTIONS ON THE RESEARCH PROCESS

8.9.1 THEORETICAL AND METHODOLOGICAL FRAMEWORK

The theoretical framework supported the systems orientated review of Climate-Smart innovation through the process of reviewing two cases of Climate-Smart Innovation by using the systems view of Cultural Historical Activity Theory. As the study's focus developed towards reflexive change within the system, a lens to study the transformative change was required. Cultural Historical Activity Theory's ability to identify and analyse the historical and cultural aspects of a system resonates with Margaret Archer's morphogenetic realist social theory's concern with identifying underlying causal mechanisms that shape agency formation. Margaret Archer's work provided a lens of transformative change through which the analysis of agency led change that the research participants were involved with and the problem of a situation of flux could be framed and discussed. Cultural Historical Activity Theory also helped to illuminate how concepts 'ascend' from the abstract to the concrete, as also modelled through the work in this study, helping to address Popkewitz's caution that idealistic concepts

or 'benchmarks' can be impositional in an education and training system if not accompanied by practical realisation of these. This study has charted out a pathway for this realisation of abstract concepts into curriculum innovation, which as argued in Section 8.7 , is a crucial dimension of the wider Agricultural Innovation System and its responsiveness to climate change risk.

As reflected above, the methodology developed for the study was an iterative process of supportive intervention, therefore the research design had to be aligned with this process. This led to the contradictions being articulated via a co-learning process through reflexive activity system analysis, which was accompanied by supportive intervention work which was also a professional / expansive learning process that supported participants to come to understand aspects of the concept of Climate-Smart Agriculture, especially how it related to their curriculum praxis. The methodological approach provided a useful systems approach to analyse the interrelationships and components within the system (Davydov, 1999; Engeström, 1987), including the educational activity system which is situated within the wider Agricultural Innovation System. The expansive learning cycle provided the research participants with a structured way to model and begin to implement their innovation plan (Sections 3.3.1 and 3.2.2).

8.9.2 CLIMATE-SMART AGRICULTURE INNOVATION TOOL

The Climate-Smart Innovation Tool was developed as a subjective, indicative tool as the score analysis is based on the opinion of the assessor. Its main purpose is to facilitate reflexivity and learning, not to provide a positivistic assessment of practice, hence the importance of maintaining the 'indicative' focus in the analytical work where the tool is applied. It provides an ***indicative picture*** of the Climate-Smart responsiveness of a department or individual and not a definite analysis. The limitations of the tool included that it was primarily developed for the North West Province, however most of the topics are relevant to other institutes. The next step would to adjust the tool to cater for all the colleges of agriculture and Agricultural Training Institutes within South Africa. As shown in this research, this requires adaptive engagement with participants, and in the agricultural sector, it also requires engagement with scientific understanding of the implications of climate change for particular agricultural streams and areas of practice given the agro-ecological dynamics of climate change impact in the agricultural sector. It is therefore not an easily 'generalisable' tool, but

the process of adapting the tool to local context and circumstance with participants is possible, as demonstrated in this study. Presently, the tool is also not freely available on the web, thus making the tool available for everyone to use is also a crucial next step. This will, however, need to be done with careful guidance on the importance of local adaptation to the agro-ecological dynamics of climate change in diverse agro-ecological zones and for diverse production streams, levels of agriculture and more. One of the positive aspects of the tool is that through the completion of the tool, the researcher is able to develop a data base of the individuals completing the tool and initial results can be stored for later comparative work and monitoring of progress over time. Thus, via the contact database, the researcher can contact the individuals to inquire about what type of support the individual requires to initiate Climate-Smart integration, thus developing the learning network. The results can also be made available for comparative analysis, or for ongoing evaluation, as Currie (2015) did with the students at Nelson Mandela University (they used the tool annually to review their progress). There is thus significant opportunity to further develop and expand the use of the tool that was developed and pilot tested in this study.

8.9.3 CONTRIBUTIONS

This study was embedded in the Amanzi For Food project that focused on knowledge engagement and expansive learning through network building and helped to consolidate a useful system of context responsive curriculum review that broadens the initial focus of the Amanzi for Food programme into Climate-Smart Agriculture. The study provided a detailed account of the process of integration and innovation of Climate-Smart Agriculture within the provincial system and within the two cases of tool mediated and intervention workshop supported innovation. The study also provided formative insights into the functioning of the curriculum and learning system during a process of supported and enabling curriculum innovation. During the study, the barriers of innovation arose and the effects of the perpetual state of flux within the system also arose. Through the research process, a tool to support and track innovation was developed that enabled the research participants to think about things, recognise, assess value and take action on a micro level. The study opens up a new understanding of how difficult change is in a state of flux and that more supportive measures and tools need to be developed to initiate and support long-term change.

8.9.4 LIMITATIONS

The study had many obstacles and challenges that in the end enabled a deepening of the understanding of the study and developed the research process. The expansive learning processes were not completed as expected due to barriers and challenges (Section 8.4, see also Sections 6.5 and 7.5). These were also to be expected given the ‘newness’ of the concept of Climate-Smart Agriculture in the system and the current state of flux of agricultural education and training in South Africa, as also critically analysed and reported on by the ASSAf study on the sector (2017). However, as shown across the study, the research participants were able to, at least to some extent, adjust to these challenges and progress was initiated via their agentive willingness to learn and engage. This was not without difficulty, as has already been mentioned, especially as there was significant change within the colleges and amongst research participants that moved to other institutions, including at management level. The constant need to re-introduce the study in such a context of flux made it difficult to keep the study on track. With all the changes within the system, it was difficult to initiate innovation and it is clear that more time is needed to produce more substantive results, especially at the level of substantive institutional change. With the ASSAf (2017) study now released into the South African Agricultural Education and Training system and with wider moves towards strengthening the stability and focus of the Agricultural Training Institutes in the country, this might become an easier task. The study also only focused on the two Colleges of Agriculture in the North West Province. Inclusion of the department and other components within the Agricultural System might have provided a better understanding of the system and how to initiate change. There is therefore potential to expand this aspect of the study too, along with more engagement with students, as well as farmers. The ASSAf (2017) study recommended a farmer-centred approach to agricultural system innovation and this could also potentially add more impetus to the movement for change that this study sought to support.

8.10 RECOMMENDATIONS FOR SUPPORTING AND ENABLING CURRICULUM INNOVATION IN SYSTEM’S CURRICULUM AND LEARNING PRACTICES

8.10.1 TOOL-BASED RECOMMENDATIONS

It is clear that tools such as the Climate-Smart Innovation Tool can influence incentives and innovation practices of higher agricultural education institutions by encouraging them to move

towards Climate-Smart responsiveness. There are not many of these tools available that can support curriculum innovation within the Agricultural Colleges within South Africa.

DEVELOPMENT OF A NATIONAL TOOL

The innovation tool should be adapted to integrate structured climate responsive concepts, policies and methodologies to conduct comprehensive, long-term and integrated reviews of the Climate-Smart responsiveness of the agricultural curricula. It is important to further develop and expand the use of the adapted Climate-Smart Innovation Tool or a similar curriculum innovation tool to a national level and to develop a data base of the individuals completing the tool. The contact database can then be used as a means to enquire and identify the needs of each participating individual and agricultural teaching staff member to initiate Climate-Smart responsiveness. The tool data can also be used for comparative analysis and ongoing evaluation to develop a clearer understanding of how to support individual micro innovations that lead to institutional change.

FURTHER DEVELOPMENT OF TOOL WITHIN AGRICULTURAL TRAINING INSTITUTES (AGRICULTURAL COLLEGES)

The tool needs to be further developed with the students to support their reflexive participation in practice-based learning. The student engaged tool could be used to catalyse significant practical engagements by the students in Climate-Smart Agriculture related practices and activities. The adapted student tool can support student engagement with the Agricultural College teaching staff and community, thus establishing learning networks and also strengthening the communication between students and teaching staff.

College staff should utilise the tool to identify the absences of the system including the absence of policy alignment and implementation (see Section 8.8.3). The focus on `absenting the absences` can enhance the transformative agency potential of the expansive learning process and help participants to articulate the directionality of the transformative agency pathways and to reflexively review agency development on such pathways. The tool should be used to identify `change projects` within the system and thus can shed light on how innovation can occur within the system.

DEVELOPMENT OF A TOOL TO SUPPORT POLICY BASED INNOVATION

The agricultural college curricula do not reflect the change in policy, agricultural vision and mission of DAFF. Resources are needed to ensure that policies are integrated and curriculum change is undertaken. There is no tool or support system to indicate to the Agricultural Training Institutes how and what needs to be implemented to research climate responsiveness. There is no tool based on the strategic plan to integrate Climate-Smart Agriculture into the provincial system. Developing a tool to translate the relevant policies into practices would increase the responsiveness to initiate change of the colleges. The policy translating tool would be able to assist the colleges to understand what concepts need urgent attention and what suggested pathways can be taken to integrate these concepts into practice. The tool will enable policy-based innovation.

8.10.2 RECOMMENDATION TO IMPROVE COORDINATION WITHIN THE AGRICULTURAL INNOVATION SYSTEM TOWARDS CLIMATE-SMART RESPONSIVENESS AND CURRICULUM INNOVATION

DEVELOPING A LEARNING NETWORK AND INNOVATION SUPPORT SYSTEM

The colleges are in the process of shifting to the Department of Higher Education and out of direct communication with DAFF. This will have an effect on the coordination and articulation between the Agricultural System and agricultural curriculum and learning systems. To provide a better understanding of the system and how to initiate change, the Department and other components within the Agricultural Innovation System need to be included in further network building and transformative change processes. Specific links of communication should be developed to make sure that alignment and articulation between these systems are functioning. Time should be invested in developing farmer-centred learning networks within the system that aim to understand the system and identify how change can be initiated. These networks should provide the foundation of support for the Agricultural Training Institutes to train farmers. The learning networks should not only focus on specialised knowledge dissemination of relevant local farming practices, but also address issues such as climate change and Climate-Smart Agriculture.

SUPPORTING THE TRANSLATION OF POLICY AND SCIENTIFIC THOUGHT

The introduction of new policies, new scientific research or agricultural practices can be seen as abstract concepts. In order for the Agricultural Training Colleges to understand and integrate new concepts, practices or policies into the curriculum and system, support is required. Through engagement in expansive learning supported by reflexive and knowledge engaging tools, contextualisation of the abstract can occur and innovation can be initiated. Ways to support the Agricultural Training Colleges during the time of integration and innovation is important and support should be provided by the management and other supporting research institutes.

8.10.3 RECOMMENDATION FOR THE AGRICULTURAL TRAINING INSTITUTES

DEVELOPMENT OF MICRO INNOVATIONS

The research showed that implementing innovation plans at a micro-level is an important starting point for more macro-level changes that can occur over time. Better support should be provided to the Agricultural training and teaching staff to enable them to initiate Climate-Smart innovation within the system. To train staff to be successful in initiating innovations, they need to be fully informed, educated, supported by reflexive tools, management and other components of the Agricultural Innovation System. Training of staff requires special professional development programmes especially in new areas of study including Climate-Smart Agriculture approach, sustainable agriculture and climate change. The training of staff also requires specialist research support to capacitate them during the transformation towards Climate-Smart responsiveness and sector curriculum alignment. To support teaching staff initiated micro innovations, the focus should be on knowledge engagement, network building and tool development within the system. By introducing 'change projects', agricultural teaching staff could further develop themselves and initiate change.

Support of college staff to design, develop and produce new Climate-Smart responsive content for the curriculum and the corresponding teaching and learning practices is important. The training of the lecturers, farm manager and curriculum developers can ensure that they are comfortable with the new material and have the confidence to engage in knowledge sharing and training of students. Lecturers and other staff require training to assist in the understanding of climate change and the importance of the integration of Climate-Smart

Agriculture into the system. To develop a course activated social network will deepen the possibilities towards transformation and initiating climate responsive practices. The course based intervention change project approach allows each participant to work on his or her own specific area and aspects to initiate change. College staff will also benefit from training on how to plan and implement practical skills programmes. This can ensure that staff and students that are not accustomed to practical training sessions can be adequately orientated. This would not only develop the practical training competencies of the staff, but also capacitate them to plan the practical sessions more effectively.

POLICY INTEGRATION

It is recommended that the agriculture curriculum should adjust and become more responsive to policy and agricultural challenges. The focus needs to shift from commercial farming and include policy aligned topics namely small-holder farming, food security, rural livelihood and Climate-Smart Agriculture. A tool developed to translate the required policies, for example the Agricultural Education and Training Strategy, into an implementable concept can help to develop articulation and alignment between policy and practice.

INTEGRATION OF CLIMATE-SMART AGRICULTURE INTO THE FORMAL CURRICULA

The curriculum content, teaching materials and methods of delivery need to be designed in such a way as to strive towards Climate-Smart responsive objectives. The integration should not be focused on the diploma but focused on individual subject-based change. The process of integration can be supported by including the Climate-Smart Innovation tool as part of staff, management and campus annual review. The integration of Climate-Smart Agriculture needs to be on a practical level, for example, teaching garden strategies to show students the practical application of Climate-Smart practices.

CURRICULUM RESPONSIVE TO STUDENT ASPIRATIONS

As noted during the research, many complications arose around the students' aspirations of the agricultural programme. A compulsory weekend for future students where they are provided with career guidance, conduct practical agricultural tasks and write an entry essay or test could ensure that the students that attend the colleges are competent and interested in the course. Training the lecturers and farm managers to ensure that practical sessions are

planned and implemented effectively can ensure that they can compensate for the students that are unaccustomed to practical skills training.

EXPANDING THE TIME FRAME OF INNOVATION

Expansive learning can expand in different ways and it is recommended that expansive learning cycles should expand in the social-spatial dimension by establishing a learning network within the surrounding communities. The extension of a time perspective of the study will also be beneficial. By expanding the time frame of the expansive learning, the impact of the newly emerged contradictions and findings can be established.

8.11 FUTURE RESEARCH

A course activated social network building to initiate transformation is the next step towards understanding the system and the practices required to initiate successful change. This process will be researched and closely monitored to find ways to stabilise the system or innovate within a system of flux. In addition, the possibility needs to be researched of developing innovative supporting online tools that can translate agricultural and environmental policies into practical concepts that can be translated into practice within the Agricultural Training Institutes.

The dimensioning of the processes of flux inhibiting both local curriculum innovation using the Climate-Smart tools and the functioning within the concepts of an innovation system for responses to the emergent dimensions of climate change also needs further investigation.

REFERENCES

- Academy of Science of South Africa (ASSAf). (2017). *Revitalising Agricultural Education and Training in South Africa. Consensus Study*. Academy of Science of South Africa.
- Acha, G. B. (2014). *Problems faced by small-scale farmers in Taung irrigation scheme in the North West province, South Africa*. Unpublished Masters thesis (Social Science), North-West University, Mafikeng.
- Action Aid International. (2017). Climate-Smart concerns. Retrieved June 12, 2016, from <http://www.climatesmartagconcerns.info/>
- Aerni, P., Nichterlein K., Rudgard S., & Sannino, A. (2015). Making Agricultural Innovation Systems (AIS) work for Development in Tropical Countries. *Sustainability* 7(1). 831-850. doi: 10.3390/su7010831
- AFC Conference. (2013) *The Third Global Conference on Agriculture, Food, nutrition security and climate change*. Retrieved June 1, 2017, from <http://afconference.agric.za>
- Africa Research Institute. (2013). *Waiting for the Green Revolution Land Reform in South Africa*. Briefing Note 1301, May 2013.
- Agbedahin, A. V. (2016). *A morphogenic and laminated system explanation of position-practice systems and professional development training in mainstreaming education for sustainable development in African Universities*. Unpublished PhD thesis, Rhodes University, Grahamstown.
- Agenbach, D. J. (1972). *The Agricultural Colleges in RSA*. Department of Agriculture and Marine Development.
- Agricor. 1978-1990. Annual Reports, Agricor, Mmabatho.
- AgriSETA. (2010). *Sector analysis: Agriculture*. Prepared for submission to the Department of Higher Education and Training. June 2010
- AgriSETA. (2014). *Agricultural Sector Skills Plan 2011-2016*. September 2014. Update.
- AgriSETA. (2016). *Agricultural Sector Skills Plan 2017-2018*. Prepared on behalf of the Sector by AgriSETA for submission to the Department of Higher Education and Training.
- Ahier, J., Beck, J., & Moore, R. (2003). *Graduate citizens? Issues of citizenship and higher education*. London: Routledge/Falmer.
- ARC. (2014). History of the ARC-ISCW. Retrieved November 29, 2016 from <http://www.arc.agri.za/arc-iscw/Pages/History-of-ARC-ISCW.aspx>
- ARC. (2016). Media release: *Agricultural Research Council celebrates Earth Day 2016, remains focused on Climate Smart Agriculture Research*. Retrieved June 1, 2017 from <http://www.arc.agric.za/arc-gci/Press%20Release%20Library/Agricultural%20Research%20Council%20celebrates%20Earth%20Day%202016,%20remains%20focused%20on%20Climate%20Smart%20Agricultural%20Research.pdf>
- Archer, M. (1995). *Realist social theory: The morphogenetic approach*. Cambridge: Cambridge University Press.

- Archer, M. (2007). The trajectory of thy morphogenetic approach: An account in the first-person. *Sociologia. Problemas e Praticas*, 54, 35-47.
- Baloi, A. (2017). *Exploring transformative social learning and sustainability in community based irrigation scheme context in Mozambique*. Unpublished PhD thesis, Rhodes University, Grahamstown.
- Banathy, B. (1992). *A systems view of education: Concepts and principles for effective practice*. New Jersey: Englewood Cliffs.
- Bapela, M. & Mariba, W. (2002). *Provincial report on education and training for agriculture and rural development in the North West Province*. North-West Department of Agriculture.
- Bean, R. & Radford, R. W. (2002). *The business of innovation: Managing the corporate imagination for maximum results*. New York: AMACOM.
- Beddington, J., Asaduzzaman, M., Fernandez, A., Clark, M., Guillou, M., Jahn, M., ... Wakhungu, J. (2011). *Achieving food security in the face of climate change: Summary for policy makers*. Commission on Sustainable Agriculture and Climate Change. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark. Retrieved June 1, 2017, from www.ccafs.cgiar.org/commission
- Bembridge, T. J., Graven, E. H., Hough, M. A. & Van Rooyen, C. J. (1982). *An evaluation of the Sheila and Mooifontein projects, Ditsobotla district, Bophuthatswana*. Fort Hare: ADRI.
- Benhin, J. K. S. & Hassan, R. (2006). *Climate change and South Africa agriculture. A Ricardian analysis of the impacts and adaptation options (preliminary results)*.
- Bureau for Food and Agricultural Policy (BFAP). (2015). *Baseline Agricultural Outlook 2015 – 2024. Navigating policy and strategies in a turbulent world economy*. Bureau for Food and Agricultural Policy.
- Bhaskar, R. (1993). *Dialectic: The pulse of freedom*. London: Verso.
- Biowatch South Africa. (2015). *Fact Sheet: CSA and why we say NO!* Retrieved December 6, 2016, from http://www.biowatch.org.za/docs/fs/2015/Biowatch_Fact_Sheet_CSA_web.pdf
- Blignaut, J., Ueckermann, L., & Aronson, J. (2009). Production's sensitivity to changes in climate in South Africa. *South African Journal of Science*, 105, 61-68.
- Bodker, S. (1991). Activity theory as a challenge to systems design. In H.E. Nissen, H.K. Klein, & R. Hirschheim (Eds.), *Information systems research: Contemporary approaches and emergent traditions*. Amsterdam: Elsevier.
- Bonneau, C. (2013). *Contradictions and their concrete manifestations: an activity-theoretical analysis of the intra-organizational*. Conference Paper, July 2013. Retrieved December 10, 2017 from <https://www.researchgate.net/publication/261097312>
- Chakeredza, S., Temu, A. B., Sak, J. D. K., Munthali, D. C., Muir-Leresche, K., Akinnifesi, F.K., ... Sileshi, G. (2008). Tailoring tertiary agricultural education for sustainable development in Sub-Saharan Africa: Opportunities and Challenges. *Scientific Research* 3(8), 326-332.

- Chakeredza S., Temu, A.B., Yaye, A., Mukingwa, S., & Saka, J.D.K. 2009. *Mainstreaming Climate Change into Agricultural Education: Challenges and Perspectives*. ICRAF Working Paper no. 82. Nairobi, Kenya: World Agroforestry Centre.
- Chaminuka, P., Lalendle, L. L., Nompozolo, S., Viljoen, M., Ceballos-Müller, J., & Brouwersjham, J. (2016). *Transformation through institutional peering - Agricultural Training Institutes learning from each other*. Experiences from a Dutch-South African partnership. Report CDI-16-007 February 2016. Wageningen: Centre for Development Innovation, Wageningen University and Research Centre.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London: Routledge.
- Coleman, A. (2010). False armyworm responsible for up to 50% losses of the barley harvest. *Farmer's Weekly*. 9 December, 2010. Retrieved December 10, 2017, from <https://www.farmersweekly.co.za/archive/false-armyworm-responsible-for-up-to-50-losses-of-the-barley-harvest/>
- Cowling, R. M., Richardson, D. M., & Pierce, S. M. (2004). *Vegetation of Southern Africa*. Cambridge: Cambridge University Press.
- Currie, B. (2015). Nelson Mandela Metropolitan University George Campus Student Mobilisation Change Project (Chapter 8). In H. Lotz-Sisitka H., A. Hlengwa, M. Ward, A. Salami, A. Ogbuigwe, M. Pradhan, ... M., S. Lauriks (Eds.) *Mainstreaming Environment and Sustainability in African Universities: Stories of change*. Grahamstown: Rhodes University Environmental Learning Research Centre.
- Davydov, E. E. (1999). *The content and unsolved problems of activity theory*. In Y. Engeström., R. Miettinen & R. Punamäki (Eds.). *Perspectives on Activity Theory* (pp. 39-52). Cambridge: Cambridge University Press.
- Department of Agriculture (DoA). (1957). *'n jaar in die Hoëveldstreek 1956-57*. Pretoria: Die staatsdrukker.
- Department of Agriculture (DoA). (1972). *Prospektus van die tweejaardiplomakursus aan die Landboukollege en proefplaas Potchefstroom Transvaal*. Departement van Landbou – Hoëveldstreek.
- Department of Agriculture (DoA). (1994). *Taung Agricultural College Amendment Act No. 16 of 1994* Retrieved April 25, 2017, from [file:///C:/Users/Wildstes/Downloads/02022011201120112011080405act16of94%20\(1\).pdf](file:///C:/Users/Wildstes/Downloads/02022011201120112011080405act16of94%20(1).pdf)
- Department of Agriculture (DoA). (1995). *White Paper on Agriculture*.
- Department of Agriculture (DoA). (2005a). *Norms and Standards for Extension and Advisory Services in Agriculture* Directorate: Scientific Research and Development, ed., Directorate: Agricultural Information Services. Retrieved June 1, 2016 from http://www.nda.agric.za/doaDev/sideMenu/NationalExtensionSupport/docs/NORMS_A_ND_STANDARD_BOOKLET.pdf.
- Department of Agriculture (DoA). (2005b). *AET Strategy - National Education and Training Strategy for Agriculture and Rural Development in South Africa*.
- Department of Agriculture (DoA). (2007). *Terms of Reference for the Appointment of a Service Provider to Develop an Analysis Report on Agricultural Education and Training Barriers: A Document to Service Providers*.

- Department of Agriculture (DoA). (2008). *National Agricultural Research and Development Strategy 2008*. Retrieved June 1, 2016 from http://www.nda.agric.za/docs/Policy/Research_and_Development_Strategy.pdf
- Department of Agriculture (DoA). (2010). *Land Redistribution for Agricultural Development LRAD*. Retrieved June 6, 2015, from http://www.nda.agric.za/docs/GenPub/LRAD_E.htm
- Department of Agriculture, Conservation, Environment and Rural Development (DACERD). (2009). *Education, Training and development policy for the Department of Agriculture, Conservation, Environment and Rural Development*. Retrieved September 5, 2017 from <http://www.nwpg.gov.za/Agriculture/nwdace%20docs/Education,%20Training%20and%20Development%20Policy.pdf>
- Department of Agriculture and Fisheries (DAF). 2008. *Evaluation of agricultural education and training curricula in South Africa*. Republic of South Africa.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2010). *Agricultural Education and Training Access Barriers Report*.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2012). *Strategic Plan for Department of Agriculture, Forestry and Fisheries 2012/2013 to 2016/2017*.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2013a). Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries. *Government Gazette*, 9 January (36063), 3-22.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2013b). Department of Agriculture, Forestry and Fisheries, *Presentation of Colleges of Agriculture* to the Technical Implementation Forum at DHET, 24 January 2013.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2013c). *Strategic Plan for the Department of Agriculture, Forestry and Fisheries 2013/2014 to 2017/2018*.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2014). *Economic Review of the South African Agriculture 2014/2015* Compiled by Directorate: Statistics and Economic Analysis, Pretoria.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2015a). *Strategic Plan 2015/2016 to 2019/20*. Department of Agriculture, Forestry and Fisheries.
- Department of Agriculture, Forestry and Fisheries (DAFF). (2015b). Governance and Financing Framework for Agricultural Training Institutes of South Africa. Retrieved January 9, 2018 from http://www.nda.agric.za/doaDev/sideMenu/SectoralColleges/docs/ITCAFF%20final%2001_10_15%20governance%20content.pdf
- Department of Agriculture, Forestry and Fisheries (DAFF). (2017). *National Assembly Written Reply: Question 2611 / MW 2916E. Minister of Agriculture, Forestry and Fisheries: Mr. W. M. Madisha (Cope) to ask the Minister of Agriculture, Forestry and Fisheries*. Retrieved February 4, 2018 from pmg.org.za/files/RNW2611-170929.docx
- Department of Agriculture and Rural Development (DARD). (2012). *Annual Report for 2012/2013*.
- Department of Agriculture and Water (DAW) (1985). *Landboukollege Potchefstroom Prospectus*.

- Department of Education (DoE). (2008). *National Curricula Statement Grades 10-12. Learning Programme Guidelines: Engineering Graphics and Design.*
- Department of Environmental Affairs (DEA). (2011). *The National Climate Change Response Policy.* Retrieved June 1, 2016, from <http://www.thedti.gov.za/parliament/DEA.pdf>
- Department of Environmental Affairs (DEA). (2013). *Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Change Implications for the Water Sector in South Africa.* Pretoria.
- Department of Environmental Affairs (DEA). (2015). *Climate Support Programme (CSP) – Vulnerability Assessment. Final Report for North West Province.* Pretoria.
- Department of Higher Education and Training (DHET). (2014). Government Notice No. 784 10 October 2014. Higher Education Act, 1997 (Act No. 101 of 1997). Incorporation of the Lowveld College of Agriculture Mbombela Campus into the University of Mpumalanga. Staatskoerant, 10 October 2014.
- Department of Rural, Environment and Agricultural Development (READ). (2013). North West Environment Outlook 2013.
- Department of Rural, Environment and Agricultural Development (READ). (2015a). *Department of Rural, Environment and Agricultural Development North West Provincial Government Strategic Plan 2015-2020 PR117/2015.*
- Department of Rural, Environment and Agricultural Development (READ). (2015b). *Annual Report for 2014/2015 Financial Year Vote 13.* READ Province of the North West.
- Department of Rural, Environment and Agricultural Development (READ). (2015c). *Climate Support Programme (CSP) Vulnerability Assessment. Final Report for North West Province August 2015.*
- Department of Rural, Environment and Agricultural Development (READ). (2016). Media Release: Taung Agricultural College confer new diploma. Tuesday 2 June 2016.
- Didiza, T. (2005) *AET Strategy Launch.* Speech by Honourable Minister of Agriculture and Land Affairs, Pretoria. Retrieved December 11, 2017 from nda.agric.za/doaddev/sidemenu/educationandtraining/aet_minister_speech.pdf
- Dockés, A., Tisenkofs, T., & Bock, B. (2011). *Reflection paper on AKIS.* Retrieved November, 15, 2015 from <http://ec.europa.eu/research/agriculture/scar/pdf/aks-wp1-final.pdf>
- Drucker, P.F. (1998). The discipline of innovation. *Harvard Business Review*, 76(6), 149-157.
- Du Toit, D. C., Ramonyai, M. D., Lube, P. A., & Ntushelo, V. (2011). *Food Security in South Africa.* Pretoria: Directorate of Economics, Department of Agriculture, Forestry, and Fisheries.
- Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research.* Helsinki: Orienta-Konsultit.
- Engeström, Y. (1999a). Activity theory and transformation. In Y. Engeström., R. Miettinen & R. Punamäki (Eds.). *Perspectives on Activity Theory* (pp. 39-52). Cambridge: Cambridge University Press.

- Engeström, Y. (1999b). Innovative learning in work teams: Analysing cycles of knowledge creation in practice. In Y. Engeström, R. Miettinen & R-L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 377-406). Cambridge: Cambridge University Press.
- Engeström, Y. (2005). *Developmental work research: Expanding activity theory in practice*. Berlin: Lehmanns Media.
- Engeström, Y. (2016). *Studies in expansive learning. Learning what is not yet there*. Cambridge: Cambridge University Press.
- Engeström, Y., Jaana Nummijoki, J., & Sannino, A. (2012). Embodied germ cell at work: Building an expansive concept of physical mobility in home care. *Mind, Culture, and Activity*, 00, 1-23. Doi: 10.1080/10749039.2012.688177.
- Engeström, Y. & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review*, 5, 1-24.
- European Commission & Standing Committee on Agricultural Research (EU SCAR). (2012). *Agricultural knowledge and innovation systems in transition – a reflection paper*. Brussels: European Commission, & Standing Committee on Agricultural Research.
- European Commission & Standing Committee on Agricultural Research (EU SCAR). (2013). *Agricultural knowledge and innovation systems towards 2020 - An orientation paper on linking innovation and research*. doi:10.2777/3418.
- FANRPAN. (2012). FANRPAN at the 2nd Limpopo LBDC Reflection Workshop. Retrieved June, 1, 2017, from <http://www.fanrpan.org/documents/d01310>
- FANRPAN. (2016). Climate-Smart Agriculture Conference Report, Johannesburg, 8 September 2016. Retrieved December 9, 2017, from aaiks.net/wp-content/uploads/2017/07/aaReport-Climate-Smart-Agriculture-Conference-Aug-2016.pdf
- Folke, C., Hahn, T, Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources*, 30, 8.1-8.33.
- Food and Agriculture Organisation (FAO). (2013). *Climate-Smart Agriculture Sourcebook*.
- Food and Agriculture Organisation (FAO). (2010). *“Climate-Smart” Agriculture: Policies, Practices and Financing for Food Security, Adaptation and Mitigation*.
- Francis, C. A., Jordan, N., Porter, P., Breland, T. A., & Lieblein, G. 2011. Innovation education in Agroecology: Experiential learning for a sustainable agriculture. *Critical Reviews in Plant Sciences*, 30, 226-237.
- Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, 33(6-7), 987-920.
- Goergen, G., Kumar, P. L., Sankung, S. B., Togola, A., & Tamo, M. (2016). First Report of Outbreaks of the Fall Armyworm *Sodeoptera frugiperda* (J E Smith) (Lepidoptera, Noctuidae), a New Alien Invasive Pest in West and Central Africa. *PLOS ONE* 11(10): e0165632. doi:10.1371/journal.pone.0165632
- Goldblatt, A. (2011). *Agriculture: Facts and trends South Africa*. World Wide Fund for Nature (WWF). Retrieved April 15, 2017 from http://awsassets.wwf.org.za/downloads/facts_brochure_mockup_04_b.pdf

- Gwantyu, M. (2010). Conference News: The poor state of extension services. *Farming SA*, Saturday 2 January 2010, pp. 40-41.
- Halai, A. (2006). *Ethics in qualitative research: Issues and challenges*. EdQual Working Paper No. 4. Plenary Address: Multi-Disciplinary Qualitative Research in Developing Countries, Aka Khan University, Karachi, November 2006.
- Hammersley, M. & Traianou, A. (2012). Ethics and educational research. *British Educational Research Association*. Retrieved July 17, 2017 from <http://www.learnersfirst.net/private/wp-content/uploads/Ethics-and-Educational-Research.pdf>
- Ikehi, M. E., Ifeanyieze, F. O., & Ugwuoke, C. U. (2014). Integration of Climate Change into the Senior Secondary School Agricultural Science Curriculum in Nigeria. *Atmospheric and Climate Sciences*, 4, 614-612. doi:10.4236/acs.2014.44054
- Intergovernmental Panel on Climate Change (IPCC). 2007. *Impacts, adaptation and vulnerability. Summary for Policymakers in Climate Change: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- IPCC (Intergovernmental Panel on Climate Change). 2014. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- Klink, F. May 13, 2015. Head of Animal Department, Taung Agricultural College. Personal communication.
- Knickel, K., Brunori, G. R., & Proost, J. (2009). Towards a better conceptual framework for innovation processes in agriculture and rural development: for linear models to systemic approaches. *Journal of Agricultural Education and Extension*, 12(2), 131-146.
- Leeuwis, C. (2004). *Communication for rural innovation: Rethinking agricultural extension*. Oxford: Blackwell.
- Lemos, M., Pereira-Querol, M., & Almeida, I. (2013). The Historical-Cultural Activity Theory and its contributions to education, health and communication: Interview with Yrjö Engeström. *Interface*, 17(46).
- Lindley, D. (2014). *Can expansive (social) learning process strengthen organizational learning from improving wetland management in a plantation forestry company, and if so how? A case study of Mondi*. Unpublished PhD thesis, Rhodes University, Grahamstown.
- Lotz-Sisitka, H., Hlengwa, A., Ward, M., Salami, A., Ogbuigwe, A., Pradhan, M., Lauriks, S. (Eds.) (2015). *Mainstreaming Environment and Sustainability in African Universities: Stories of Change*. Grahamstown: Rhodes University Environmental Learning Research Centre.
- Lotz-Sisitka, H., Pesanayi, T., Weaver, K., Lupele, C., Sisitka, L., Denison, J., 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 small scale agriculture*. Volume 1: research and development report. Report to the Water Research Commission.

- Lozano, R. (2006). A tool for a Graphical Assessment for Sustainability in Universities (GASU). *Journal of Cleaner Production*, 14, 963-972.
- Mnkeni, P. & Mutengwa, C. (2014). *A comprehensive scoping and assessment study of CSApolicies in South Africa*. Report 30 April 2014. Food, Agriculture and Natural Resource Policy Analysis Network (FANRPAN).
- Moorhead, A. (2009). *Climate change, agriculture and food security: a strategy for change*. Alliance of the CGIAR Centres.
- Mukute, M. & Lotz-Sisitka, H. (2012). Working with cultural-historical activity theory and critical realism to investigate and expand farmer learning in Southern Africa. *Mind, Culture, and Activity*, 19(4), 342-367.
- Mukute, M. (2010). *Exploring and expanding learning processes in sustainable agriculture workplace contexts*. Unpublished PhD thesis, Rhodes University, Grahamstown.
- Mukute, M. (2016). Dialectical critical realism and Cultural Historical Activity Theory (CHAT). Exploring and expanding learning processes in sustainable agriculture workplace contexts. In L. Price & H. B. Lotz-Sisitka (Eds.), *Critical realism, environmental learning and social-ecological change* (pp. 190–211). London: Routledge.
- Mulder, M. (2012). Competence-based education and training. *Journal of Agricultural Education and Extension*, 18, 3, 305-314.
- Murray, S. (2006). *Ethics and research. Research design course*. Rhodes University, Education Department.
- Nciizah, A. D. & Wakindiki, I. I. C. (2015). Climate Smart Agriculture: Achievements and Prospects in Africa. *Journal of Geoscience and Environment Protection*, 3, 99-105. doi: 4236/gep.2015.36016
- National Department of Agriculture (NDA). (1998a). *Agricultural policy in South Africa*. Retrieved July 6, 2016 from <http://www.nda.agric.za/docs/Policy/policy98.htm>
- National Department of Agriculture (NDA). (1998b). *Policy on Agriculture in Sustainable Development*. Retrieved December 10, 2017 from <http://www.nda.agric.za/docs/Policy/SustainableDev.pdf>
- NEPAD (2017). The Fourth Global Science Conference on Climate-Smart Agriculture. Retrieved June 1, 2017 from <http://csa2017.nepad.org/en/>
- Nordwig, K. (2015). *The South African Agricultural Innovation System – Stakeholders, Structure and Process*. Unpublished PhD thesis, Stellenbosch University, Stellenbosch.
- Organisation for Economic Co-Operation and Development (OECD). (2015). *Agriculture and Climate Change*. Retrieved January 8, 2018 from <https://www.oecd.org/tad/sustainable-agriculture/agriculture-climate-change-september-2015.pdf>
- Peck, L. S. (2005). Prospects for surviving climate change in Antarctic aquatic species. *Frontiers in Zoology* 2, 9. doi:10.1186/1742-9994-2-9

- Pesanayi, T. (2016). *Exploring contradictions and absences in mobilizing learning as process for sustainable agricultural practices*. In L. Price & H. B. Lotz-Sisitka (Eds.), *Critical realism, environmental learning and social-ecological change*. London: Routledge.
- Pesanayi, T. (2018). *Boundary crossing expansive learning across agricultural learning activity systems and networks in southern Africa*. Unpublished PhD Thesis, Rhodes University (in press)
- Ponniah, A. (2011). *The role of agricultural R & D within the Agricultural Innovation Systems Framework*. Conference Working Paper 6. Prepared for the Agricultural Science & Technology Indicators (ASTI)/FPRI-FARA Conference. Accra, Ghana. December 5-7, 2011.
- Ponniah, A., Puskur, R., Worhneh, S., & Hoekstra D. (2008). *Concepts and practices in agricultural extension in developing countries: A source book*. IFPRI (International Food Policy Research Institute), Washington, DC, USA, and ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Popkewitz, T. (2017). *The promise of empirical evidence and benchmarks: The Lorelei's whispers*. Research Gate. Retrieved January 28, 2018 from <https://www.researchgate.net/publication/32170927>
- Potchefstroom College of Agriculture (PCA). (2009). *Prospectus: Quality assurance, design development, delivery and evaluation of training programmes, assessment and off site*. Potchefstroom: PCA.
- Potchefstroom College of Agriculture (PCA). (2011). *Student prospectus*. Potchefstroom: PCA.
- Potchefstroom College of Agriculture (PCA). (2014). *General rules and regulations*. Potchefstroom: PCA.
- Rajalahti, R., Janssen, W., & Pehu, E. (2008). Agricultural innovation systems: From diagnostics toward operational practices systems. *Agriculture and Rural Development*, 38, 87. Retrieved July 7, 2016 from <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Agricultural+Innovation+Systems:+From+Diagnostics+toward+Operational+Practices+Systems#0>
- Republic of South Africa (RSA). (2011). *National Climate Change Response White Paper*. Retrieved November, 10, 2015, from <http://www.sanbi.org/sites/default/files/documents/documents/national-climate-change-response-white-paper.pdf>
- Republic of South Africa (RSA). (2012). *A new Diploma programme for Taung agricultural College*. Press Release December, 10, 2012. Retrieved June 30, 2016 from <http://www.gov.za/new-diploma-programme-taung-agricultural-college>
- Republic of South Africa (RSA). (2015). *North West Agriculture gears towards excellence in irrigation technology*. Media Statement 22 July 2015.
- Roorda, N. (2001). *Auditing instrument for sustainability in higher education*. Dutch Committee on Sustainable Higher Education.
- Rowe, D. (2007). Education for a sustainable future. *Science*, 317(5836), 323-324.
- Sayer, A. (2000). *Realism and social science*. London: Sage.

- Serage, D. May 26, 2015. Director of Structured Agricultural Training and Empowerment for the Department of Rural, Environmental and Agriculture Development for the North West province. Personal communication.
- Shriber, M. (2002). Institutional assessment tools for sustainability in higher education: Strengths, weaknesses, and implications for practice and theory. *International Journal of Sustainability in Higher Education*, 3(3), 254-270. doi:10.1108/14676370210434714
- Singer, E. (2008). Ethical issues in surveys. In E. De Leeuw, J. Hox, & D. Dillman (Eds.) *International handbook of survey methodology*. London: Routledge.
- South African Biodiversity Institute (SANBI). (2014). Climate change and bio adaptation. Retrieved June 1, 2017, from <https://www.sanbi.org/biodiversity-science/state-biodiversity/climate-change-and-bioadaptation-division/national-implement-1>
- Southern African Regional Universities (SARUA). (2014). *Climate Change Counts. Strengthening university contributions to climate compatible development*. Volume 1: Knowledge Co-Production Framework. Retrieved July 7, 2016 from www.sarua.org
- Spielman, D. J., Ekboir, J., & Davis, K. (2009). The art and science of innovation systems inquiry: Applications to Sub-Saharan African agriculture. *Technology in Society*, 31, 399-405.
- Sumberg, J. (2005). Systems of innovation theory and the changing architecture of agricultural research in Africa. *Food Policy*, 30, 21-41.
- Synnevåg, G. & Lambrou, J. (2012). *Climate-Smart Agriculture: Possible roles of agricultural universities in a strengthened Norwegian climate change engagement in Africa*. Noragric Report No. 64. February 2012
- Taung Agricultural College (TAC). (2014a). *Amplified prospectus – Taung*.
- Taung Agricultural College (TAC). (2014b). *Prospectus: Quality assurance, design development, delivery and evaluation of training programmes, assessment and off site work*.
- Taung Agricultural College (TAC). (2014c). *Taung Agriculture College Prospectus*.
- Taung Agricultural College (TAC). (2017a). *Fees Structure*. Retrieved December 20, 2017, from <http://taungagricollege.co.za/fees/>
- Taung Agricultural College (TAC). (2017b). *Mission Statement*. Retrieved July 7, 2017, from www.taungagricollege.co.za/mission-statement
- Tekana, S. & Oladele, O. (2011). Impact analysis of Taung irrigation scheme on household welfare among farmers in North-West Province, South Africa. *Journal of Human Ecology*, 36(1), 69-77.
- Togo, M. & Lotz-Sisitka, H. (2009). *Unit Based Sustainability Assessment Tool. A resource book to complement the UNEP Mainstreaming Environment and Sustainability in African Universities Partnership*. Howick: Share-Net.
- Togo, M. (2009). *A systems approach to mainstreaming environment and sustainability in universities: The case of Rhodes University, South Africa*. Unpublished PhD thesis, Rhodes University, Grahamstown.
- Togo, M. (2015). Development, use and significance of the Unit-Based Sustainability Assessment Tool for Universities in Africa and Asia (Chapter 3) In H. Lotz-Sisitka H.,

- A. Hlengwa, M. Ward, A. Salami, A. Ogbuigwe, M. Pradhan, ... M., S. Lauriks (Eds.) *Mainstreaming Environment and Sustainability in African Universities: Stories of change*. Grahamstown: Rhodes University Environmental Learning Research Centre.
- Union Department of Agriculture (UDA). (1915). *The work of the agricultural department*.
- United Nations Educational, Scientific and Cultural Organisation (UNESCO). (2000). *Education for Sustainable Development and the Millennium Development Goals, Policy Dialogue 2*.
- University Leaders for a Sustainable Future (ULSF). (1999). *Sustainability assessment questionnaire (SAQ) for colleges and universities*. Washington, DC: University Leaders for a Sustainable Future.
- Van Vuuren, L. (2010). Vaalharts – A garden in the desert. *The Water Wheel*, Jan/Feb 2010. Retrieved April 25, 2017, from [file:///C:/Users/Wildstes/Downloads/02022011201120112011080405act16of94%20\(1\).pdf](file:///C:/Users/Wildstes/Downloads/02022011201120112011080405act16of94%20(1).pdf)
- Verschoor, A. J. (2005). *Chapter 5: Contextualising Agricultural Development Planning in the North West Province*. University of Pretoria. Retrieved May 28, 2015 from <http://repository.up.ac.za/bitstream/handle/2263/25033/02chapter5.pdf?sequence=3>
- Verwey, P. M. J. & Vermeulen, P. D. (2011). Influence of irrigation on the level, salinity and flow of groundwater at Vaalharts Irrigation Scheme. *Water SA*, 37(2). Retrieved November 19, 2017, from http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502011000200004
- Virkkunen, J. & Newnham D. S. (2013). *The Change Laboratory: A tool for collaborative development of work and education*. Rotterdam: Sense.
- Vygotsky, L. S. (1978). *Mind in society. The development of higher psychological processes*. Cambridge: Harvard University Press.
- Weik, E. (2006). *Working relationships: A meta-view on structure and agency*. Retrieved December 10, 2017, from <http://theoryandscience.icaap.org/content/vol7.1/weik.html>
- Westley, F. (2002). Devil in the dynamics. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems theories for sustainable future* (pp. 333-360). Washington, D.C.: Island.
- Wiek, A., Withycombe, L., & Redman, C. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science*, 6, 203-218. doi: 10.1007/s11625-011-0132-6
- WordPress. (2012). North West News Online *Taung and Potchefstroom Colleges of Agriculture media conference*. Retrieved February 14, 2017, from <https://northwestnewsonline.wordpress.com/2012/12/05/taung-and-potchefstroom-colleges-of-agriculture-confer-diplomas-to-qualify-graduates/graduation/#main>
- World Bank. (2014). *Foster Climate-Smart Agriculture*. Retrieved February 28, 2017 from <https://www.worldbank.org/en/topic/agriculture/brief/foster-climate-smart-agriculture>
- Yarime, M. & Tanaka, Y. (2012). The issues and methodologies in sustainability assessment tools for higher education institutions. A review of recent trends and future challenges. *Journal of Education for Sustainable Development*, 6(1), 63-77. doi: 10.1177/097340821100600113
- Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). London: Sage.

VOLUME 2

**A REVIEW OF CLIMATE-SMART SYSTEM INNOVATIONS
IN TWO AGRICULTURAL COLLEGES IN THE NORTH WEST
PROVINCE
OF SOUTH AFRICA**

APPENDIX 1

SURVEY – PRELIMINARY CONSULTATIVE WORKSHOP

SURVEY – HOW CLIMATE RESPONSIVE IS YOUR CURRICULUM?

Name		e-mail address	
Your position at the college	Lecturer	Management	Other: <i>Please Specify</i>
Location	Taung Agricultural College	Potchefstroom College of Agriculture	Other: <i>Please specify</i>

Please answer the following questions:			
The following list indicates some key aspects of the climate change challenges that agricultural training in South Africa is facing. <i>Just “tick” the relevant column.</i>			
	This topic is not included in the curriculum	This topic does not receive sufficient attention in the curriculum	This topic is address in the curriculum
Sustainable agriculture			
Household food security			
Water harvesting			
Organic farming			
Development of Homestead Food Gardens			
Soil fertility management			
Homestead irrigation techniques			
Water conservation irrigation techniques			
Crop rotation			
Conservation of water in agricultural practices			
Seed saving			
The concept of climate change			
The causes of climate change			
The relevance and importance of climate change.			
The effect of climate change on crop production			
The effect of climate change on livestock			
The effect of climate change on farming communities			

Please answer the following questions to the best of your abilities.	
To your knowledge does interdisciplinary education form a component in your curriculum, e.g. in linking education, extension education and food security?	
Can you mention any other challenges that S.A agriculture is facing that your subject syllabus / curriculum addresses	
In your opinion, are the effects of climate change on agriculture an important component to integrate in the agricultural curriculum?	
How do you think your faculty can integrate the climate change challenges that South Africa agriculture is facing into the faculty?	
In your opinion, can your subject syllabus benefit from integration of climate change components?	
What component of climate change do you think if any, can be integrated into your subject content?	
In your opinion, do you think the graduates can benefit from climate change adaptation knowledge?	
What practical tools do you think would you require to integrate climate change adaptation techniques into your subject content?	

APPENDIX 2

CONSENT FOR USE OF DATA FOR RESEARCH PURPOSES

CONSENT FOR USE OF DATA FOR RESEARCH PURPOSES

Thank you for agreeing to be part of this study. This document serves to obtain your written consent for being involved in this study.

Project title: A systems oriented review of agricultural curricula in the South African post-schooling system in the transition to Climate-smart agriculture

Participant

- I have received information about this study
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage.
- I understand that participation in this study is done on a voluntary basis.

Name: _____

Signed: _____ Date: _____

Researcher

I have provided information about the research to the research participant and believe that he/she understands what is involved.

Name: _____

Signed: _____ Date: _____.

APPENDIX 3

RESEARCH PARTICIPANT DETAILS AND WORKSHOP ATTENDANCE

Workshop attendance between July 2015 to March 2017										
Case Study One	√	Initial Contact Session	First Consultative Workshop	Second Consultative Workshop (Amanzi For Food)	First Intervention Innovation Workshop	First Intervention innovation Workshop	Second Intervention innovation workshop	Second Intervention innovation workshop	Third Intervention Innovation workshop	Third Intervention Innovation workshop
Case Study Two	√									
Case Study One and Two	√									
		Potchefstroom	Potchefstroom	Rhodes	Taung	Potchefstroom	Taung	Potchefstroom	Taung	Potchefstroom
Participant nr:		31/03/2015	07/07/2015	12&13/05/2016	30/05/2016	31/05/2016	29/09/2016	30/09/2016	28/02/2017	01/03/2017
1	L ¹²		√			√		√		√
2	L		√			√				
3	L		√					√		
4	L									√
5	L		√			√				
6	L		√			√				
7	L		√							
8	L		√	√		√				
9	L		√							
10	L		√			√		√		
11	L		√							
12	L		√							
13	L		√							
14	L		√			√		√		
15	L					√				

¹² L = Lecturer & M = Management

16	L		√					√		
Workshop attendance between July 2015 to March 2017										
Case Study One	√	Initial Contact Session	First Consultative Workshop	Second Consultative Workshop (Amanzi For Food)	First Intervention Innovation Workshop	First Intervention innovation Workshop	Second Intervention innovation workshop	Second Intervention innovation workshop	Third Intervention Innovation workshop	Third Intervention Innovation workshop
Case Study Two	√									
Case Study One and Two	√									
Participant nr:		31/03/2015	07/07/2015	12&13/05/2016	30/05/2016	31/05/2016	29/09/2016	30/09/2016	28/02/2018	01/03/2017
17	M ¹³		√			√		√		√
18	M		√			√				√
19	M		√			√				√
20	M	√	√							
21	M		√							
22	L		√							
23	L		√							
24	L		√							
25	L		√							
26	L		√							
27	L		√							
28	L				√		√			
29	L								√	
30	L						√			
31	L								√	

¹³ L = Lecturer & M = Management

32	L		√							
33	L		√		√		√			
Workshop attendance between July 2015 to March 2017										
Case Study One	√	Initial Contact Session	First Consultative Workshop	Second Consultative Workshop (Amanzi For Food)	First Intervention Innovation Workshop	First Intervention innovation Workshop	Second Intervention innovation workshop	Second Intervention innovation workshop	Third Intervention Innovation workshop	Third Intervention Innovation workshop
Case Study Two	√									
Case Study One and Two	√									
Participant nr:		31/03/2015	07/07/2015	12&13/05/2016	30/05/2016	31/05/2016	29/09/2016	30/09/2016	28/02/2018	01/03/2017
34	L ¹⁴				√		√		√	
35	L								√	
36	L								√	
37	L				√		√		√	
38	L				√		√			
39	L						√			
40	L								√	
41	L		√		√		√		√	
42	L						√			
43	L				√		√			
44	L				√		√		√	
45	L				√		√		√	
46	L						√			
47	L		√		√		√			

¹⁴ L = Lecturer & M = Management

48	L								√	
49	L								√	
50	L		√							
51	M			√	√		√		√	
Workshop attendance between July 2015 to March 2017										
Case Study One	√	Initial Contact Session	First Consultative Workshop	Second Consultative Workshop (Amanzi For Food)	First Intervention Innovation Workshop	First Intervention innovation Workshop	Second Intervention innovation workshop	Second Intervention innovation workshop	Third Intervention Innovation workshop	Third Intervention Innovation workshop
Case Study Two	√									
Case Study One and Two	√									
Participant nr:		31/03/2015	07/07/2015	12&13/05/2016	30/05/2016	31/05/2016	29/09/2016	30/09/2016	28/02/2018	01/03/2017
52	M ¹⁵						√			
53	M				√		√			
54	M				√		√			
Total Participants		1	29	2	12	11	17	6	13	5

¹⁵ L = Lecturer & M = Management

APPENDIX 4

PHASE TWO – PRELIMINARY CONSULTATIVE WORKSHOP REPORT



CONSULTATIVE WORKSHOP REPORT
BY W VAN STADEN





Climate Change and Water Conservation Farming – Curriculum Development 2015

No. of attendees	29 From Taung & Potchefstroom Agricultural Colleges
Location	Potchefstroom College of Agriculture
Date	6 July 2015
Topic	Climate Change and water conservation farming curriculum workshop

On July 14th, 2015, Amanzi for Food hosted a full-day curriculum workshop entitled Climate Change and water conservation farming at Potchefstroom Agricultural College, Potchefstroom. The workshop was part of the Amanzi for Food project led by ELRC, Rhodes University.

The purpose of the workshop was to bring lecturers and managers together to learn about and identify opportunities for curriculum development towards Climate Smart Agriculture. The 29 workshop participants represented Potchefstroom Agricultural College and Taung Agricultural College. The Agenda began with an introduction on the effects of climate change on the agricultural sector and the role that the college curriculum plays in responding to climate change

The balance of the day consisted of interactive small group discussions which discussed the major gaps within the agricultural college's curricula in relation to Climate-Smart Agriculture. The attendees were grouped into 6 groups and asked to discuss the specific questions below in their groups.

A transitioning approach....Question for discussion

- *A separate new course on Climate-Smart Agriculture and water conservation?*
- *Integration into which subjects?*
- *What levels*
- *Whole institutions approaches e.g green campus etc.*
- *Which patterns / stakeholders to engage for this curriculum*
- *Where to from here?*
- *Training of Trainings?*
- *Course Design and development for curriculum revision.*

A curriculum transitioning approach towards climate smart agriculture was also discussed. Participants prioritised the integration of climate smart agriculture therefore, curriculum revision is required. Colleges felt that they need assistance and Amanzi for Food must help to develop a climate smart agricultural curriculum. Lectures emphasised the need for training of Trainers to carry this knowledge over to the students and community.

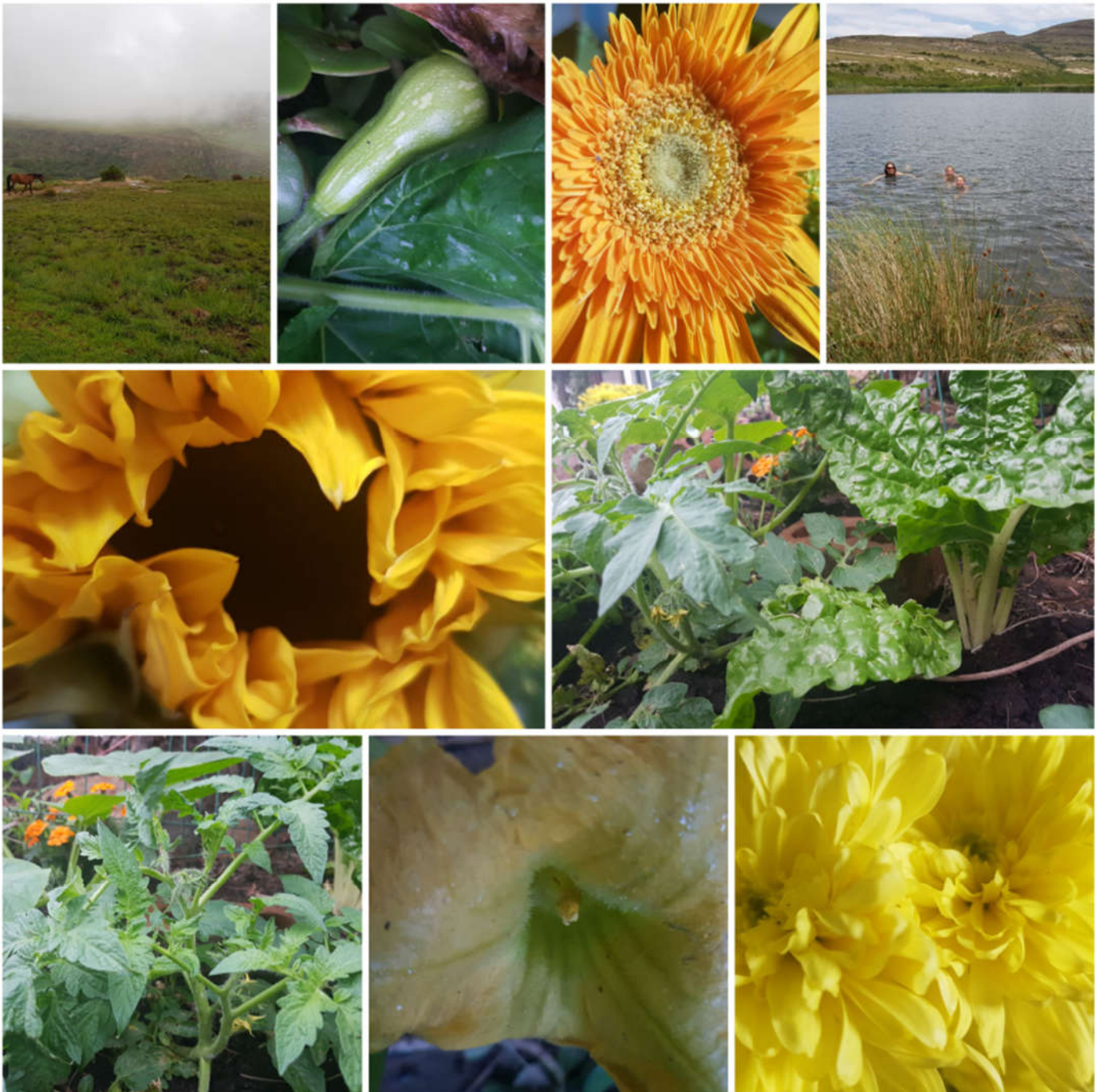
APPENDIX 5

CLIMATE-SMART INNOVATION TOOL

APPENDIX 5.1

CLIMATE-SMART INNOVATION TOOL BOOKLET

Climate-Smart Innovation Tool





General Participant Information

Name:	
Surname:	
E-Mail:	
Contact No.:	
College:	
Position at College:	
Subject specialty:	

Consent Form for use of data for research purpose

Thank you for agreeing to be part of this study. This document serves to obtain your written consent for being involved in this study.

Participant

- I have received information about this study.
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage.
- I understand that participation in this study is done on voluntary basis.

Name:

Signed:

Date: _____

The Climate-Smart Innovation Tool is divided into three parts for ease of administration

- **Part A** deals with teaching approaches that include the theoretic and practical curriculum content's Climate-Smart responsiveness. It focusses on student competencies, research, community engagement, assessment and staff expertise and willingness to participate in the process of innovation towards Climate-Smart responsiveness. Part A focusses on lecturers and Departments' general Climate-Smart responsiveness.
- **Part B** of the Climate-Smart Innovation Tool pays attention to the Climate-Smart responsive concepts and principles in the curriculum outline, core competencies and the curriculum content in relation to general topics such as climate change, Rural wealth creation, food security, agriculture as a sustainable profit-making business, development of entrepreneur skills, organic farming, climate adaptation and resilience. Indicators under Part B are meant to establish the Climate-Smart responsiveness of the Agriculture Training Institutes curriculum content, course competencies, curriculum outcomes and specific subject content. Part B is specific topic orientated.
- **Part C** reviews the Agriculture Training Institute's operations and the management of the Institute. Part C identifies the institutes performance towards Climate-smart responsiveness. It also deals with the student involvement and activities that are linked to address issues relating to Climate-smart approach and community engagement. Part C concludes with the policies and written statements of the Institute and its alignment with Climate-smart responsiveness and the National Agriculture Strategic plan for Agriculture Training Institutes.

Assessment Criteria

Rating

0	None	There is no evidence on the indicator
1	Unsatisfactory	The indicator does not meet the necessary requirements.
2	Needs Development	Indicates performance, but improvement is required.
3	Adequately	Evidence show adequate Climate-Smart responsiveness
4	Meets requirements	Evidence indicates that the Climate-Smart responsive standard has been met.

- 5 **Exceed requirements** Evidence indicate that expectations has been exceeded and Climate-Smart responsiveness has been successfully attained.

SECTION A							
Curriculum, teaching approach and student-community engagements							
		LEVEL					
		None (0)	Unsatisfactory (1)	Needs development (2)	Adequately (3)	Meets requirements (4)	Exceed requirements (5)
C1	STAFF EXPERTISE AND INNOVATION						
A1	The level of expertise of staff members in the area of Climate-Smart Agriculture.						
A2	The level of training that staff members have completed in any of the aspects concerning Climate-Smart Agriculture including Climate Change etc.						
A3	The extent to which staff members are willing to integrate Climate-Smart Agriculture aspects / topics within their practical framework.						
A4	The extent to which you as lecturer are willing to teach Climate-Smart Agriculture topics.						
	C1 TOTAL						
C2	DEVELOPMENT OF CLIMATE-SMART AGRICULTURE AWARENESS COMPETENCES AMONG STUDENTS						
	Which of the following Climate-Smart Agriculture competencies does your teaching approach develop amongst the students	LEVEL					
		0	1	2	3	4	5
B1	The capacity to make informed decisions related to Climate-Smart Agriculture issues and challenges						
B2	Critical thinking skills						

B3	Systems thinking skills to understand complex problems from an integrated social-ecological systems perspective to solve Climate-Smart related problems						
B4	To anticipate possible scenarios and consequences, while assessing the vulnerability and risk of a specific agriculture system at risk of Climate-Smart Agriculture related problems						
B5	The competence to adapt by conceptualising appropriate alternatives and responses that are sustainable and viable through planning and strategic development.						
B6	To consider the implications of decisions and how these decisions can affect the current and future well-being of the surrounding community, agriculture system and ecological systems.						
B7	To be able to engage in adaptive management and to participate in social innovations that generate new practices						
B8	A sense of responsibility towards the community, ecological system and the environment, while understanding the role one has to play as part of these systems						
B9	Integrated problem solving						
B10	Respect of the opinions of others						
B11	Does the teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking						
B12	Does the teaching approach create awareness of values and ethics including respect for other people's opinions, democracy, respect for planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms.						
B13	Does the teaching approach capacitates the learner for social learning and innovation by exposing students to knowledge concerning the past, present and future Climate-Smart challenges.						

B14	Does the teaching approach develop Climate-Smart Agriculture core competencies such as adaptability and problem solving skills.						
B15	Does the teaching approach follow an interdisciplinary approach where various knowledge are combined and connected.						
B16	Does the teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts.						
	C2TOTAL						
C3	CLIMATE-SMART AGRICULTURE GENERAL TOPICS						
	<i>Which of the following Climate-Smart Agriculture topics are integrated into your subject content?</i>	LEVEL					
		0	1	2	3	4	5
D1	Climate Change						
D2	Rural wealth creation						
D3	Food security						
D4	Agriculture as a sustainable profit-making business using sustainable agricultural practices						
D5	Development of entrepreneur skills						
D6	Organic farming						
D7	Renewable energy						
	C3 TOTAL						
C4	EXAMINATION (ASSESSMENT) OF CLIMATE-SMART AGRICULTURE TOPICS						
		LEVEL					
		0	1	2	3	4	5
E1	The extent to which Climate-Smart Agriculture aspects are practically assessed during course.						
E2	The extent to which Climate-Smart Agriculture aspects are examined during course.						

E3	The extent to which Climate-Smart Agriculture aspects are considered in evaluating and assessing projects.						
E4	The degree to which Climate-Smart Agriculture aspects are assessed in evaluating service learning programmes.						
	C4 TOTAL						
C5	PRACTICAL CURRICULUM CONTENT AND RESEARCH						
		LEVEL					
		0	1	2	3	4	5
F1	The extent to which the department (staff and students) are involved in research in the area of Climate-Smart Agriculture.						
F2	The extent to which the department pursuit solutions for the climate change challenges and vulnerability within local community and context by applying Climate-Smart Agriculture practical techniques.						
F3	The extent to which the department within the study programme is collaborating with other research organisations to pursuit of solution to Climate-Smart Agriculture problems and adaptability.						
F4	The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching.						
F5	The extent of the practical application of Climate-Smart Agriculture competencies in student practical sessions.						
F6	The extent to which bursaries for studying Food Security and water harvesting are granted.						
F7	Using practical methods to practice Climate-Smart Agriculture in farming and other activities on campus.						
	C5 TOTAL						

C6	COMMUNITY ENGAGEMENT						
		LEVEL					
		0	1	2	3	4	5
G1	Extend of community engagement (staff and students) are involved in community engagement in the area of food security and rural development utilising the Climate-Smart Agriculture approach						
G2	Level of commitment of the college resources to Climate-Smart Agriculture projects in the community.						
G3	The degree to which local agriculture issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of the department's community engagement.						
G4	The extent to which the department collaborates with other stakeholders in addressing the household and small-scale farmers' climate change challenges.						
G5	The extent to which aspects of Climate-Smart Agriculture is used in the selection/execution of community engagement projects.						
	C6 TOTAL						
C7	CLIMATE-SMART AGRICULTURE INTEGRATION WITHIN THE FORMAL CURRICULUM						
		LEVEL					
		0	1	2	3	4	5
H1	The degree to which issues and challenges surrounding the sustainable increase of agriculture productivity and income forms part of the teaching programme.						
H2	The degree to which issues and challenges surrounding the adaptation and building resilience to climate change forms part of the teaching programme.						

H3	The degree to which issues and challenges surrounding the reduction of greenhouse gas emission by the agriculture industry forms part of the teaching programme.						
H4	The degree to which issues and challenges surrounding the food insecurity and small-scale farming forms part of the teaching programme.						
H5	The extent to which the program is relevant to climate change challenges that the farmers and extension officers are facing						
H6	The degree to which interdisciplinary education forms a component of the curriculum e.g. linking extension education, food security and climate change.						
	C7 TOTAL						

SECTION B																			
CURRICULUM CONTENT OUTLINE OF TOPICS RELATED TO CLIMATE-SMART AGRICULTURE WITHIN THE DIPLOMA		Level																	
		None (0)	Unsatisfactory(1)	Needs development (2)	Adequately (3)	Meets requirements(4)	Exceed requirements(5)												
B1 ANIMAL PRODUCTION																			
TA1	Sustainable livestock management and pasture management																		
TA2	Indigenous knowledge																		
TA3	Techniques to capacitate livestock farmers to enhance resilience towards Climate change effects such as increase in pathogens and increase in variations of temperature.																		
TA4	Adaptation to Climate Change problems and challenges effecting livestock farming.																		
TA5	Reducing Carbon footprint of livestock farming.																		
TA6	Methods to increase nutrition quality that will increase reproduction efficiency. Protect against diseases and reduce Greenhouse gas emissions.																		
B1 TOTAL																			
B2 CROP PRODUCTION																			
		<table><tr><th colspan="6">LEVEL</th></tr><tr><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr></table>						LEVEL						0	1	2	3	4	5
LEVEL																			
0	1	2	3	4	5														
TC1	The benefits of mixed farming.																		
TC2	Sustainable crop management.																		
TC3	Indigenous knowledge inclusion																		
TC4	Resilience to Climate Change																		
TC5	Adaptation to Climate Change problems and challenges																		
TC6	Reducing Carbon footprint of crop production																		

TC7	Methods to increase yield while sustaining natural resources and ecosystems.																		
TC8	Methods to reduce agriculture expansion by intensification on already established cultivated land.																		
B2 TOTAL																			
B3 NATURAL RESOURCES – WATER																			
		<table><tr><th colspan="6">LEVEL</th></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr></table>						LEVEL						0	1	2	3	4	5
LEVEL																			
0	1	2	3	4	5														
TW1	Sustainable Water management																		
TW2	Indigenous knowledge on sustainable water management																		
TW3	Integration of watering system and fish farming																		
TW4	Monitoring, improving and maintaining water quality of water resources																		
TW5	Water Harvesting techniques (Adaptation and resilience practices to save and manage water resources)																		
TW6	Hydroponics																		
B3 TOTAL																			
B4 NATURAL RESOURCES – SOIL																			
		<table><tr><th colspan="6">LEVEL</th></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr></table>						LEVEL						0	1	2	3	4	5
LEVEL																			
0	1	2	3	4	5														
TS1	Adaptation and resilience practices to improve quality of soil and decrease erosion.																		
TS2	Indigenous knowledge and practices to improve quality of soil																		
TS3	Sustainable management of soil quality while increasing yield and productivity of livestock and crop production.																		
TS4	Reducing Carbon footprint																		
TS5	The sustainable increase in nutrient cycle.																		
TS6	Water harvesting techniques																		
B4 TOTAL																			

B5 HORTICULTURE							
		LEVEL					
		0	1	2	3	4	5
TH1	Adaptation and resilience to climate change						
TH2	Indigenous knowledge and alternative farming techniques						
TH3	Reducing Carbon footprint						
TH4	Sustainable increase in productivity and incomes in a sustainable way						
B5 TOTAL							
B6 AQUA AGRICULTURE							
		LEVEL					
		0	1	2	3	4	5
FH1	Adaptation and resilience						
FH2	Indigenous knowledge and alternative farming techniques.						
FH3	Reducing Carbon footprint						
FH3	Sustainable increase in productivity and incomes in sustainable way.						
B6 TOTAL							
B7 – NATURAL RESOURCES - RENEWABLE ENERGY							
RE1	Solar power						
RE2	Bio-technology						
RE3	Biogas						
B7 TOTAL							

SECTION C

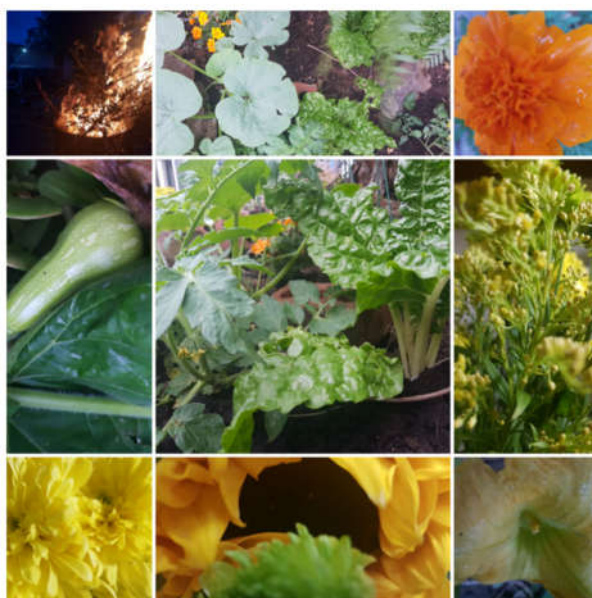
Climate-Smart Innovation – Management and institutional policies		Level					
		None	Unsatisfactory	Needs development	Adequately	Meets requirements	Exceed requirements
P1	CURRICULUM OUTLINE OF THE NATIONAL DIPLOMA						
I1	The extent that issues and challenges surrounding the sustainable increase of agriculture productivity form part of your teaching programme.						
I2	The extent that challenges surrounding adaptation and building resilience to climate change is covered within the institute's teaching programme?						
I3	The extent that the challenges relating to greenhouse gas emission is included in the Diploma?						
I4	The extent to which food security and homestead farming are covered in the curriculum.						
I5	The extent to which the curriculum is relevant to the Climate-Smart Agriculture responsive challenges that farmers and extension officers are facing in South Africa.						
I6	The extent to which interdisciplinary education forms a component of the curriculum e.g. linking extension education, food security and climate change.						
P1 TOTAL							

P2 OPERATIONS AND MANAGEMENT							
		LEVEL					
		0	1	2	3	4	5
O1	The degree of waste reduction practices on the campus.						
O2	The extent of recycling practices on the campus.						
O3	The extent to which practices to reduce greenhouse gas emissions are implemented on campus.						
O4	The extent to which energy conservation practices are implemented on campus.						
O5	The extent of Climate-Smart Agriculture awareness on the campus.						
O6	The extent that water saving practices are implemented on campus.						
O7	The extent to which rain water harvesting and conservation practices are implementation on campus.						
P2 TOTAL							
P3 STUDENT CLIMATE-SMART RESPONSIVENESS & PARTICIPATION							
		LEVEL					
		0	1	2	3	4	5
S1	Is there a student climate and environmental organisation or group on campus?						
S2	Does students have access to career counselling that focusses on work opportunities related to climate change and agriculture sustainability?						
S3	Is there sustainable and environmental practices practiced within the residence or dormitories by students (e.g. recycling and waste reduction)?						
S4	Is there a community garden programme that students are involved in?						
S5	Are students involved in practical programmes that promote food security, homestead gardening and entrepreneurship.						

S6	Does student assessment projects allow for the practical application of Climate-Smart Agriculture concepts?																		
S7	Does the college have a Climate-Smart Agriculture responsive awareness programme that promotes awareness of climate change, food security and sustainable agriculture?																		
P3 TOTAL																			
P4	POLICIES & WRITTEN STATEMENTS																		
		<table><tr><th colspan="6">LEVEL</th></tr><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr></table>						LEVEL						0	1	2	3	4	5
LEVEL																			
0	1	2	3	4	5														
PS1	The extent to which the province’s policies related to agriculture reflects the educational engagement with CSA and responsiveness.																		
PS2	The extend which national and global Climate Change issues inform decision making processes in the institutes policy and structure.																		
PS3	The level of support that your College / Agriculture Training Institute receives for the integration of CSA and climate responsiveness aspects into the Diploma.																		
PS4	The level of integration of CSA concepts such as sustainability into the existing institutional policies.																		
PS5	The level of integration of Climate Change and other CSA concepts into the institutes vision and mission statement.																		
PS6	Level of implementation of policies related to CSA concepts.																		
PS7	The level of future consideration to improve the integration of CSA concepts in the next policy review cycle.																		
P4 TOTAL																			

Sore analysis for Section A:				
Indicator	Topic	Score	Total Score	% Climate-Smart responsive
C1	Staff expertise and innovation.		/20	
C2	Development of Climate-Smart Agriculture awareness Competencies among students.		/80	
C3	Climate-Smart Agriculture general topics		/35	
C4	Examination and assessment of Climate-Smart Agriculture Topics		/20	
C5	Practical curriculum content and research		/35	
C6	Community engagement		/25	
C7	Climate-Smart Agriculture integration within the formal curriculum		/30	
Total Climate-Smart responsiveness for Section A		($\%C1+\%C2+\%C3+\%C4+\%C5+\%C6+\%C7$) ÷ 7		
Score analysis for Section B: Curriculum Content outline of topics related to Climate-Smart Agriculture within the Diploma				
Indicator	Topic	Score	Total Score	% Climate-Smart responsive
B1	General Topic		/30	
B2	Animal Production		/30	
B3	Crop Production		/40	
B4	Natural Resources – Water		/30	
B5	Natural Resources – Soil		/30	
B6	Horticulture		/20	
B7	Aqua Agriculture		/20	
B8	Natural Resources – Renewable Energy		/15	
Total Climate-Smart responsiveness for Section A		($\%B1+\%B2+\%B3+\%B4+\%B5+\%B6+\%B7$) ÷ 7		

Score analysis for Section C: Climate-Smart Innovation Tool - Management				
Indicator	Topic	Score	Total Score	% Climate-Smart responsive
P1	Curriculum outline and National Diploma		/30	
P2	Operations and Management		/35	
P3	Student Climate-Smart responsiveness and participation		/35	
P4	Policies and written statements		/35	
Total Climate-Smart responsiveness for Section C		$(\%P1 + \%P2 + \%P3 + \%P4 + \%P5 + \%P6 + \%P7) \div 7$		



APPENDIX 5.2

ONLINE SUB-TOOL

CLIMATE-SMART INNOVATION TOOL - LECTURER¹⁶

¹⁶

<https://www.onlineassessmenttool.com/climate-smart-innovation-tool-lecturer/assessment-55808>

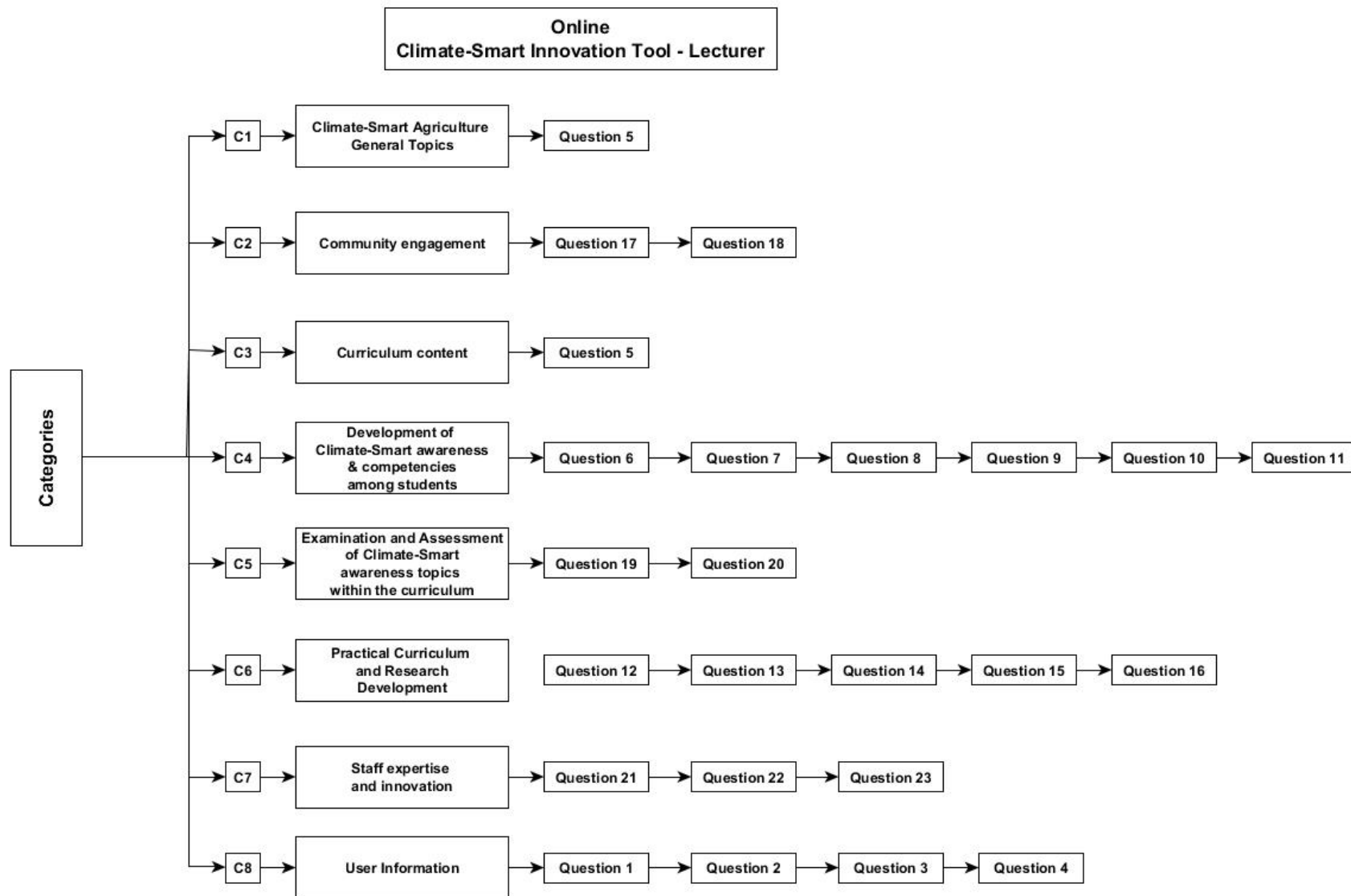
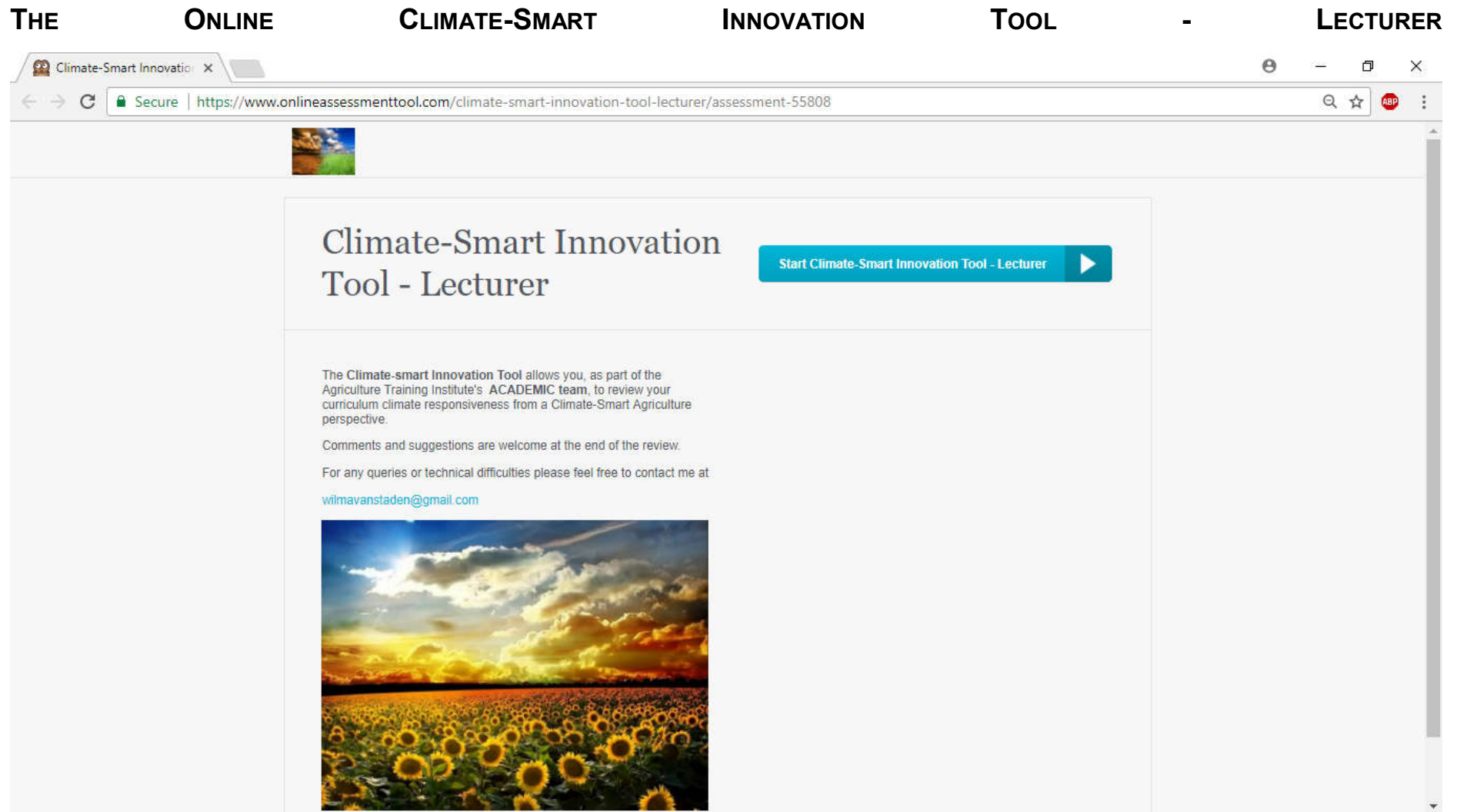


FIGURE 5.1 A FLOWCHART OF THE ONLINE CLIMATE-SMART CURRICULUM REVIEW TOOL - LECTURER



Climate-Smart Innovation X

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Question 1 / 23

Name & Surname

Next question ›

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Question 2 / 23

Which College of Agriculture or Training Institute are you associated with?

Select an option ▼

- Select an option
- Taung Agricultural College
- Potchefstroom College of Agriculture
- Fort Cox Agricultural College
- Cedara Agricultural College
- Tsolo Agricultural College
- Glen College of Agriculture
- An Agricultural Training Institute not mentioned above

Climate-Smart Innovation X

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Question 3 / 23

What is your position at the College of Agriculture / Agriculture Training Institute?

Select an option ▼

- Select an option
- Head of Department
- Lecturer
- Managment
- Administration
- Farm Manager

Climate-Smart Innovation X

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Question 4 / 23

Which Department are you associated with?

Multiple answers possible

- ☐ Animal Production
- ☐ Crop / Plant Production
- ☐ Irrigation and Arable Farming
- ☐ Engineering and Technology
- ☐ None of the above

[Next question >](#)

Climate-Smart Innovation X

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Question 5 / 23

Which of the following general Climate-Smart Agriculture topics are integrated into your subject content?

Multiple answers possible

- ☐ Climate Change
- ☐ Rural health creation
- ☐ Food security
- ☐ Sustainable agricultural practices
- ☐ Development of entrepreneur skills
- ☐ Renewable energy
- ☐ Organic farming
- ☐ Sustainable water management
- ☐ Adaptation and resilience to climate change
- ☐ Non of the above
- ☐ No relevance to my subject

Climate-Smart Innovation X

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Question 6 / 23

Which of the following Climate-Smart Agriculture competencies does your teaching approach developed among students ?

Multiple answers possible

- ☐ The capacity to make informed decisions related to Climate-smart challenges and issues.
- ☐ Critical thinking skills
- ☐ Systems thinking skills to understand complex problems from an agricultural systems perspective to solve Climate-smart responsive challenges.
- ☐ Anticipatory skills to assess the vulnerability and risk of a specific agriculture system.
- ☐ The competence to adapt through alternative responses that are sustainable through planning and strategic development.
- ☐ The competence to consider implications and effects that decisions have on the community, agriculture and ecological systems
- ☐ The ability to engage in adaptive management and to participate in social innovation that generate new practices.
- ☐ A sense of responsibility towards the community, agriculture and ecological systems.
- ☐ Integrated problem solving skills
- ☐ Respect for the opinion of other

Next question »

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Question 7 / 23

Does your teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking?

Yes

No

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Question 8 / 23

Does your teaching approach create awareness of values and ethics including respect for other people's opinions, democracy, respect for the planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms?

Yes

No

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Question 9 / 23

Does your teaching approach develop the learner for social learning and innovation by exposing students to knowledge relating to Climate-Smart Agriculture as a response to the the past, present and future climate variation challenges?

Yes

No

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Question 10 / 23

Does your teaching approach follow an interdisciplinary approach where various knowledge and skills are combined and connected?

Yes

No

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Question 11 / 23

Does your teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts?

Yes

No

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Question 12 / 23

The extend that your Department is involved in research concerning Climate-Smart Agriculture concepts?

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Climate-Smart Innovation

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Question 13 / 23

The extent to which your Department pursues solutions for Climate change and food security vulnerability within local community by applying the Climate-Smart Agriculture approach and concepts?

0	None	0
1	Unsatisfactory	1
2	Needs development	2
3	Adequately	3
4	Meets requirements	4
5	Exceed requirements	5

Climate-Smart Innovation

Secure

https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en

Question 14 / 23

The extent to which your Department is collaborating with other departments or research organisations to develop solution to climate change responsive problems and adaptability.

0	None	0
1	Unsatisfactory	1
2	Needs development	2
3	Adequately	3
4	Meets requirements	4
5	Exceed requirements	5

Climate-Smart Innovation

Securehttps://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en

Question 15 / 23

The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching pedagogy of your subject.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Climate-Smart Innovation X

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Question 16 / 23

The extent to which bursaries for studying Food Security and Rain Water Harvesting and Conservation are granted.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Climate-Smart Innovation X

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Question 17 / 23

Level of commitment of the college resources in Climate-Smart Agriculture projects in the community.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

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Climate-Smart Innovation

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Question 18 / 23

The degree to which local agricultural issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of your Department's community engagement.

0	None	0
1	Unsatisfactory	1
2	Needs development	2
3	Adequately	3
4	Meets requirements	4
5	Exceed requirements	5

Climate-Smart Innovation

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Question 19 / 23

The extent to which Climate-Smart Agriculture aspects are formally assessed within your subject.

0	None	0
1	Unsatisfactory	1
2	Needs development	2
3	Adequately	3
4	Meets requirements	4
5	Exceed requirements	5

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Climate-Smart Innovation

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Question 20 / 23

The extent to which Climate-Smart Agriculture aspects are considered when evaluating and assessing student's practical projects.

0	None	0
1	Unsatisfactory	1
2	Needs development	2
3	Adequately	3
4	Meets requirements	4
5	Exceed requirements	5

Climate-Smart Innovation X

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Question 21 / 23

To what extend do you think is Climate-Smart Agriculture concepts relevant to your subject specialty?

Not relevant

Slightly relevant

Relevant

The topic should play an important part in my subject content.

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Question 22 / 23

To what extend are you willing to integrate Climate-Smart Agriculture into your subject's practical framework.

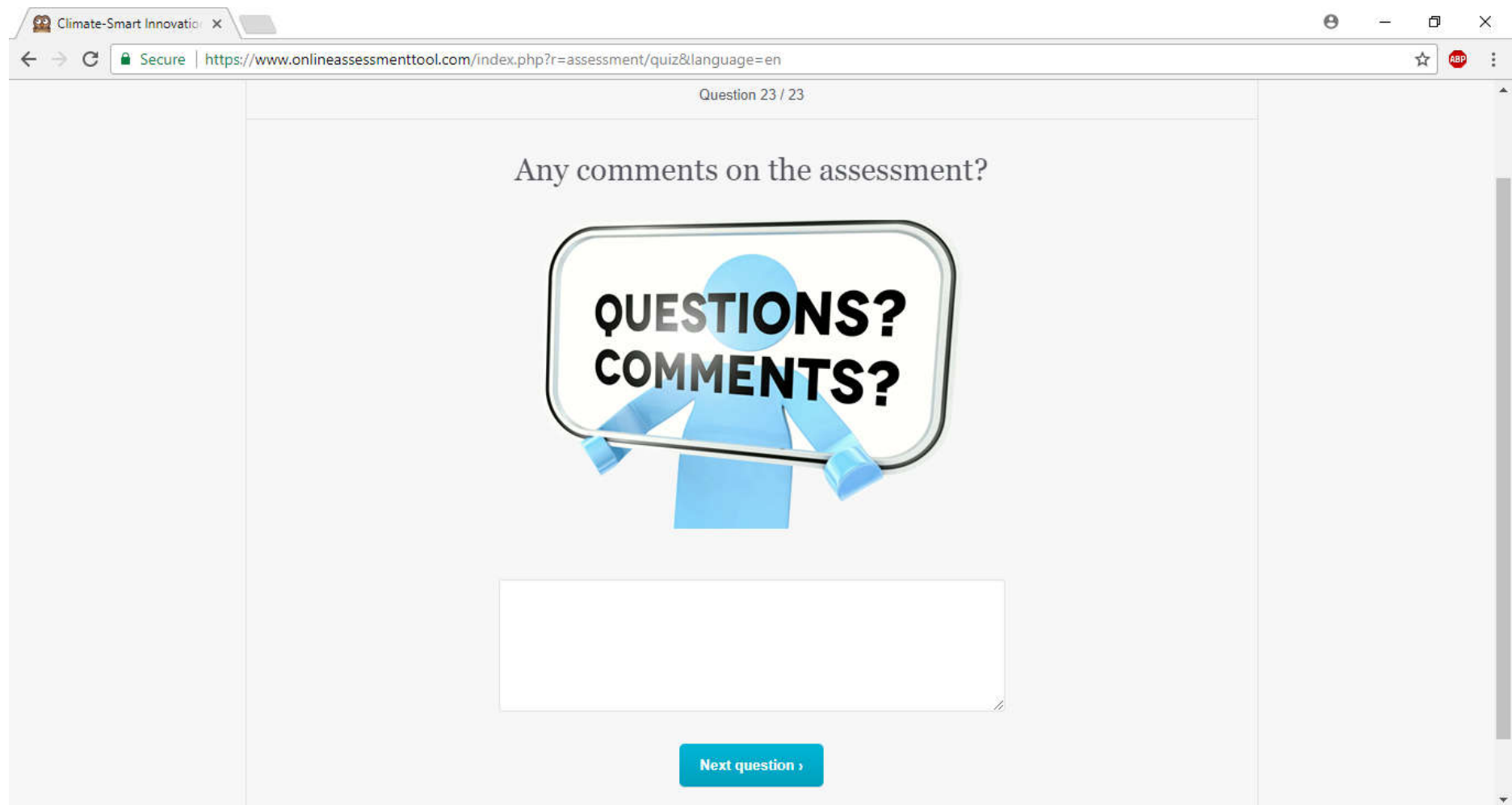
Not willing. No relevance to my subject content

Slight integration possible

The integration is important and I am planning to integrate Climate-Smart Agriculture components.

I have integrated Climate-Smart Agriculture into the practical component of my subject.

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Climate-Smart Innovation X

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Enter your details

Name *

Email address *

Show my result

Online Assessment Tool part of Easy LMS

EXAMPLE OF THE REPORT PRESENTED TO THE REVIEWER AFTER THE ONLINE REVIEW OF THE CLIMATE-SMART INNOVATION TOOL - LECTURER

Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55808&language=en>

Congratulations, you've completed Climate-Smart Innovation Tool - Lecturer

Based on your answers, you can see your result below



60%

Staff expertise and innovation

This section focusses on the participants views on

- participant's level of expertise on Climate-Smart responsive concepts.
- the relevance of Climate-Smart Agriculture concepts to Animal Production curriculum.
- the integration of Climate-Smart Agriculture concepts into curriculum
- further training for lecturers
- type of further training for lecturers

<http://amanziforfood.co.za/about/>

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55808&language=en>



50%

Development of Climate-Smart awareness & competencies among students

This section reviews to what extent teaching approach contributes to the development of the Climate-smart responsive competencies and skills among students. This cluster addresses

- the development of critical thinking skills
- informed decision making
- anticipatory skills
- respect for others
- System thinking competences
- Normative competence
- Socially engage practical competence

These competencies are essential to prepare graduates to engage in adaptation, resilience and climate-smart responsive practices.

Climate-Smart Innovation X

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36%

Examination and Assessment of Climate-Smart awareness topics within curriculum

This section determines to what extent Climate-smart responsive concepts are practically and theoretically assessed within specific subject area being reviewed.

<http://amanziforfood.co.za/downloadable-resources/>

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33%

Climate-Smart Agriculture General Topics

This section reviews the integration of Climate-Smart responsive content and principles within the curriculum.

General Topics include:

- Climate Change
- Food security
- Rural health development
- Entrepreneur skills
- Climate adaptation and resilience
- Rainwater Harvesting and Conservation
- Sustainable Agriculture

<http://www.fao.org/docrep/018/i3325e/i3325e.pdf>

Climate-Smart Innovation

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30%

Community engagement

This section reviews your students and your own involvement in community initiatives that addresses Climate-Smart responsive issues and focuses on green job creation, poverty eradication, sustainable agriculture and food security.

<http://amanziforfood.co.za/downloadable-resources/>

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28%

Practical Curriculum and Research Development

This section evaluates the extend of the integration of Climate-Smart responsiveness within the practical projects and assignments. It establishes if specific practical competencies such as Rain Water Harvesting and Conservation techniques are integrated within the practical projects.

<http://amanziforfood.co.za/about/>

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55808&language=en>



0%

Curriculum content

This section explores the integration of Climate-Smart responsive topics into the curriculum.

<http://www.fanrpan.org/documents/d01761/>

EXAMPLE OF SUMMATIVE SCORE ANALYSIS OF THE ONLINE CLIMATE-SMART INNOVATION TOOL – LECTURER

View details

[Take the assessment >](#)

Name Example of Climate-Smart Innovation Tool - Lecturer

Email address wilmavanstaden@gmail.com

Category	Score
Staff expertise and innovation	60%
Development of Climate-Smart awareness & competencies among students	50%
Examination and Assessment of Climate-Smart awareness topics within curriculum	36%
Climate-Smart Agriculture General Topics	33%
Community engagement	30%
Practical Curriculum and Research Development	28%
Curriculum content	0%

EXAMPLE OF A REPORT PROVIDED THAT INCLUDE THE QUESTIONS AND ANSWER OF THE ONLINE CLIMATE-SMART INNOVATION TOOL - LECTURER

Question	Answer
Name & Surname	Demo
What College of Agriculture / Training Institute are you associated with?	An Agricultural Training Institute not mentioned above
What is your position at the College of Agriculture / Agriculture Training Institute?	Lecturer
Which Department are you associated with?	Crop / Plant Production
Which of following general Climate-Smart Agriculture topics are integrated into your subject content?	1. Climate Change 2. Organic farming 3. Adaptation and resilience to climate change
Which of the following Climate-Smart Agriculture competencies does your teaching approach developed among students ?	1. Critical thinking skills 2. The ability to engage in adaptive management and to participate in social innovation that generate new practices. 3. Integrated problem solving skills 4. Respect for the opinion of other
Does your teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking?	Yes
Does your teaching approach create awareness of values and ethics including respect for other people's opinions, democracy, respect for the planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms?	Yes
Does your teaching approach develop the learner for social learning and innovation by exposing students to knowledge relating to Climate-Smart Agriculture as a response to the the past, present and future climate variation challenges?	No
Does your teaching approach follow an interdisciplinary approach where various knowledge and skills are combined and connected?	Yes
Does your teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts?	Yes
The extend that your Department is involved in research concerning Climate-Smart Agriculture concepts?	2
The extent to which your Department pursues solutions for Climate change and food security vulnerability within local community by applying the Climate-Smart Agriculture approach and concepts?	1

Question	Answer
The extent to which your Department is collaborating with other departments or research organisations to develop solution to climate change responsive problems and adaptability.	2
The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching pedagogy of your subject.	2
The extent to which bursaries for studying Food Security and Rain Water Harvesting and Conservation are granted.	
Level of commitment of the college resources in Climate-Smart Agriculture projects in the community.	2
The degree to which local agricultural issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of your Department's community engagement.	1
The extent to which Climate-Smart Agriculture aspects are formally assessed within your subject.	1
The extent to which Climate-Smart Agriculture aspects are considered when evaluating and assessing student's practical projects.	2
To what extend do you think is Climate-Smart Agriculture concepts relevant to your subject specialty?	Relevant
To what extend are you willing to integrate Climate-Smart Agriculture into your subject's practical framework.	The integration is important and I am planning to integrate Climate-Smart Agriculture components.
Any comments on the assessment?	

APPENDIX 5.3

ONLINE SUB-TOOL

CLIMATE-SMART INNOVATION TOOL – MANAGEMENT¹⁷

¹⁷ URL Link: <https://www.onlineassessmenttool.com/climate-smart-innovation-tool-management/assessment-55035>

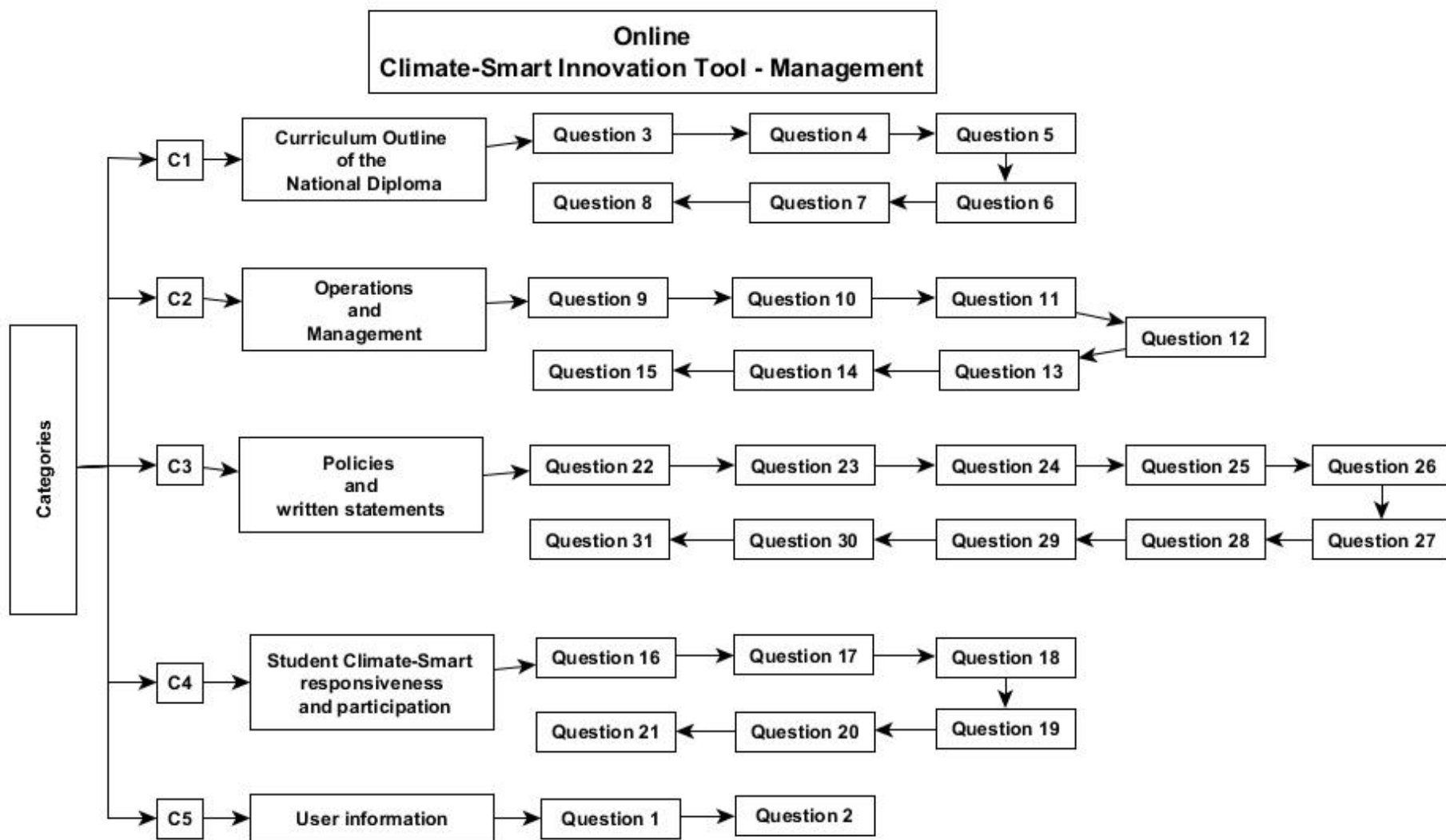
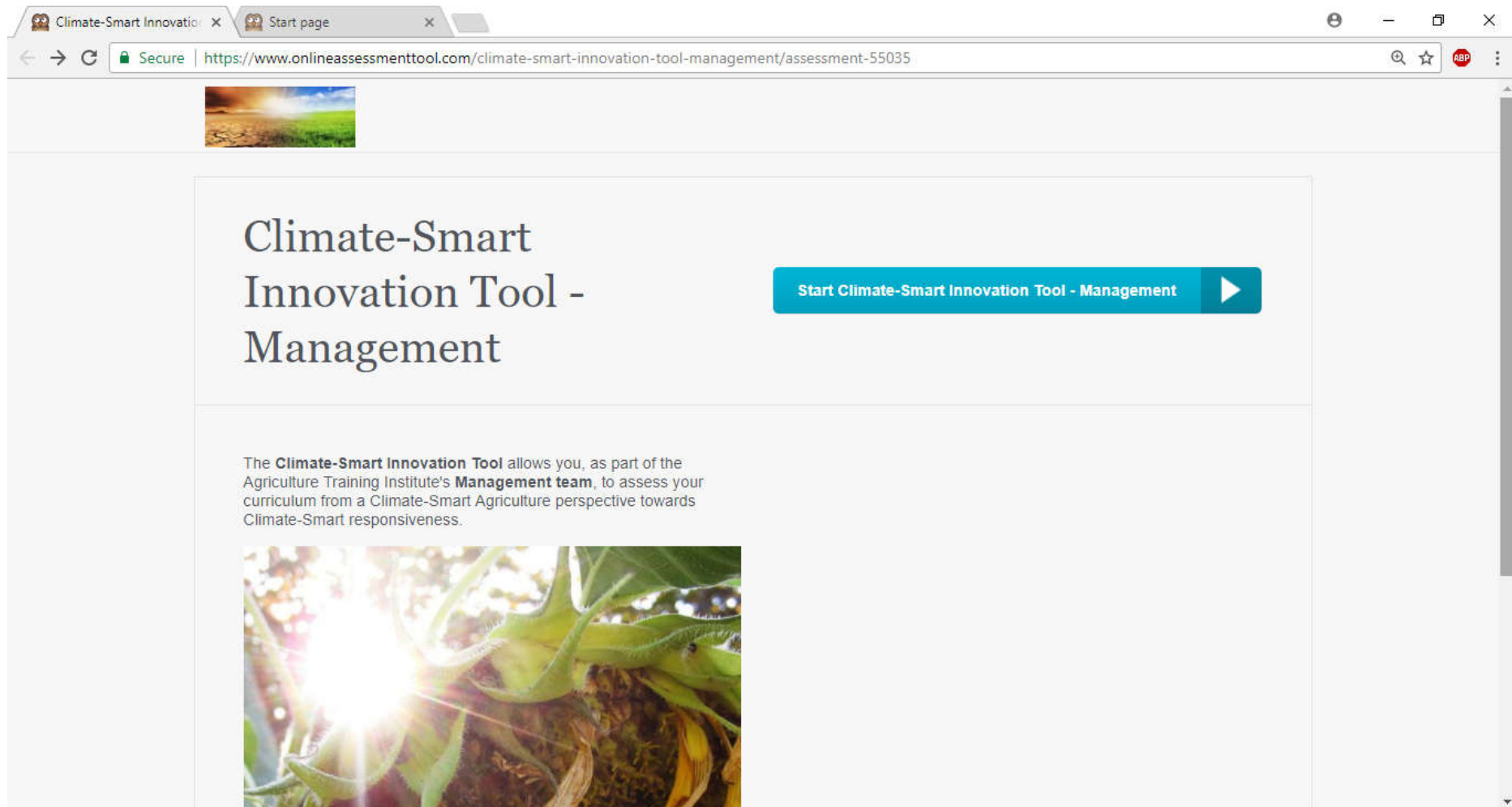


FIGURE 5.2 A FLOWCHART OF THE ONLINE CLIMATE-SMART INNOVATION TOOL – MANAGEMENT

THE ONLINE CLIMATE-SMART INNOVATION TOOL – MANAGEMENT



The screenshot shows a web browser window with two tabs: "Climate-Smart Innovation" and "Start page". The address bar displays a secure connection to <https://www.onlineassessmenttool.com/climate-smart-innovation-tool-management/assessment-55035>. The page features a header image of a sunset over a green field. The main content area has a large heading "Climate-Smart Innovation Tool - Management" and a blue button labeled "Start Climate-Smart Innovation Tool - Management" with a play icon. Below this, a paragraph explains that the tool allows users, as part of the Agriculture Training Institute's Management team, to assess their curriculum from a Climate-Smart Agriculture perspective towards Climate-Smart responsiveness. A small image of corn plants is shown at the bottom.

Climate-Smart Innovation Tool - Management

Start Climate-Smart Innovation Tool - Management

The **Climate-Smart Innovation Tool** allows you, as part of the Agriculture Training Institute's **Management team**, to assess your curriculum from a Climate-Smart Agriculture perspective towards Climate-Smart responsiveness.

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/login&id=55035&language=en>



Enter your details

Name *

Email address *

Start Climate-Smart Innovation Tool - Management

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Logged in as Demo | [Logout](#)

Question 1 / 31

Which Agricultural Training Institute are you currently employed by?

Select an option ▼

- Select an option
- Taung Agricultural College
- Potchefstroom College of Agriculture
- Fort Cox College of Agriculture
- Tsolo Agriculture and Rural Development Institute
- Glen Agricultural College
- Cedara Agricultural College
- An Agricultural Training Institute not mentioned above

Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

ABP



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Question 2 / 31

Your position at the College of Agriculture / Agricultural Training Institute

Select an option

Select an option

Head of Department

College Campus Head

Other management position not specified above

Lecturer

Administration

Farm Manager

Climate-Smart Innovation x Manage questions x

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 3 / 31

The extent to which issues and challenges surrounding the sustainable increase of agriculture productivity form part of your institutes's teaching program.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 4 / 31

The extent to which challenges surrounding adaptation and building resilience to climate change is covered within the institute's teaching program?

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 5 / 31

The extent to which the challenges relating to greenhouse gas emission is included in the Diploma?

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 6 / 31

The extent to which food security and homestead farming are covered in the curriculum.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 7 / 31

The extent to which the curriculum is relevant to the Climate-Smart responsive challenges that farmers and extension officers are facing in South Africa.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 8 / 31

The extent to which interdisciplinary education forms a component of the curriculum e.g. linking extension education, food security and climate change.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

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Question 9 / 31

The degree of waste reduction practices on the campus.

0 – None

1 – Unsatisfactory

2 – Needs development

3 – Adequately

4 – Meets requirements

5 – Exceed requirements

0

1

2

3

4

5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

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Question 10 / 31

The extent of recycling practices on the campus.

0 – None

1 – Unsatisfactory

2 – Needs development

3 – Adequately

4 – Meets requirements

5 – Exceed requirements

0

1

2

3

4

5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 11 / 31

The extent to which practices to reduce greenhouse gas emissions are implemented on campus.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 12 / 31

The extent to which energy conservation practices are implemented on campus.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation

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Question 13 / 31

The extent of Climate-Smart awareness on the campus.

0 – None

1 – Unsatisfactory

2 – Needs development

3 – Adequately

4 – Meets requirements

5 – Exceed requirements

0

1

2

3

4

5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

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Question 14 / 31

The extent that water conservation practices are implemented on campus.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 15 / 31

The extent to which Rain Water Harvesting and Conservation practices are implementation on campus.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation

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ABP



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Question 16 / 31

Is there a student climate and environmental organisation or group on campus?

Choose up to 1 response:

☐ Yes

☐ No

[Next question >](#)

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Climate-Smart Innovation

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ABP



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Question 17 / 31

Does students have access to career counselling that focuses on work opportunities related to climate change and agriculture sustainability?

Choose up to 1 response

☐ Yes

☐ No

[Next question >](#)

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation

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Question 18 / 31

Are sustainable and environmental friendly practices applied within the residence or dormitories by students (e.g. recycling and waste reduction)?

Choose up to 1 response

☐ Yes

☐ No

Next question ›

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

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Question 19 / 31

Is there a community garden programme that students are involved in?

Choose up to 1 response:

☐ Yes

☐ No

Next question ›

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Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

ABP



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Question 20 / 31

Are students involved in a practical program that promote food security, homestead gardening and entrepreneurship?

Choose up to 1 response

☐ Yes

☐ No

[Next question ›](#)

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

ABP



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Question 21 / 31

Does student assessment projects allow for the practical application of Climate-Smart Agriculture concepts?

Choose up to 1 response:

☐ Yes

☐ No

[Next question >](#)

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

ABP



Logged in as Demo | [Logout](#)

Question 22 / 31

Does the college / institute have a Climate-Smart responsive awareness program that promotes awareness of climate change, food security and sustainable agriculture?

Choose up to 1 response

☐ Yes

☐ No

[Next question >](#)

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 23 / 31

The extent to which the province's policies related to agriculture reflects the educational engagement with Climate-Smart Agriculture and climate change responsiveness.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 24 / 31

The extent to which national and global climate change issues inform decision making processes in the institute's policy and structures.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 25 / 31

The level of support that your College / Agriculture Training Institute receives for the integration and policy alignment of Climate-Smart Agriculture and climate change responsiveness aspects into the Diploma.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 26 / 31

The level of integration of Climate-Smart Agriculture concepts such as sustainability into the existing institutional policies.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 27 / 31

The level of integration of climate change responses and other Climate-Smart Agriculture concepts into the institutes vision and mission statement.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 28 / 31

Level of implementation of policies aligned with or related to Climate-Smart Agriculture.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 29 / 31

The level of future consideration to improve the integration of Climate-Smart Agriculture concepts during the next policy review cycle.

0 – None	0
1 – Unsatisfactory	1
2 – Needs development	2
3 – Adequately	3
4 – Meets requirements	4
5 – Exceed requirements	5

Online Assessment Tool part of Easy LMS

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 30 / 31

The extend to which the curriculum is aligned with AgriSETA's norms and standards for Extension and Advisory Services in the Agricultural Sector.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Climate-Smart Innovation

Manage questions

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 31 / 31

The extend to which the curriculum articulate with the Agricultural Education and Training Strategy (AET) of South Africa.

0	None	0
1	Unsatisfactory	1
2	Needs development	2
3	Adequately	3
4	Meets requirements	4
5	Exceed requirements	5

EXAMPLE OF THE REPORT PRESENTED TO THE REVIEWER AFTER THE ONLINE REVIEW FOR CLIMATE-SMART INNOVATION TOOL - MANAGEMENT.

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&language=en>

Congratulations, you've completed Climate-Smart Innovation Tool - Management

Based on your answers, you can see your result below



71%

Student Climate-Smart responsiveness and participation

This section ranks the **student involvement** in voluntary community engage activities related to Climate-Smart Agriculture responsive concepts such as Food security, homestead-gardening community projects and water conservation projects.

This cluster also includes indicators for student orientation programs, career counselling and student political and governance relating to Climate-Smart responsiveness. To summarise this section covers

- student community activities
- student support
- student organisation and governance systems

.....in transitioning towards innovation

A comprehensive and complete report on this sections result will be send to you via e-mail.
<http://amanzi4orfood.co.za/>

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&language=en>



41%

Policies and written statements

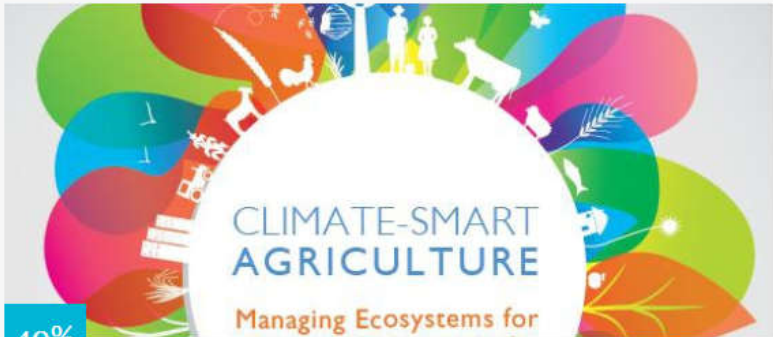
This section deals with the **policies and written statements** of the Agriculture Training Institute and its alignment with Climate-Smart Agriculture concepts, climate responsiveness and the National Agriculture Strategic plan for Agriculture Training Institutes.

A comprehensive and complete report on this sections result will be send to you via e-mail.

http://www.fanrpan.org/documents/d01761/South%20Africa_Comprehensive_Scoping_Assessment_of_CSA_Policies.pdf

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&language=en>



40%

Curriculum Outline of the National Diploma

This section focus on the extend of integration of Climate-Smart responsiveness within the general outline of the Agriculture curriculum. It identifies the challenges and possibilities for change and transformation towards a more Climate-Smart responsive curriculum.

A comprehensive and complete report on this sections result will be send to you via e-mail.

This section focuses on the general Climate-Smart Agriculture concepts that can be integrated into the Agriculture curriculum

- Sustainable increase in agriculture productivity and incomes
- Adaption and building resilience to climate change
- Reducing emission of greenhouse gases
- Sustainable agriculture
- National Food security

<http://amanziforfood.co.za/>

Climate-Smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&language=en>



35%

Operations and Management

This section reviews the **OPERATIONS AND MANAGEMENT** of the Agriculture Training Institute. This review enables the participant to identify the institutes performance in relation to Climate-Smart responsiveness.

A comprehensive and complete report on this sections result will be send to you via e-mail.

Topics covered during this section included:

- Waste reduction practices
- Recycling
- Reduction of greenhouse gas emissions
- Energy conservation practices
- Awareness of Climate-Smart Agriculture programs
- Water conservation practices

<http://www.fao.org/docrep/018/i3325e/i3325e00.htm>

EXAMPLE OF SUMMATIVE SCORE ANALYSIS OF THE ONLINE CLIMATE-SMART INNOVATION TOOL – MANAGEMENT

Name	Demo
Email address	wilmavanstaden@gmail.com

Category	Score
Student Climate-Smart responsiveness and participation	71%
Policies and written statements	41%
Curriculum Outline of the National Diploma	40%
Operations and Management	35%
Core competencies for curriculum	0%
User information	0%

EXAMPLE OF A REPORT PROVIDED THAT INCLUDE THE QUESTIONS AND ANSWER OF THE ONLINE CLIMATE-SMART INNOVATION TOOL - MANAGEMENT

#	Question	Answer
1	Which Agricultural Training Institute are you currently employed by?	An Agricultural Training Institute not mentioned above
2	Your position at the College of Agriculture / Agricultural Training Institute	Other management position not specified above
3	The extent to which issues and challenges surrounding the sustainable increase of agriculture productivity form part of your institutes's teaching program.	2
4	The extent to which challenges surrounding adaptation and building resilience to climate change is covered within the institute's teaching program?	2
5	The extent to which the challenges relating to greenhouse gas emission is included in the Diploma?	2
6	The extent to which food security and homestead farming are covered in the curriculum.	2
7	The extent to which the curriculum is relevant to the Climate-Smart responsive challenges that farmers and extension officers are facing in South Africa.	2
8	The extent to which interdisciplinary education forms a component of the curriculum e.g. linking extension education, food security and climate change.	2
9	The degree of waste reduction practices on the campus.	2
10	The extent of recycling practices on the campus.	2

#	Question	Answer
11	The extent to which practices to reduce greenhouse gas emissions are implemented on campus.	2
12	The extent to which energy conservation practices are implemented on campus.	2
13	The extent of Climate-Smart awareness on the campus.	2
14	The extent that water conservation practices are implemented on campus.	2
15	The extent to which Rain Water Harvesting and Conservation practices are implementation on campus.	2
16	Is there a student climate and environmental organisation or group on campus?	Yes
17	Does students have access to career counselling that focuses on work opportunities related to climate change and agriculture sustainability?	No
18	Are sustainable and environmental friendly practices applied within the residence or dormitories by students (e.g. recycling and waste reduction)?	No
19	Is there a community garden programme that students are involved in?	Yes
20	Are students involved in a practical program that promote food security, homestead gardening and entrepreneurship?	Yes

#	Question	Answer
21	Does student assessment projects allow for the practical application of Climate-Smart Agriculture concepts?	Yes
22	Does the college / institute have a Climate-Smart responsive awareness program that promotes awareness of climate change, food security and sustainable agriculture?	Yes
23	The extent to which the province's policies related to agriculture reflects the educational engagement with Climate-Smart Agriculture and climate change responsiveness.	2
24	The extent to which national and global climate change issues inform decision making processes in the institute's policy and structures.	2
25	The level of support that your College / Agriculture Training Institute receives for the integration and policy alignment of Climate-Smart Agriculture and climate change responsiveness aspects into the Diploma.	2
26	The level of integration of Climate-Smart Agriculture concepts such as sustainability into the existing institutional policies.	2
27	The level of integration of climate change responses and other Climate-Smart Agriculture concepts into the institutes vision and mission statement.	2
28	Level of implementation of policies aligned with or related to Climate-Smart Agriculture.	2
29	The level of future consideration to improve the integration of Climate-Smart Agriculture concepts during the next policy review cycle.	2
30	The extend to which the curriculum is aligned with AgriSETA's norms and standards for Extension and Advisory Services in the Agricultural Sector.	2
31	The extend to which the curriculum articulate with the Agricultural Education and Training Strategy (AET) of South Africa.	2

APPENDIX 5.4

CLIMATE-SMART INNOVATION TOOL – ANIMAL PRODUCTION¹⁸

¹⁸ URL Link: <https://www.onlineassessmenttool.com/climate-smart-innovation-tool-animal-production/assessment-55477>

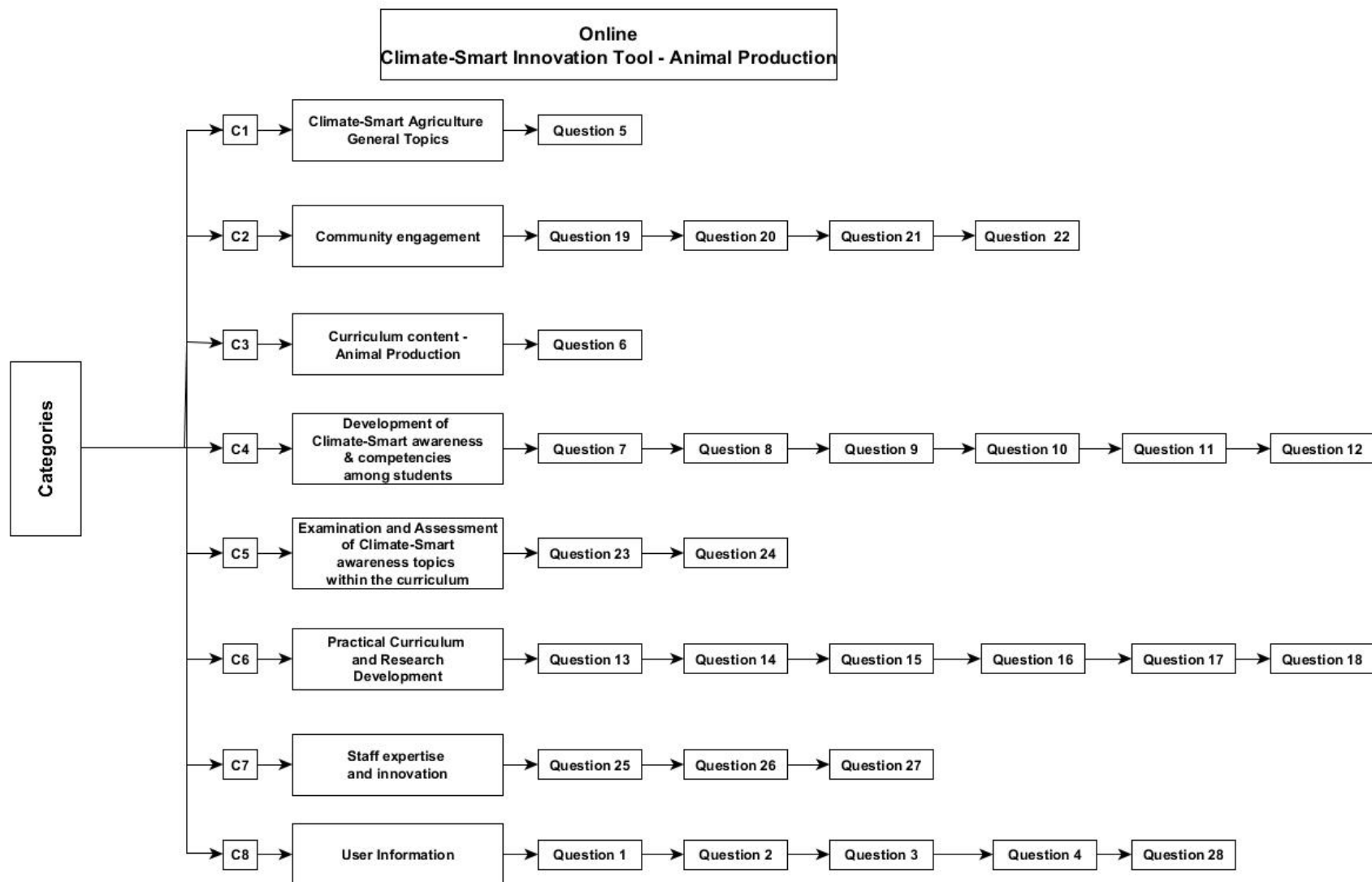
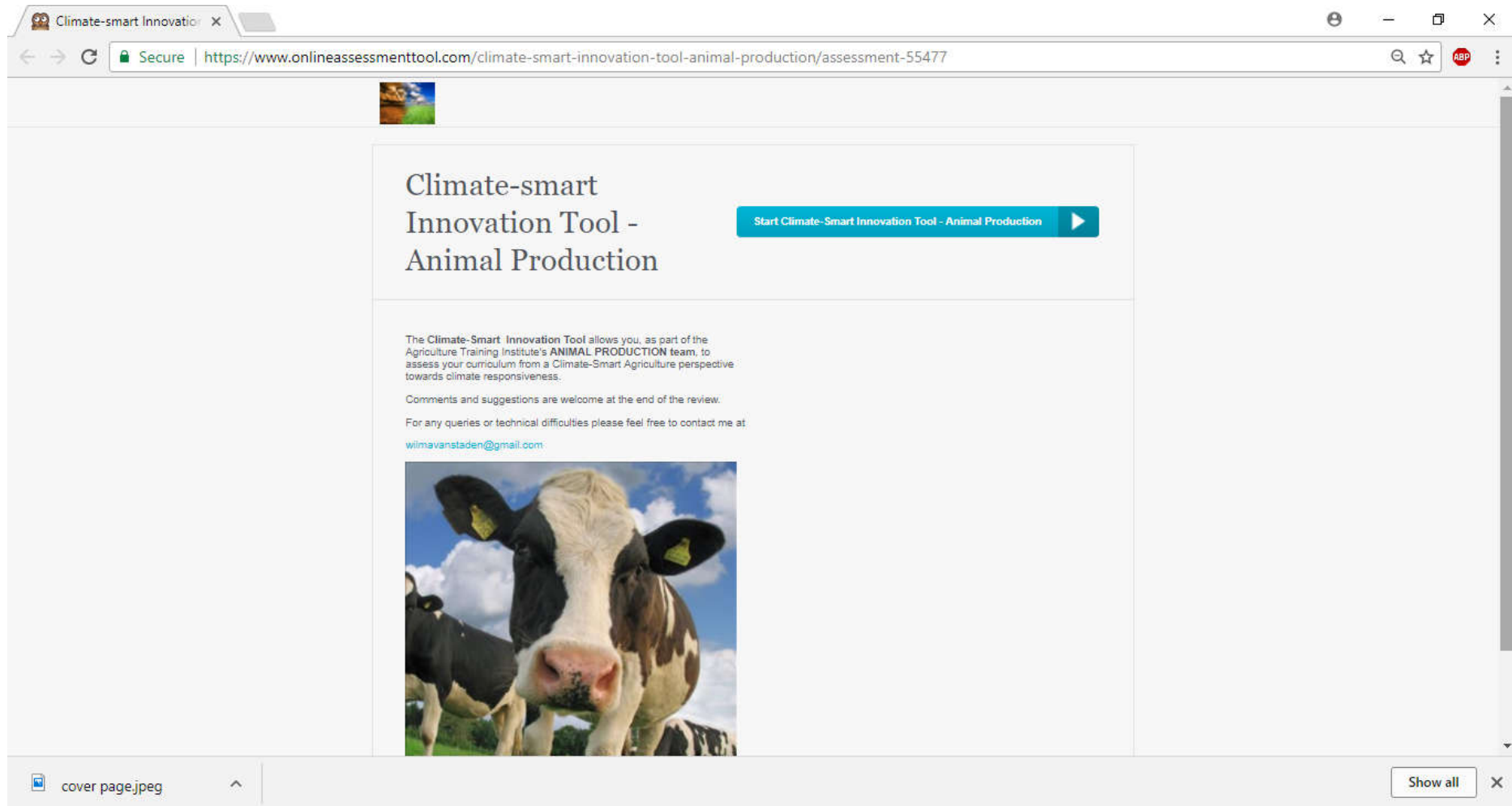


FIGURE 5.3 FLOWCHART OF THE ONLINE CLIMATE-SMART INNOVATION TOOL – ANIMAL PRODUCTION

THE ONLINE CLIMATE-SMART INNOVATION TOOL – ANIMAL PRODUCTION



Climate-smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 1 / 28

Name & Surname

Next question ›

Online Assessment Tool part of Easy LMS

cover page.jpeg

Show all

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 2 / 28

Which College of Agriculture or Training Institute are you associated with?

Select an option ▼

- Select an option
- Tuang Agricultural College
- Potchefstroom College of Agriculture
- Cedara Agricultural College
- Tsolo Agricultural College
- Fort Cox College of Agriculture
- Glen College of Agriculture
- Another Agricultural Institute not mentioned above

cover page.jpeg ^

Show all X

Climate-smart Innovation x

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 3 / 28

What is your position at the college / Agriculture Training Institute?

Select an option ▼

- Select an option
- Lecturer
- Head of Department
- Management

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 4 / 28

Tick the relevant area of subject under review.

Multiple answers possible

- ☐ Anatomy and Physiology of Farm Animals
- ☐ Pig Production
- ☐ Small Stock Production
- ☐ Dairy Production
- ☐ Animal Health
- ☐ Artificial Insemination
- ☐ Large Stock Judging
- ☐ Animal Breeding
- ☐ Animal Nutrition
- ☐ Beef Cattle Production Management
- ☐ Feedlot Management
- ☐ Poultry production
- ☐ Animal Production

Next question >

Climate-smart Innovation x Assessment dashboard x

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 5 / 28

Which of the following general Climate-Smart Agriculture topics are integrated into your subject content?

Multiple answers possible

- ☐ Climate Change
- ☐ Rural health creation
- ☐ Food security
- ☐ Sustainable agricultural practices
- ☐ Development of entrepreneur skills
- ☐ Renewable energy
- ☐ Organic farming
- ☐ Sustainable water management
- ☐ Adaptation and resilience to climate change
- ☐ NOT APPLICABLE

Next question >

Climate-smart Innovation X

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Question 6 / 28

Which of the following Climate-Smart Agriculture topics relevant to Animal Production are integrated into your subject content?

Multiple answers possible

- ☐ Adapted sustainable livestock and pasture management
- ☐ Indigenous knowledge
- ☐ Techniques to capacitate livestock farmers to enhance resilience towards Climate Change effects.
- ☐ Adaptation to Climate Change problems and challenges effecting livestock farming.
- ☐ Reducing the Carbon footprint of livestock farming
- ☐ Methods to increase nutrition quality that increases reproduction, protect against diseases and reduce greenhouse gas emissions.
- ☐ Fodderbanks
- ☐ NOT APPLICABLE

Next question »

Climate-smart Innovation X

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Question 7 / 28

Which of the following Climate-Smart Agriculture competencies does your teaching approach developed among students ?

Multiple answers possible

- ☐ The capacity to make informed decisions related to Climate-smart challenges and issues.
- ☐ Critical thinking skills
- ☐ Systems thinking skills to understand complex problems from an agricultural systems perspective to solve Climate-smart responsive challenges.
- ☐ Anticipatory skills to assess the vulnerability and risk of a specific agriculture system.
- ☐ The competence to adapt through alternative responses that are sustainable through planning and strategic development.
- ☐ The competence to consider implications and effects that decisions have on the community, agriculture and ecological systems
- ☐ The ability to engage in adaptive management and to participate in social innovation that generate new practices.
- ☐ A sense of responsibility towards the community, agriculture and ecological systems.
- ☐ Integrated problem solving skills
- ☐ Respect for the opinion of other

Next question »

Climate-smart Innovation X

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Question 8 / 28

Does your teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking?

Choose up to 1 response

☐ Yes

☐ No

[Next question ›](#)

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Climate-smart Innovation X

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Question 9 / 28

Does your teaching approach create awareness of values and ethics including respect for other people's opinions, democracy, respect for planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms?

Choose up to 1 response

☐ Yes

☐ No

[Next question ›](#)

Online Assessment Tool part of Easy LMS

Climate-smart Innovation X

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Question 10 / 28

Does your teaching approach develop the learner for social learning and innovation by exposing students to knowledge concerning the past, present and future climate changes and food security challenges?

Choose up to 1 response

☐ Yes

☐ No

Next question ›

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Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 11 / 28

Does your teaching approach follow an interdisciplinary approach where various knowledge and skills are combined and connected?

Choose up to 1 response

☐ Yes

☐ No

[Next question ›](#)

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Climate-smart Innovation X

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Question 12 / 28

Does your teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts?

Choose up to 1 response

☐ Yes

☐ No

Next question ›

Online Assessment Tool part of Easy LMS

Climate-smart Innovation

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Question 13 / 28

The extent to which the Animal Production Department (staff and students) are involved in research concerning Climate-Smart Agriculture concepts?

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 14 / 28

The extent to which the department pursues solutions for Climate Change and food security vulnerability within local community by applying Climate-Smart Agriculture concepts?

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 15 / 28

The extent to which the department within the study program is collaborating with other research organisations to develop solutions for climate change and food insecurity challenges.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

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Question 16 / 28

The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching pedagogy.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

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Question 17 / 28

The extent to which bursaries to study and research topics related to Climate-Smart livestock and Food Security are granted.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

Manage questions

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 18 / 28

The extent to which the Animal Production Department use practical methods to practice Climate-Smart Agriculture in farming and other activities within the department.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 19 / 28

Level of commitment of the college resources towards Climate-Smart Agriculture related projects in the community.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

☐

0

☐

1

☐

2

☐

3

☐

4

☐

5

Next question >

Climate-smart Innovation

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Question 20 / 28

The degree to which local agriculture issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of the department's community engagement.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 21 / 28

The extent to which the department collaborates with other stakeholders to address the household and small holder farmers' climate change challenges.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>

Question 22 / 28

The extent to which aspects of Climate-Smart Agriculture is used in the selection and execution of community engagement projects.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0 1 2 3 4 5

Next question >

Online Assessment Tool part of Easy LMS

Climate-smart Innovation

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 23 / 28

The extent to which Climate-Smart Agriculture aspects are formally assessed within your subject.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

☐ 0

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

Next question >

Online Assessment Tool part of Easy LMS

Climate-smart Innovation

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Question 24 / 28

The extent to which Climate-Smart Agriculture aspects are considered in evaluating and assessing practical projects.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

Climate-smart Innovation

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Question 25 / 28

The level of your academic expertise in the area of Climate-Smart Agriculture and climate responsiveness.

0	None
1	Unsatisfactory
2	Needs development
3	Adequately
4	Meets requirements
5	Exceed requirements

0

1

2

3

4

5

Next question >

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Climate-smart Innovation X

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Question 26 / 28

To what extend do you think is Climate-Smart Agriculture concepts are relevant to your field of expertise?

It is not relevant.

Slightly relevant

Relevant

The topic should play an important part in the curriculum

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Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/quiz&language=en>



Question 27 / 28

To what extend are you willing to integrate Climate-Smart Agriculture concepts into your practical framework.

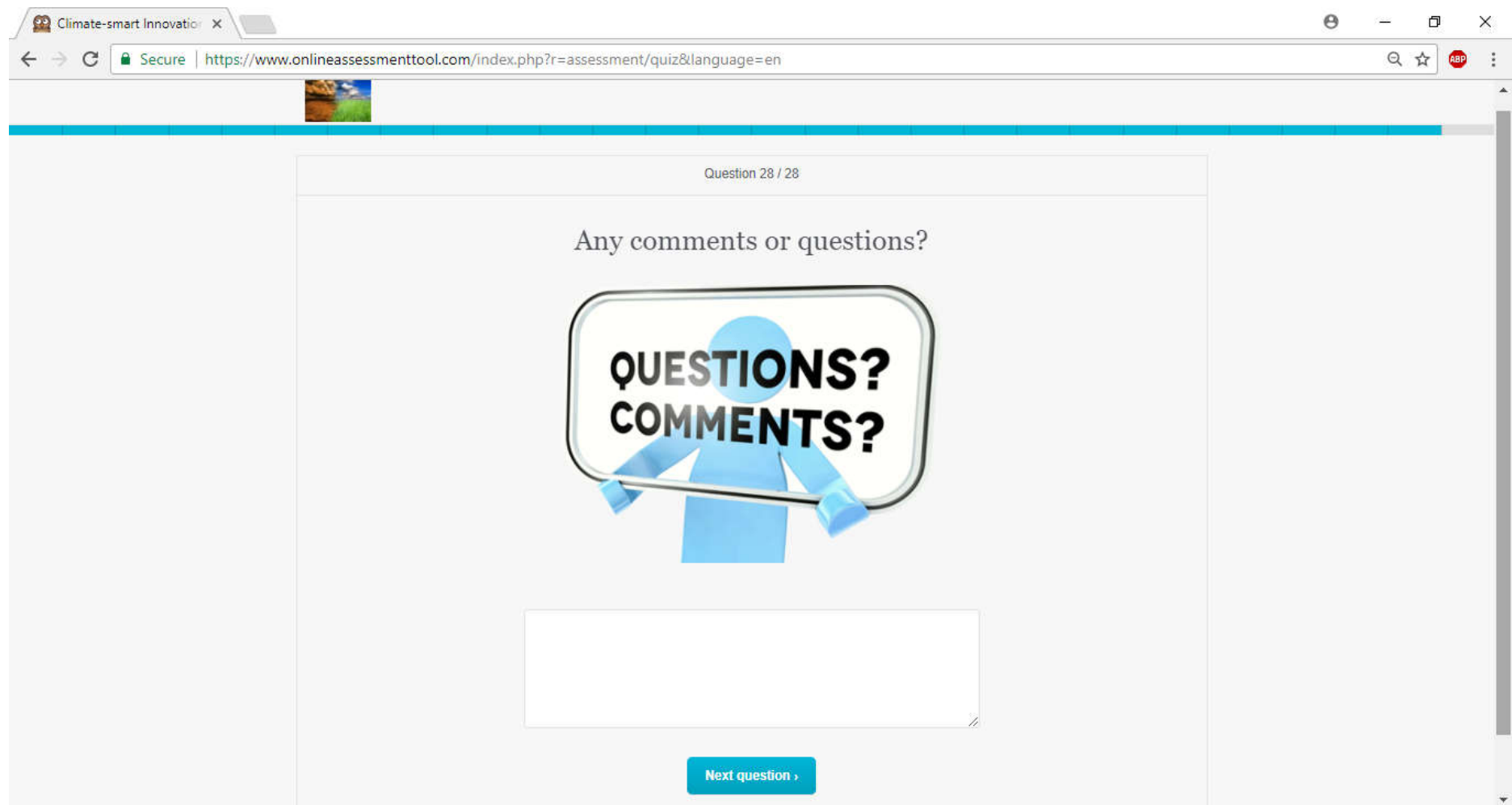
Not willing. Not relevant to my subject content

Some integration is possible

Integration is important and I am planning to integrate Climate-Smart Agriculture related topics into my subject.

I have integrated the Climate-Smart Agriculture into my subject's practical content.

Online Assessment Tool part of Easy LMS



EXAMPLE OF THE REPORT PRESENTED TO THE REVIEWER AFTER THE ONLINE REVIEW FOR CLIMATE-SMART INNOVATION TOOL – ANIMAL PRODUCTION.

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55477&language=en>

Result

Congratulations, you've completed Climate-smart Innovation Tool - Animal Production

Based on your answers, you can see your result below



57%

Curriculum content - Animal Production

This section explores the integration of Climate-smart responsive topics including adaptive livestock and pasture management into the curriculum. Adaptation options include re-matching stocking rates and timing with pasture production, new varieties and species of forage and livestock, updated fertilizer application, and using supplementary feeds and concentrates.

http://www.bdspublishing.com/_webedit/uploaded-files/All%20Files/Blog/Climate-smart-livestock-Blog.pdf & <http://www.tulicattle.co.za/images/photos/TradingPost-September2014.pdf>

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55477&language=en>



43%

Development of Climate-Smart awareness competencies among students

This section reviews to what extent teaching approach contributes to the development of the Climate-Smart responsive competencies and skills among students. This cluster addresses

- the development of critical thinking skills
- informed decision making
- anticipatory skills
- respect for others
- System thinking competences
- Normative competence
- Socially engage practical competence

These competences are essential to prepare graduates to engage in adaptation, resilience and climate-smart responsive practices.

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55477&language=en>



40%

Community engagement

This section reviews the staff and students within the Animal Production Department's involvement in community initiatives that addresses Climate-Smart responsive issues and focuses on green job creation, poverty eradication and food security.

<http://amanziforfood.co.za/downloadable-resources/>

Waiting for www.google-analytics.com...

Climate-smart Innovation X

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40%

Examination and Assessment of Climate-Smart awareness topics within Curriculum

This section determines to what extent Climate-Smart responsive concepts are practically and theoretically assessed within specific subject area being reviewed.

<http://amanziforfood.co.za/downloadble-resources/>



Climate-smart Innovation X

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40%

Practical Curriculum and Research Development

This section evaluates the extend of the integration of Climate-Smart responsiveness within the practical projects and assignments. It establishes if specific Climate-Smart practical competencies are integrated within the practical projects.

<http://amanziforfood.co.za/about/>

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55477&language=en>



33%

Climate-Smart Agriculture General Topics

This section reviews the integration of Climate-Smart responsive content and principles within the participant's specific learning area within Animal Production.

General Topics include:

- Climate Change
- Food security
- Rural health development
- Entrepreneur skills
- Climate adaptation and resilience

<http://www.fao.org/docrep/018/i3325e/i3325e.pdf>

Climate-smart Innovation X

Secure | <https://www.onlineassessmenttool.com/index.php?r=assessment/ranking&id=55477&language=en>



27%

Staff expertise and innovation

This section focuses on the participants views on

- Participant's level of expertise on Climate-Smart responsive concepts.
- The relevance of Climate-Smart Agriculture concepts to Animal Production curriculum.
- The integration of Climate-Smart Agriculture concepts into curriculum
- Further training for lecturers
- Type of further training for lecturers

<http://amanziforfood.co.za/about/>

Online Assessment Tool part of Easy LMS

EXAMPLE OF SUMMATIVE SCORE ANALYSIS OF THE ONLINE CLIMATE-SMART INNOVATION TOOL – ANIMAL PRODUCTION

View details		Take the assessment >
Name	Example of Climate-Smart Innovation Tool - Animal Production	
Email address	wilmavanstaden@gmail.com	
Category	Score	
Curriculum content - Animal Production	57%	
Development of Climate-Smart awareness competencies among students	43%	
Community engagement	40%	
Examination and Assessment of Climate-Smart awareness topics within Curriculum	40%	
Practical Curriculum and Research Development	40%	
Climate-Smart Agriculture General Topics	33%	
Staff expertise and innovation	27%	

EXAMPLE OF A REPORT THAT INCLUDE THE QUESTIONS AND ANSWER OF THE ONLINE CLIMATE-SMART INNOVATION TOOL – ANIMAL PRODUCTION

#	Question	Answer
1	Name & Surname	Example of Climate-Smart Innovation Tool - Plant Production
2	Which College of Agriculture or Training Institute are you associated with?	Another Agricultural Institute not mentioned above
3	What is your position at the college / Agriculture Training Institute?	Head of Department
4	Tick the relevant area of subject under review.	Anatomy and Physiology of Farm Animals
5	Which of following general Climate-Smart Agriculture topics are integrated into your subject content?	1. Climate Change 2. Renewable energy 3. Organic farming
6	Which of the following Climate-Smart Agriculture topics relevant to Animal Production are integrated into your subject content?	1. Adapted sustainable livestock and pasture management 2. Techniques to capacitate livestock farmers to enhance resilience towards Climate Change effects. 3. Reducing the Carbon footprint of livestock farming 4. Fodderbanks
7	Which of the following Climate-Smart Agriculture competencies does your teaching approach developed among students ?	1. The capacity to make informed decisions related to Climate-smart challenges and issues. 2. Anticipatory skills to assess the vulnerability and risk of a specific agriculture system. 3. The competence to consider implications and effects that decisions have on the community, agriculture and ecological systems

#	Question	Answer
8	Does your teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking?	Yes
9	Does your teaching approach create awareness of values and ethics including respect for other people's opinions, democracy, respect for planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms?	Yes
10	Does your teaching approach develop the learner for social learning and innovation by exposing students to knowledge concerning the past, present and future climate changes and food security challenges?	No
11	Does your teaching approach follow an interdisciplinary approach where various knowledge and skills are combined and connected?	Yes
12	Does your teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts?	No
13	The extent to which the Animal Production Department (staff and students) are involved in research concerning Climate-Smart Agriculture concepts?	2
14	The extent to which the department pursues solutions for Climate Change and food security vulnerability within local community by applying Climate-Smart Agriculture concepts?	2
15	The extent to which the department within the study program is collaborating with other research organisations to develop solutions for climate change and food insecurity challenges.	2
16	The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching pedagogy.	2
17	The extent to which bursaries to study and research topics related to Climate-Smart livestock and Food Security are granted.	2
18	The extent to which the Animal Production Department use practical methods to practice Climate-Smart Agriculture in farming and other activities within the department.	2

#	Question	Answer
19	Level of commitment of the college resources towards Climate-Smart Agriculture related projects in the community.	2
20	The degree to which local agriculture issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of the department's community engagement.	2
21	The extent to which the department collaborates with other stakeholders to address the household and small holder farmers' climate change challenges.	2
22	The extent to which aspects of Climate-Smart Agriculture is used in the selection and execution of community engagement projects.	2
23	The extent to which Climate-Smart Agriculture aspects are formally assessed within your subject.	2
24	The extent to which Climate-Smart Agriculture aspects are considered in evaluating and assessing practical projects.	2
25	The level of your academic expertise in the area of Climate-Smart Agriculture and climate responsiveness.	2
26	To what extent do you think is Climate-Smart Agriculture concepts are relevant to your field of expertise?	Slightly relevant
27	To what extent are you willing to integrate Climate-Smart Agriculture concepts into your practical framework.	Some integration is possible
28	Any comments or questions?	

APPENDIX 5.5

CLIMATE-SMART INNOVATION TOOL – IRRIGATION¹⁹

¹⁹ URL Link: <https://www.onlineassessmenttool.com/climate-smart-innovation-tool-irrigation/assessment-82119>

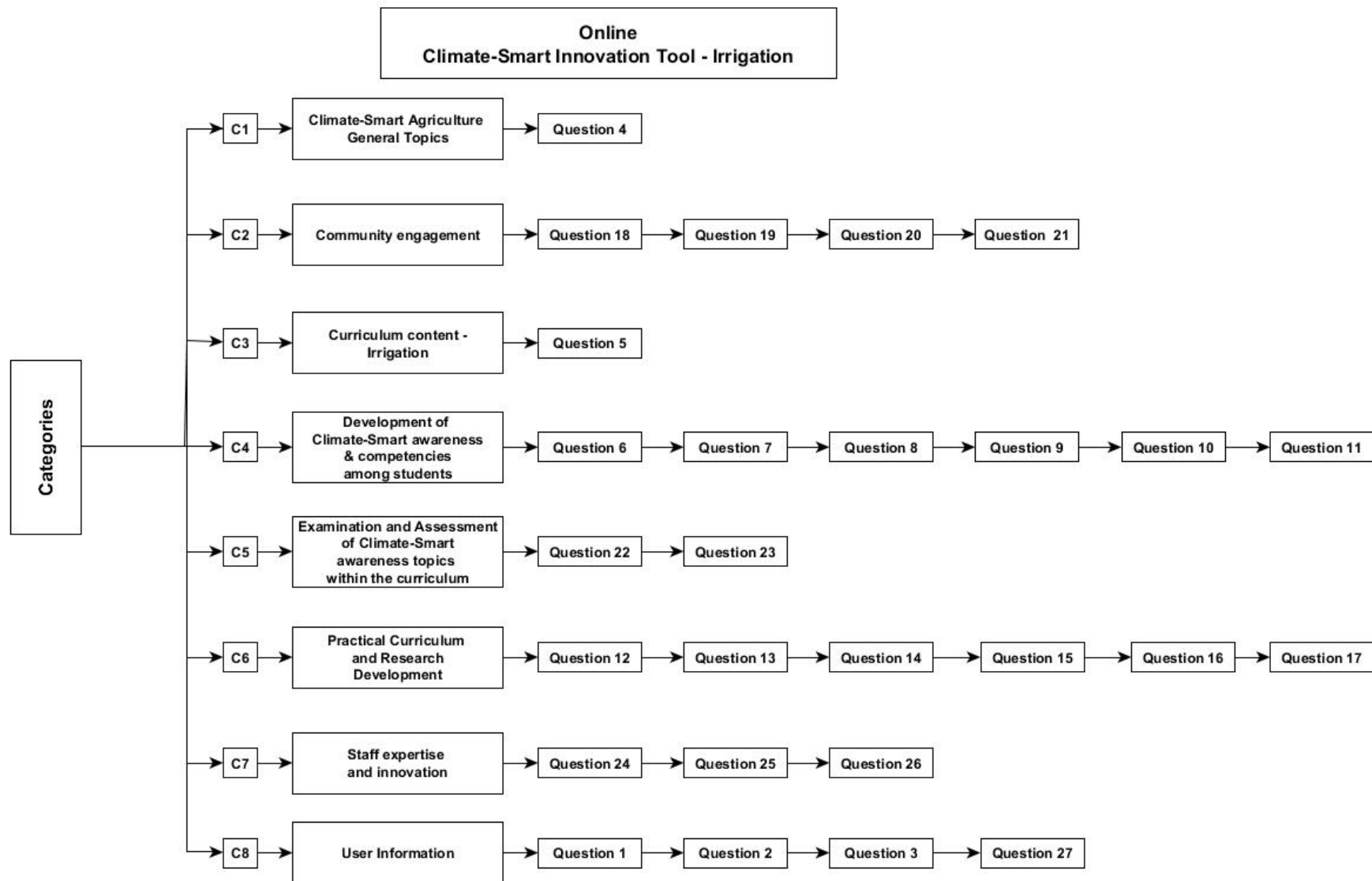


FIGURE 5.5 FLOWCHART OF THE ONLINE CLIMATE-SMART INNOVATION TOOL – IRRIGATION

About

Assessment title	Climate-Smart Innovation Tool - Irrigation
Type	Multiple categories
URL	https://www.onlineassessmenttool.com/climate-smart-innovation-tool-irrigation/assessment-82119
Number of questions	27

A LIST OF THE CLIMATE-SMART INNOVATION TOOL – IRRIGATION’S QUESTIONS

Number	Question
1	Name & Surname
2	Which College of Agriculture or Training Institute are you associated with?
3	What is your position at the college or Agricultural Training Institute?
4	Which of the following general Climate-Smart Agriculture topics are integrated into your subject content?
5	Which of the following Climate-Smart irrigation topics are integrated into your subject content?
6	Which of the following Climate-Smart Agriculture competencies does your teaching approach developed among students?
7	Does your teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking?
8	Does your teaching approach create awareness of values and ethics including respect for other people's opinions, democracy, respect for the planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms?
9	Does your teaching approach develop the learner for social learning and innovation by exposing students to knowledge relating to Climate-Smart Agriculture as a response to the the past, present and future climate variation challenges?

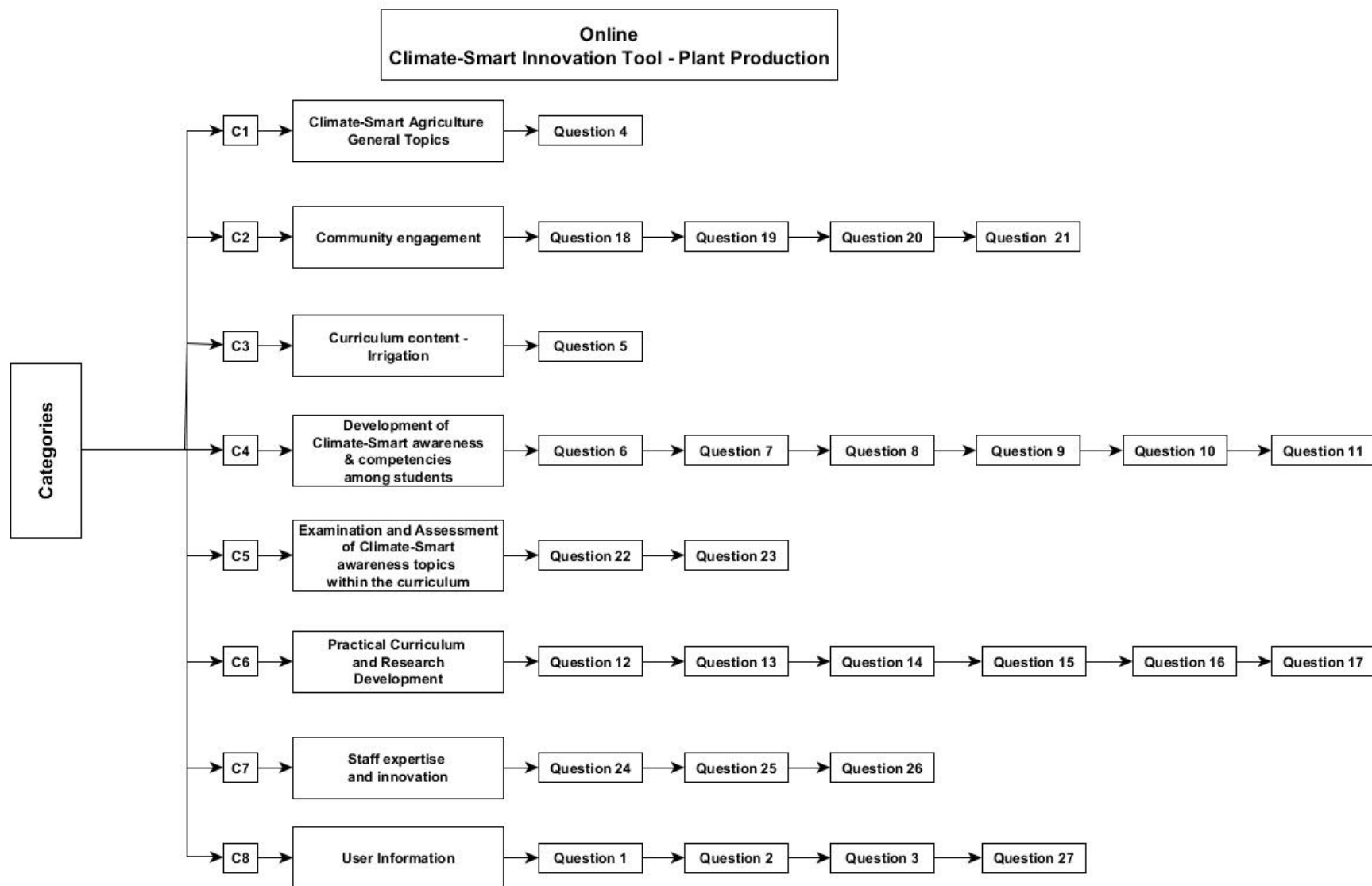
10	Does your teaching approach follow an interdisciplinary approach where various knowledge and skills are combined and connected?
11	Does your teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts?
12	The extend to which the Department of Irrigation(staff and students) are involved in research concerning Climate-Smart Agriculture concepts?
13	The extent to which your Department pursues solutions for Climate change and food security vulnerability within local community by applying the Climate-Smart Agriculture approach and concepts?
14	The extent to which your Department is collaborating with other departments or research organisations to develop solution to climate change responsive problems and adaptability.
15	The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching pedagogy of your subject.
16	The extent to which bursaries for studying Food Security and Rain Water Harvesting and Conservation are granted.
17	The extend to which the Department of Irrigation use practical methods to practice Climate-Smart Irrigation in farming and other activities.
18	Level of commitment of the college resources in Climate-Smart Agriculture projects in the community.

19	The degree to which local agricultural issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of your Department's community engagement.
20	The extend to which the department collaborates with other stakeholders to address the household and small holder farmers' climate response challenges
21	The extend to which aspects of Climate-Smart Agriculture - Irrigation is used in the selection and execution of community engagement projects.
22	The extent to which Climate-Smart Agriculture aspects are formally assessed within your subject.
23	The extent to which Climate-Smart Agriculture aspects are considered when evaluating and assessing student's practical projects.
24	The level of your academic expertise in the area of Climate-Smart Agriculture and Climate-Smart Irrigation.
25	To what extend do you think is Climate-Smart Agriculture concepts relevant to your subject specialty?
26	To what extend are you willing to integrate Climate-Smart Agriculture into your subject's practical framework.
27	Any comments on the assessment?

APPENDIX 5.6

CLIMATE-SMART INNOVATION TOOL – PLANT PRODUCTION²⁰

²⁰ URL Link: <https://www.onlineassessmenttool.com/climate-smart-innovation-tool-plant-production/assessment-82135>



Figure

5.6 Flowchart of the Online Climate-Smart Innovation tool – Plant Production

About

Assessment title	Climate-Smart Innovation Tool - Plant Production
Type	Multiple categories
URL	https://www.onlineassessmenttool.com/climate-smart-innovation-tool-plant-production/assessment-82135
Number of questions	26

A LIST OF THE CLIMATE-SMART INNOVATION TOOL – IRRIGATION’S QUESTIONS

Number	Question
1	Name & Surname
2	Which College of Agriculture or Training Institute are you associated with?
3	What is your position at the college or Agricultural Training Institute?
4	Which of the following general Climate-Smart Agriculture topics are integrated into your subject content?
5	Which of the following Climate-Smart topics related to Plant Production are integrated into your subject content?
6	Which of the following Climate-Smart Agriculture competencies does your teaching approach developed among students?
7	Does your teaching approach contribute to the development of paradigm thinking such as systems thinking, integrative thinking, critical and creative thinking?
8	Does your teaching approach create awareness of values and ethics including respect for other people’s opinions, democracy, respect for the planet and all life forms, empathy; appreciation of nature; care and concern towards all life forms?

9	Does your teaching approach develop the learner for social learning and innovation by exposing students to knowledge relating to Climate-Smart Agriculture as a response to the the past, present and future climate variation challenges?
10	Does your teaching approach follow an interdisciplinary approach where various knowledge and skills are combined and connected?
11	Does your teaching approach combine practical and theoretical teaching methods to explain Climate-Smart Agriculture concepts?
12	The extend to which the Department of Plant Production or Crop Production (staff and students) are involved in research concerning Climate-Smart Agriculture concepts?
13	The extent to which your Department pursues solutions for Climate change and food security vulnerability within local community by applying the Climate-Smart Agriculture approach and concepts?
14	The extent to which your Department is collaborating with other departments or research organisations to develop solution to climate change responsive problems and adaptability.
15	The extent to which aspects of Climate-Smart Agriculture are integrated within the practical projects and teaching pedagogy of your subject.
16	The extent to which bursaries for studying Food Security and Rain Water Harvesting and Conservation are granted.
17	The extend to which the Department of Plant Production or Crop Production use practical methods to practice Climate-Smart Irrigation in farming and other activities.

18	Level of commitment of the college resources in Climate-Smart Agriculture projects in the community.
19	The degree to which local agricultural issues and challenges that can benefit from the application and innovation of Climate-Smart Agriculture form part of your Department's community engagement.
20	The extend to which the department collaborates with other stakeholders to address the household and small holder farmers' climate response challenges
21	The extend to which aspects of Climate-Smart Agriculture is used in the selection and execution of community engagement projects.
22	The extent to which Climate-Smart Agriculture aspects are formally assessed within your subject.
23	The extent to which Climate-Smart Agriculture aspects are considered when evaluating and assessing student's practical projects.
24	To what extend do you think is Climate-Smart Agriculture concepts relevant to your subject specialty?
25	To what extend are you willing to integrate Climate-Smart Agriculture into your subject's practical framework.
26	Any comments on the assessment?

APPENDIX 6

CASE STUDY RECORDS ²¹

GOOGLE DRIVE LINK:

https://drive.google.com/open?id=1nCXLd_5Y8WT4t1PPEY7oBO6pY-qEKu67

²¹ GOOGLE DRIVE LINK:

https://drive.google.com/open?id=1nCXLd_5Y8WT4t1PPEY7oBO6pY-qEKu67