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**Sustainability Focus in Water Management and  
Curriculum Practices in an Agricultural College:  
A Case Study of Fort Cox Agriculture and Forestry Training Institute**

**A full thesis submitted in partial fulfilment of the requirement of the degree of  
MASTER OF EDUCATION (Environmental Education)**

**at**

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**by**

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## **Abstract**

This case study of Fort Cox Agriculture and Forestry Training Institute explored the sustainability focus in water management and curriculum practices. I was inspired to develop a deeper understanding of current water management and curriculum practices at Fort Cox with fellow academics involved in the teaching of water dependent curricula, students who were enrolled in water dependent subjects, and support staff involved in water management practices around campus. My initial assumption was there was a practice disconnect or mismatch between water management practices and the stated curriculum requirements at Fort Cox.

To develop a deeper understanding and possible responses, the study adopted the Practice Architectures Theory (PAT) developed by Kemmis (2009) and Kemmis, McTaggart and Nixon (2013). A supportive theory was also considered in the form of the action learning process developed by Marquardt (2007), which was aimed at bringing people together in an attempt to respond to water management practice concerns in their context. Practice Architectures Theory was used with the view to understand the ‘sayings, doings, and relatings’ regarding water management and curriculum practices at Fort Cox, in particular around Irrigation, Soil and Water Conservation subjects and the other water dependent subjects. Kemmis *et al.* (2013) suggested that practices come into being because people do not act alone but as a collective, and bring them into being. In practice, individual understanding and action are orchestrated in collective social-relational projects.

A qualitative case study approach was used to solicit data using different techniques namely workshops, semi-structured interviews, document analysis, observations and Unit-Based Sustainability Assessment Tool questionnaires. Data collected through all these techniques was triangulated in the form of analytical memoranda which helped to develop analytical statements aligned with the research goals.

The findings confirmed the evident practice disconnect between water management and curriculum practices which was found to be problematic at Fort Cox. The findings also suggest that there were inadequate water management topics across the curriculum. The findings lead to recommendations including future research recommendations for possible implementation. One notable recommendation is staff development on current sustainable water management and curriculum practices to address the challenges of both Fort Cox and the region.

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To the Fort Cox community, I thank you for allowing me to conduct this research in your context. This goes to the management, academics, students and support staff of Fort Cox collectively. Furthermore, I express my sincere gratitude to all participants who helped me in providing the data required for this study at Fort Cox.

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## **List of Acronyms**

- AE221:** Irrigation, Soil and Water Conservation
- ASCE:** American Society of Civil Engineers
- CDAs:** Cultural-discursive arrangements
- CHE:** Council on Higher Education
- CS211:** Fruit Production I
- CS221:** Vegetable Production
- DEAT:** Department of Environmental Affairs and Tourism
- ELRC:** Environmental Learning Research Centre
- ESD:** Education for Sustainable Development
- FAO:** Food and Agriculture Organisation
- FTQ:** Field Technician Questionnaire
- ILBN:** Invoto Bubomi Learning Network
- IPCC:** Intergovernmental Panel on Climate Change
- MEAs:** Material-Economic Arrangements
- NCCRWP:** The National Climate Change Response White Paper
- NGO:** Non-Governmental Organisation
- NQF:** National Qualifications Framework
- OECD:** Organisation for Economic Co-Operation and Development
- PAT:** Practice Architectures Theory
- RDC:** Rural Development Centre
- RSA:** Republic of South Africa
- SAI:** Sustainable Agriculture Initiative
- SDGs:** Sustainable Development Goals
- SPAs:** Social-political arrangements
- SQ:** Student questionnaire
- SW221:** Soil and Water Conservation
- SWOT:** Strength, Weakness, Opportunities and Threats
- TQA:** Total Quality Assurance
- UNCED:** United Nations' Conference on Environment and Development
- UNESCO:** United Nations Educational, Scientific and Cultural Organisation
- USAT:** Unit-Based Sustainability Assessment Tool
- VST:** Voluntary Sampling Technique
- WHO:** World Health Organisation

## **CHAPTER 1: INTRODUCTION AND CONTEXT OF THE STUDY**

### **1.0 Introduction**

This chapter presents the rationale and contextual framework behind this case study of Fort Cox Agriculture and Forestry Training Institute which seeks to understand the sustainable focus of water management and curriculum practices of an agricultural college. The chapter highlights the significance of Education for Sustainable Development (ESD) in agricultural colleges in a global context, as well as the specific context and significance of this study for Fort Cox. It introduces the Practice Architectures approach to researching the practices of teaching and learning, as well as the main research question and sub-questions, and research goals. Finally, the chapter outlines the next five chapters to guide the reader's expectations.

### **1.1 Background and rationale of the study**

Water is considered a scarce resource in many countries worldwide as well as a universally critical resource because of its value to human life and ecosystem existence (Bouwer, 2000). Without water many lives are threatened because water is a significant resource for both socio-economic and ecological necessities. Molden (2007) referred to water as life, because without it no life would exist on Earth. The significance of water for life and health cannot be overstated, and hence the significance of ethics of care regarding water (Jennings, Heltne, & Kintzele, 2009). It is important for every person to have a well-reasoned understanding of the moral values and obligations that correspond to that significance (*ibid.*). Caring about water is given expression through water management, which is defined as the planning, developing, distributing and optimum use of water resources under defined water policies and regulations, for both socio-economic and ecological needs (World Health Organisation [WHO], 2004).

South Africa is referred to as a water-stressed country that requires careful water management strategies to support socio-economic and ecological necessities (Chartzoulakis & Bertaki, 2015). There are many challenges concerning water management in South Africa, mainly due to long cycles of dry weather conditions with inadequate rainfall, as well as mishandling of available water resources due to breakdowns of infrastructure and authority (Molobela & Sinha, 2011). Challenges include limited freshwater resources, a rapidly growing population and water demands and slow economic growth in the country. Complex challenges such as these prompt a critical need to manage and conserve available water resources properly. If not, uncertainties such as Day Zero of water availability which

threatened some parts of South Africa, especially in the Western Cape and Eastern Cape provinces in 2018 and 2019, will become a reality soon in other parts of the country.

South Africa has an average annual rainfall which is well below the world average of about 860mm per year (Benhin, 2006). Many rural South Africans depend on irrigated agriculture as the primary source of food for their families and source of income (Nel & Davies, 1999). South Africa's dryland crop production is based on 11 million ha, with an average annual rainfall of below 600mm (*ibid.*). Only 12% of this rainfall is utilised with irrigated crop production from stored surface and underground resources utilising under 2%. An average of 60% of rainfall is used to maintain the growth of forests and the natural vegetation for grazing of livestock and game farming, and the remaining 26% ends up as runoff to the sea or is used for industrial and other socio-economic purposes (Bennie & Hensley, 2001).

The current trends in South Africa suggest that water problems will become more complex and will jeopardise developmental objectives in the sectors such as agriculture, mining and energy, industry, transportation and communications, education, environment, health, rural and regional development (Molobela & Sinha, 2011). Poor water management practices have serious repercussions for agricultural development and food security for many households (Rosegrant, Ringler & Zhu, 2009). For all these reasons, agricultural colleges such as Fort Cox need to pay attention to sustainable water management practices for agriculture through Education for Sustainable Development strategies. Education for Sustainable Development (ESD) is an educational approach that enables social change or a catalyst of social change by promoting sustainability practices (Teise & Le Roux, 2016). According to Teise and Le Roux (2016), South African education policy and practice appear to be oriented towards ESD, but this concept is contested, and ragged with ambiguity and vagueness. Because the transformation of South African education is primarily aimed at social change, such vagueness and ambiguity could prevent the achievement of the vision of an education system that contributes to social change and sustainable development amongst several aspects of the environment such as water for agriculture practices.

The necessity to embed Education for Sustainable Development (ESD) in the higher education curriculum is well recognised in international sustainable development dialogues (Ryan & Tilbury, 2013). However, early pioneers in this area have met with substantial obstacles and now face the prospect of attempting systemic education change in a new and

difficult sector climate (*ibid.*). For the integration of education for sustainable development into the classroom to be effective, experts in the field should support the work of educational commissions responsible for organising the curriculum (Martínez-Borreguero, Maestre-Jiménez, Mateos-Núñez, & Naranjo-Correa, 2020). This approach would ensure that the integration of education for sustainability is a robust process rather than a mere option for educators who are encouraged to go beyond the organisation of content on sustainable development in the curriculum (*ibid.*).

Through the curriculum practices, agricultural colleges have a role to play in developing relevant expertise for sustainable agriculture to address the current challenges of climate change, food security and dwindling water resources for agriculture. Fort Cox is one of the institutions of higher learning offering an Agriculture and Forestry curriculum. Fort Cox is situated north-east of Middledrift town, adjacent to the Amatole mountains and on the peripheries of Keiskamma River. Fort Cox falls within Raymond Mhlaba municipality in the Eastern Cape Province of South Africa. The institution is accredited by the Council of Higher Education (CHE) to offer diplomas in both Agriculture and Forestry at the National Qualification Framework (NQF) Level Six (Fort Cox Prospectus, 2017). In 2020 Fort Cox was accredited to offer the Advanced Diploma at NQF Level Seven qualification for three curriculum options. This could help expand students' knowledge and experiences in advanced agriculture practices including sustainable water management practices. I am currently working as a lecturer at Fort Cox in the department of Forestry and Natural Resource Management. One of my key instructional offerings relevant to this research is to facilitate teaching and learning for Soil and Water Conservation (SW 211) subjects offered to Forestry diploma students.

Fort Cox is geographically situated in the drought prone region of the Eastern Cape which has been experiencing rain below average for many years (Alonge & Afullo, 2012). For Fort Cox students and local farmers to learn how to manage water optimally and sustainably in this region, the goals of ESD which involve developing the knowledge, skills, attitudes and values necessary to shape a sustainable future, will have to be realised (Taylor, 2014). The Brundtland Report defined the principles of sustainable development as “meeting the needs of the present generation without compromising the ability of current and future generations” (Brundtland, 1987). ESD enables people to develop the knowledge, skills and values to participate in critical decisions about natural resource management as individuals or

collectively at both the local and global levels and to improve the quality of human life without damaging the planet (Harding, 2006). Hence ESD would encourage sustainable water management and curriculum practices in a range of educational institutions from basic education schools to universities and agricultural colleges to help learners comprehend socio-economic and ecological sustainability imperatives (Pretty, Toulmin & Williams, 2011).

According to Tilman, Cassman, Matson, Naylor and Polasky (2002), sustainable water management in an agricultural training institution which has multiple functions can be achieved by adopting improvements in sustainable irrigation applications, soil and plant practices, rainwater harvesting, reuse of treated wastewater and by increasing knowledge capacity in sustainability topics. Sustainability is achieved if water consumed is not overexploited but naturally replenished, facilities are maintained in a condition that ensures a reliable and adequate potable water supply and the benefits of the supply continue to be realised over a prolonged period (Loucks, 2000).

For ESD to be achieved, sustainable water management at Fort Cox must be linked to curriculum practices. There is no one single correct pedagogy for ESD, but rather a broad consensus that it requires a shift towards active, participative and experiential learning approaches that engage the learner to make a real difference in their understanding, thinking and ability to act on matters of concern in their context (Cotton, Warren, Maiboroda & Bailey, 2007). The pedagogical approaches that ESD can follow towards such curriculum objectives would include critical reflection on educators' practice, systemic thinking and an analytical approach in teaching and learning, as well as participatory and collaborative learning approaches (Kopnina, 2012). These pedagogical approaches have potential to change the way of doing things since the learners are encouraged to be involved in action learning activities in the place of practice (*ibid.*). These will be elaborated in the next chapter of this study (Chapter 2 - Literature Review).

## **1.2 Significance of the study**

Fort Cox as a higher educational institute has been experiencing water management concerns prompted by issues related to the farm water management and curriculum practices. These have presented themselves as contradictions between water management and curriculum practices at Fort Cox. For instance, the Animal and Crop Production curriculum depends on the Fort Cox farm to support active teaching and learning. But what the stated curriculum

says is contradicted by the current water management practices on the ground which reflect a mismatch with and lack of willingness from support staff steeped in traditional agriculture practices, to manage water more sustainably.

The water infrastructure at Fort Cox has collapsed and been left derelict for many years, with little or no maintenance to promote sustainability. As a result, some of these challenges include raw sewage spillage resulting in water pollution in the nursery water pond and nearby river in the form of eutrophication. The pond on campus was contaminated to the extent that it can no longer supplement the nursery with water for plant propagation (see Picture 1.1 below showing a sewage polluted nursery water pond). In addition, Fort Cox livestock were uncontrollably accessing the water from the same polluted pond despite concerns being raised by lecturers and students regarding the likely bio-health hazards.

At Fort Cox, projects affecting water management practices were commonly designed without academics' or students' awareness. The majority of these projects were meant to uplift the farm. These projects could be good opportunities for teaching and learning and could contribute to fulfilling curriculum requirements. Small water management projects could serve action learning purposes; they are a squandered opportunity when academics and students are excluded during the planning and implementation phases. Some of these projects have ironically resulted in mismanagement of water resources which could potentially have been avoided with wider participation, while other projects have totally failed to serve their intended purpose. Fort Cox farms have the capacity to offer the required practicals in-house if water management and curriculum practices contradictions are addressed and the sustainability focus is strengthened. In addition, the water management topics in the stated curriculum could be enhanced if supported by ethical water management practices on the campus and farm supporting practices.

These concerns and potential opportunities have motivated me to undertake a study to explore the possibilities of involving academics, support staff and students in the process of introducing a sustainability focus to water management and curriculum practices at Fort Cox.



*Picture 1.1: A sewage spill resulting into water pollution in the nursery water pond*

### **1.3 Research questions and goals**

This research explored the water management practices and curriculum practices of Fort Cox using the Practice Architectures framework (Kemmis, 2009). The following research question, sub-questions and research goals guided this study.

#### ***1.3.1 Research question and sub-questions***

The main research question of this study was:

**How can the academics, students and support staff collaborate in strengthening the sustainability focus in the water management and curriculum practices of Fort Cox?**

Research sub-questions were as follows:

- What are the current ‘sayings, doings and relatings’ related to water management at Fort Cox?
- What are the ‘sayings, doings and relatings’ regarding water management in the stated curriculum at Fort Cox?
- What are the associated arrangements and conditions, enabling and constraining factors of water management and curriculum practices at Fort Cox?
- What are the implications of the research findings for Fort Cox’s curriculum development?

### **1.3.2 Research goals**

The following were the research goals of this study.

- To use the ‘sayings, doings and relatings’ derived from a Practice Architectures framework to understand more fully the current water management practices and curriculum practices of Fort Cox.
- To bring members of the Fort Cox community and stakeholder partnerships together in an action learning process aimed at advancing a common understanding of current water management and curriculum practices as a form of Education for Sustainable Development.
- Out of this process, the research findings seek to stimulate an improved sustainability focus in the water management practices for both the agriculture curriculum and community awareness.

### **1.4 Research participants**

The research participants included **four academics** involved in teaching water management courses and production courses who accepted the invitation to participate in this study. These staff members had extensive experiences in their respective work regarding sustainable water management practices at Fort Cox, other previous employment and collaboration with other academic institutions and learning networks such Rhodes University, Environmental Learning Research Centre (ELRC) and Invoto Bubomi Learning Network (IBLN). **Three field technicians** directly involved in water management activities and curriculum practices at Fort Cox participated, as well as support staff with similar interests and working with water management and curriculum practices. **Sixteen students** enrolled in water management dependent subjects for both Agriculture diploma options at Fort Cox also took part in the study. Finally, **one member of executive management** was engaged to give guidance on institutional policies and buy-in of the ideas emerging from the data generation processes.

### **1.5 Overview of the thesis structure**

The thesis has six chapters designed in sequence to respond to the research questions and research goals mentioned in sub-sections 1.3.1 and 1.3.2 respectively. Chapter 1 covers the introduction and the background of the research context.

**Chapter 2** focuses on the existing literature relevant for this study. This chapter begins by contextualising the importance of Education for Sustainable Development in agriculture

colleges' curricula focusing on current water management practices. Literature reviewed in this chapter was aimed at reflecting on the importance of water management practices in agricultural colleges. The chapter considers the current status of water management and policy in South Africa and its implications, as well as the history of environmental education and ESD in relation to water management practices. This is followed by a discussion of climate change effects on water management, agriculture production and agriculture curriculum. Furthermore, this chapter introduces the chosen theory and supporting theory and their suitability to the study using relevant literature. Practice Architectures Theory (PAT) developed by Stephen Kemmis (2009) was used to solicit the data and analyse the water management and curriculum practices of Fort Cox. In support of PAT, an action learning process model by Marquardt (2007) was also considered to encourage the Fort Cox community to work together towards achieving shared sustainable water management practices.

**Chapter 3** describes the research design and the data collection processes. It begins with describing the qualitative research approach and the case study method followed. The relevance of this chosen method is explained. This chapter continues by discussing the data collection techniques or tools used and processes followed to solicit the data. The chapter further details how data was organised, interpreted and triangulated in the form of analytical memorandums and analytical statements to be presented in Chapters 4 and 5 respectively. Furthermore, this chapter presents an inventory of data generation sources. The chapter concludes by elaborating on the validity and trustworthiness considerations, ethical considerations, encountered constraints and deviations from the original plan during the research process.

**Chapter 4** focuses on the presentation of data collected using the different data collection techniques presented in Chapter 3. The chapter begins by presenting the data on the 'sayings, doings and relatings' gathered with different research techniques or tools that were informed by the research questions aligned with the research goals of this study. Data collection tools included a workshop, semi-structured interviews, observations, and document analysis and questionnaires. Findings are presented in the form of analytical memoranda that were developed for each data source tool and for triangulation purposes. In conclusion, this chapter presents the associated arrangements (enablers and constraints) as informed by the Practice Architecture theory adopted for this study.

**Chapter 5** presents a discussion of the research findings. This is in the form of analytical statements developed along with PAT sayings, doings and relatings aligned with the research goals, research questions listed in Chapter 1. The literature narratives from Chapter 2 are used to inform the discussion on the findings.

**Chapter 6** provides a summary of the findings and discussion and reflections on the entire study. Finally, this chapter proposes recommendations drawn from this study for future implementation and further research purposes before making the final conclusion.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.0 Introduction**

This chapter seeks to explore the literature pertinent to water management and the curriculum practices in an agricultural institute, including Education for Sustainable Development (ESD) and curriculum theory as the main educational fields of focus. In my view, agricultural institutions are mandated to develop curricula that help find answers to societal issues and to produce graduates who are capable of addressing challenges facing the ecological and socio-economic context for agriculture development which includes the impacts of climate change. The literature review in this chapter aims to explore the concepts relevant to this mandate.

This chapter will also discuss the theory which forms the conceptual and analytical framework for this study. The substantive theory relevant for this research is the Practice Architecture theory developed by Kemmis (2009) and Kemmis, McTaggart and Nixon (2013), supported by an action learning process model as developed by Marquardt (2007). Well-known theorist, Eisner, proposed similar thinking on curriculum theory in 1994 which has significantly shaped the education system framework today.

### **2.1 The importance of Education for Sustainable Development and Environmental Education**

Over the past decade or so, Education for Sustainable Development (ESD) has emerged as a concept to foster transformative social learning in curriculum settings and expanding education contexts of reflexive social-ecological change (Pesanayi, O'Donoghue and Shava, 2019). The past United Nations Decade of Education for Sustainable Development has served both to shape and to clarify ESD as a proposition for implementation in five priority areas through a Global Action Programme (United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2014) towards transformative learning for future sustainability (*ibid.*). In 2002, the United Nations declared 2005 to 2014 the Decade for Education for Sustainable Development and highlighted the difference between environmental education and ESD (Venkataraman, 2009). In many parts of the world, environmental education is “a well-established discipline, which focuses on humankind’s relationship with the natural environment and on ways to conserve and preserve it and properly steward its resources” (Hughes, 2016). Venkataraman (2009) suggested that Education for Sustainable

Development encompasses environmental education but sets it in the broader context of socio-cultural factors and the socio-political issues of equity, poverty, democracy and quality of life. In Southern Africa, environmental education has also been approached with due recognition of the socio-cultural and socio-political dimensions of environmental issues. This is evident in the diagram produced by O'Donoghue (1992) following the United Nations' Conference on Environment and Development which put the connections between environmental and social concerns on the global agenda (UNCED, 1992).

With the world population over seven billion and dwindling natural resources, individuals and societies need to learn to live together with surrounding nature sustainably (Adger, Hug, Brown, Conway, & Hulme, 2003). People need to act responsibly based on the understanding that what humans do today can have implications in their lives, other people's lives and the planet in future (Kollmuss & Agyeman, 2002). ESD therefore helps people to change the way they think and empowers them to work towards a sustainable future (Hardin, 2009). UNESCO (1999) aims to improve access to quality education for sustainable development at all levels of the education system and in all social contexts, to transform society by reorienting education and helping people develop the knowledge, skills, values and behaviours needed for sustainable development. This involves including sustainable development issues, such as sustainable water management, climate change and biodiversity, into teaching and learning. Individuals are encouraged to be responsible actors who resolve challenges and contribute to creating a more sustainable world (Barth, Godemann, Rieckmann, & Stoltenberg, 2007).

As mentioned in Chapter 1 section 1.1, the most frequent definition of sustainable development is that proposed by the United Nations World Commission on Environment and Development, also known as the Brundtland Commission. In its report to the United Nations General Assembly, entitled *Our Common Future*, the Brundtland Commission defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Martínez-Borreguero, Maestre-Jiménez, Mateos-Núñez, & Naranjo-Correa, 2020, p. 2). In accordance with this, a change in the attitudes and behaviours of citizens will depend on good environmental education.

There is no single correct pedagogy for ESD, but rather a broad consensus that it requires a shift towards active, participative and experiential learning approaches that engage the learner to make a real difference in their understanding, thinking and ability to act on matters of concern (Cotton *et al.*, 2007). The pedagogical approaches that educators can follow to achieve these curriculum objectives are critical reflection on practice, systemic thinking and an analytical approach in teaching and learning, and developing participatory and collaborative learning approaches (Kopnina, 2012). These pedagogical approaches have the potential to change the way of doing things (practices) since the learners are encouraged to be involved in action learning in their own learning context (*ibid.*).

To consider what Education for Sustainable Development (ESD) at Fort Cox might encompass, the following section of this chapter explores the topics of sustainable water management before returning to the topic of the curriculum and action learning as a pedagogical approach suitable for ESD.

## **2.2 Water, Agriculture and Sustainable Water Management**

### *2.2.1 The policy framework in South Africa*

South Africa is one of the signatories of the Sustainable Development Goals (SDGs) previously known as the Millennium Development goals. The purposes of the SDGs are associated with the objectives of the South African Constitution (RSA, 1996), which, in Section 24 and Section 27 respectively, reflects South Africa's commitment to "secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development", and ensure that "everyone has the right to have access to sufficient food and water" (Lotz-Sisitka *et al.*, 2021, p.11).

According to Unver, Bhaduri and Hoogeveen (2017), different levels of water management in agriculture, ranging from national to basin scale to farm plots utilise different methods for improving their operations. The preferred management approach would be to use a 'dashboard' of multiple relevant indicators for multiple decisions (*ibid.*). At the broadest level, the suite of indicators adopted for target 6.4 of Sustainable Development Goals (SDG 6) comprises macro indicators related to the three aspects of sustainability: a) economic (water-use efficiency); b) environmental (water stress); and social (people affected by scarcity), although the explicit domain is water quantity (Hák, Janoušková, & Moldan, 2016). Sustainable Development Goal 6 (SDG 6 or Global Goal 6) is about clean water

and sanitation for all. It is one of 17 Sustainable Development Goals established by the United Nations General Assembly in 2015. The official wording is: “Ensure availability and sustainable management of water and sanitation for all”. This goal has eight targets to be achieved by at least 2030 (*ibid.*).

Halving the proportion of people without sustainable access to safe drinking water and basic sanitation is one of the targets of the sixth Sustainable Development Goal (Department of Water Affairs and Forestry [DWAF], 2003). In South Africa, with its mix of developed and developing regions, 9.7 million (20%) people did not have access to an adequate water supply and 16 million (33%) lacked proper sanitation services in 2003 (*ibid.*). South Africa’s water catchments need serious intervention strategies to protect them if the Millennium Development Goals regarding water management are to be achieved (Du Plessis & Landman, 2002).

South Africa has clear objectives in redressing the past injustices on water distribution for all (Republic of South Africa [RSA] National Water Act no. 36 of 1998). The purpose of the National Water Act is to ensure that the nation’s water resources are protected, used, developed, conserved, managed and controlled in ways that meet the needs of both current and future generations. Yet post South Africa’s democracy, water is still a challenge to many communities’ livelihoods and to the agriculture sector which needs to develop to more inclusively ‘benefit all’ of South African society. To sustain the established uses of water, this vital natural resource base must be appropriately protected. Since development in South Africa requires giving greater access to water to more people, it is clear that the way in which water is used, needs to change dramatically, if we are to sustain such development, given the limited nature of water resources in the country, as discussed next.

### *2.2.2 Water, a threatened resource*

Water is considered a scarce resource in many countries worldwide as well as a critical resource because of its value to human life and ecosystem existence (Bouwer, 2000). Without a reliable source of water, many lives are threatened, as water is required for socio-economic and ecological necessities (*ibid.*). Water is referred to as life, because without it no life can exist on Earth (Molden, 2007). Water management is the planning, developing, distributing and optimum use of water resources under defined water policies and regulations for both socio-economic and ecological needs (World Health Organization, 2004).

According to Loucks (2000), the world is facing enormous challenges to produce almost 50% more food by 2030 and to double production by 2050. This will have to be achieved with less water given pressures from growing urbanisation, industrialisation and climate change (see below). Consequently, it is important that farmers are able to increase water use efficiency and improve water management, especially as agriculture is the major user of water accounting for about 70% of the world's freshwater withdrawals (*ibid.*). This has implications for agricultural education for both current and future food growers.

The Food and Agricultural Organisation (FAO, 2006) forecast that by 2050 global water requirements for agriculture will increase by 50% to meet the increased food demands of a growing population. Global freshwater is becoming increasingly scarce due to improper management, indiscriminate use and the changing climate. Water scarcity and quality problems in many parts of the world are a serious challenge to both food security and environmental sustainability. To ensure food security and sustainable agriculture, there is an urgent need to produce more crop per drop of water used in the agricultural sector and to ensure that water use efficiency is increased without negative impacts on downstream water quantity and quality (FAO, 1996).

Most rural South Africans depend on rain-fed agriculture practices for their survival while irrigated agriculture is the primary source of food for the country (Nel & Davies, 1999). According to Bennie and Hensley (2001), South Africa's dryland crop production is based on 11 million ha, with an average annual rainfall of 600mm. An average of 60% of rainfall is used to maintain the growth of forests and the natural vegetation for grazing of livestock and game farming, and the remaining 26% ends up as runoff to the sea or is used for industrial and other socio-economic purposes (*ibid.*).

### 2.2.3 Climate change

Globally, climate change poses significant threats to food security and peace due to changes in water supply and impacts on crop productivity; impacts on food supply and high costs of adaptation to climate change (Hanjra & Qureshi, 2010). Climate change may affect agriculture and food security by altering the spatial and temporal distribution of rainfall, and the availability of water, land, capital, biodiversity and terrestrial resources. It may heighten uncertainties throughout the food chain, from farm to fork, and yield to trade dynamics,

ultimately impacting on the global economy, food security and the ability to feed nine billion people by 2050 (Jackson *et al.*, 2001).

According to Jara-Rojas, Bravo-Ureta and Díaz (2012), climate change in combination with the expanding human population presents a formidable food security challenge across the world. Population growth and the dynamics of climate change will also exacerbate other issues, such as desertification, deforestation, erosion, degradation of water quality, and depletion of water resources, which will further complicate the challenge of food security already in distress (*ibid.*). These factors, together with the fact that energy prices may increase in the future, which will increase the cost of agricultural inputs such as fertiliser and fuel, make future food security a major concern.

Climate change due to the enhanced greenhouse effect is likely to have significant effects on the hydrological cycle. The hydrological cycle will be intensified with more evaporation and more precipitation, but the extra precipitation will be unequally distributed (Wang, 2005). Some parts of the world may see significant reductions in precipitation or major alterations in the timing of wet and dry seasons. The Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) warned that global warming would lead to increases in both floods and droughts (Arnell, 1999).

Adams, Hurd, Lenhart and Leary (1998) argued that climate is the primary determinant of agricultural productivity. Physical effects of climatic change on agriculture, such as changes in crop and livestock yields, depletion of water sources, la-nino and el-nino occurrences as well as the economic consequences of the potential yield changes are the main threats to the agriculture sector today (*ibid.*). The role of human adaptations is to respond to climate change, possible regional impacts to agricultural systems and potential changes in patterns of food production and prices (*ibid.*).

The National Climate Change Response White Paper (NCCRWP) states that South Africa is a water scarce country with a highly variable climate and with the lowest run-offs in the world, a situation significantly exacerbated by the effects of climate change (RSA, 2011). According to Lotz-Sisitka *et al.* (2021), South Africa's current projections show that the country will exceed the limits of economically viable land-based water resources by the year 2050, and thus knowledge on rainwater harvesting and conservation practices is important especially to smallholder farmers and household food producers. The water availability in

South Africa is a key climate-change related vulnerability and the negative impacts on the availability of water directly affect people, ecosystems and the economy, including the smallholder farmers depending on rain fed agricultural practices (*ibid.*).

The current trends in South Africa indicate that water problems will become more complex and will jeopardise developmental objectives in sectors such as agriculture, mining and energy, industry, transportation and communications, as well as education, environment, health, rural and regional development (Molobela & Sinha, 2011). Poor water management practices have serious repercussions for agriculture development and food security for many households (Rosegrant, Ringler & Zhu, 2009).

South Africa is a water scarce nation and government policies show an awareness of the pressing and complex challenges of scarcities of water. Good governance includes agricultural development in remote and rural areas to stimulate equitable livelihood practices, and there is a need to strengthen the capacity of extension services through the development of appropriate agricultural skills (Lotz-Sisitka *et al.*, 2021). According to Lotz-Sisitka *et al.* (2021), there is a significant need for South Africa to invest in education and awareness programmes in rural areas and link these to agricultural extension activities to enable both subsistence and commercial producers to understand, respond and adapt to the challenges of climate change (*ibid.*). The focus of the agriculture curricula is mostly on competence development for conventional methods of agriculture, which exclude an engagement with climate change, climate change adaptability and water conservation farming activities (Lotz-Sisitka *et al.*, 2016). Hence, agricultural colleges such as Fort Cox need to pay attention to sustainable water management practices for agriculture through Education for Sustainable Development strategies to address climate change adaptation for farming activities. Fort Cox should also lead by example and implement water management practices, using this to advise the agricultural community. But what does sustainable water management practices entail? This is explored in the next section 2.2.4.

#### *2.2.4 Sustainable water management for agriculture*

The concept ‘sustainable water management’ emphasises the need to consider the long-term future as well as the present water resource systems that are managed to satisfy the changing demands placed on them now and into the future without system degradation (Loucks, 2000). Sustainable water resource systems are those designed and managed to fully contribute to the

objectives of society now and in the future while maintaining their ecological, environmental, and hydrological integrity (UNESCO, 1999). Loucks (2000) argued that sustainability is intimately related to various measures of risk and uncertainty about a future we cannot know but which we can surely influence.

According to Botha *et al.* (2012), sustainability in the agriculture context describes the appropriate use of crop systems and agricultural inputs supporting those activities that maintain economic and social viability while preserving the high quality productivity of land. Botha *et al.* (2012) highlighted the requirements for sustainable crop production which are:

- Increase in agronomic productivity / production;
- Reduction in production risk;
- Conservation of natural resources;
- Economic viability; and
- Social acceptability.

The White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997) defines the term conservation as both 'conservation of biological diversity', and the 'sustainable use of its components' (South Africa. Department of Environmental Affairs and Tourism [DEAT], 1997) which reflects the importance of sustainable use of natural resources. Therefore, using water harvesting techniques that both conserve and contribute to a sustainable environment is ideal.

Rainwater harvesting is one of the techniques widely used in the farming communities and adopted by an Eastern Cape project Amanzi for Food, through the Invoto Bubomi Learning Network (IBLN). This is one example of more sustainable water management practices. According to Botha *et al.*, (2012), rainwater harvesting is the process of concentrating rainfall as runoff from a larger area for its productive use in a smaller target area. Types of rainwater harvesting include trench beds, mulching and storage tanks and open ponds where water collected can be applied either directly to an agricultural field for crop production or be stored in some type of storage facility for domestic use and/or supplementary irrigation. In other words, rainwater that could have been lost through runoff is collected and used productively for crop production and domestic use. Rainwater harvesting techniques increase production with higher profit margins without harming the natural resources and are socially acceptable to rural community members.

The scope of sustainable water management in agriculture concerns the responsibility of water managers and users to ensure that water resources are allocated efficiently and equitably and used to achieve socially, environmentally and economically beneficial outcomes (Organisation for Economic Co-Operation and Development [OECD], 2008). This includes:

- Irrigation to smooth water supply across the production seasons;
- Water management in rain-fed agriculture;
- Management of floods, droughts, and drainage; and
- Conservation of ecosystems and associated cultural and recreational values.

Sustainable agricultural water resource management covers a wide range of agricultural systems and climatic conditions across the world, drawing on varying water sources, including surface water; groundwater; rainwater harvesting; recycled wastewater; and desalinated water (*ibid.*). It also operates in a highly diverse set of political, cultural, legal and institutional contexts, encompassing a range of areas of public policy: agriculture, water, and environment, energy, fiscal, economic, social and regional (*ibid.*). Because sustainability is a function of various economic, environmental, ecological, social, and physical goals and objectives, water resources management must inevitably involve multi-objective trade-offs in a multidisciplinary and multi-participatory decision-making process (American Society of Civil Engineers [ASCE], 1998).

### **2.3 Water management and curriculum practices in agricultural institutions**

Over the years, requirements of the agriculture curriculum have been developed and changed to cope with the changing demands and environmental changes (Van Staden, 2020). For the implementation of new knowledge and practices within the agriculture curriculum and new learning practices, the lecturers within the system have to be given adequate and relevant training in the new teaching topics and learning practices infused in the curriculum (Department of Agriculture, 2008).

This study was undertaken at Fort Cox Agricultural and Forestry Training Institute which is geographically situated in the drought prone region of the Eastern Cape which has been experiencing rain below average in recent years (Alonge & Afullo, 2012). Learning how to manage water optimally and sustainably would meet the goals of Education for Sustainable

Development (ESD) which involves the knowledge, skills, attitudes and values necessary to shape a sustainable future (Taylor, 2014). As noted above, ESD aims to enable people to develop the knowledge, skills and values to participate in critical decisions about natural resource management as individuals or collectively, at both the local and global level, and to improve the quality of human life without damaging the planet (Harding, 2006). Hence, ESD is vital to encourage sustainable water management and curriculum practices in eco-schools, universities and agricultural colleges to enable learners to comprehend sustainable socio-economic and ecological imperatives (Pretty *et al.*, 2011).

Sustainable water management in an agriculture institution which has multi-functions can be achieved by adopting improvements in sustainable irrigation applications, soil and plant practices, rainwater harvesting, reuse of treated wastewater and by increasing the knowledge capacity on sustainability topics (Tilman, Cassman, Matson, Naylor & Polasky, 2002). Sustainability must also be part of Fort Cox water management and curriculum practices through ESD. Sustainable water management can be achieved if water consumed is not overexploited but naturally replenished, facilities are maintained in a condition that ensures a reliable and adequate potable water supply and the benefits of the supply continue to be realised over a prolonged period (Loucks, 2000).

According to Unver, Bhaduri and Hoogeveen (2017), the management of a farm is a factor which can determine productivity in any agricultural industry. The effectiveness of water use on a farm is measured in the output-litres of water used to produce a ton of grain (*ibid.*). Mueller, Gerber, Johnston, Ramankutty and Foley (2012) claimed that a well set-up farm should comply with the national norms and standards on sustainable water management practices. Every water user should be made to understand the daily operations and equipped with knowledge to address any challenge regarding water utilisation within their context (Sustainable Agriculture Initiative [SAI], 2010). A farm that manages its operations well in terms of sustainable water management practices will be a good example of success in agricultural development and Education for Sustainable Development (*ibid.*). This can be achieved, for example, by keeping records of water irrigation performance and costing every drop of water used (to determine the balance between the input and output), by estimating potential saving/costs of conservation measures for water quality, through conservational tillage and buffer strips, and by encouraging innovation (this includes new ideas,

technologies, methodologies, crop plans, processes, new markets and new approaches to old markets) – all ideal tools for any farmer (Biswas, 2008).

Assessing the exposure to water risks in agriculture practices and making the key information available to everyone, is a good strategy for promoting water efficiency and avoiding water pollution (Chambers & Conway, 1992). This would take into account the cost impact of alternative water supplies and the revenue impact of operating interruptions or restrictions due to inadequate water availability (Pretty, 1995). Further good strategies include: assessing how the farm might be affected by changes in water supply, quality, reliability, and price; assessing how water supply, quality, and reliability in key markets are potentially affected by climate change; understanding how the amount and source of the water withdrawals and the quantity and quality of wastewater discharges impact local communities and ecosystems; assessing the quantity/quality of the wastewater discharges in relation to permitted levels and/or industry averages; preparing contingency plans to respond to water risks, such as supply disruptions, price increases, more stringent regulations and drought (Sustainable Agriculture Initiative, 2010).

#### **2.4 Curriculum giving effect to Education for Sustainable Development**

The word ‘curriculum’ comes from the Latin word meaning ‘a course for racing’. It is interesting how closely this metaphor fits the way in which educators perceive the curriculum in schools. Educators often speak about ‘covering’ concepts as one would speak about ‘covering’ ground, and that coverage is often a race against the testing clock (Cuban, 1995).

In education, a curriculum is broadly defined as the totality of student experiences that occur in the educational process of learning (Pajares, 1992). The term ‘curriculum’ often refers specifically to a planned sequence of instruction, or to a view of the student’s experiences in terms of the educator’s or institutional instructional goals (Marsh & Willis, 2003).

Curriculum development can be defined as the systematic planning of what is taught and learned in schools and other educational institutions as reflected in courses of study and teaching programmes. However, according to Eisner (1985), there are three types of educational curriculum: the explicit curriculum, the implicit curriculum and the null curriculum.

The explicit or stated curriculum is simply that which is written to guide formal instruction of learning experiences, either using curriculum documents, texts, films, or supportive teaching

materials that are overtly chosen to support the intentional instructional programme of a college and simply known as the taught curriculum in the education system (Eisner, 1994). Hafferty (1998) also argued that the explicit curriculum is the plan designed for learning, set by the educator or the board of the institution. A lesson or lecture's explicit curriculum is what that lesson or lecture is designed to teach. This includes the topics covered and any documents included in the lesson plan, such as textbooks, posters, demonstration sites, videos and web sources. The explicit curriculum is what an educator plans for his/her class, regardless of whether this plan is seen by his/her students.

The implicit or hidden curriculum (Eisner, 1985) is implied by the very structure and nature of institutions and much of what revolves around daily or established routines; this includes practices such as water management on campus and agriculture practices of the Fort Cox activity system. The implied curriculum relates to the messages communicated by the organisation and operations of the Institution apart from the official or public documentation specifically in relation to the Fort Cox water management context. The null or excluded curriculum is the one which we do not teach, thus giving students the message that these elements are not important in their educational experiences or in our society (Eisner, 2002). Hafferty (1998) defined the implicit or hidden curriculum as the lessons that students take from teachers' attitudes and the institutional environment. This learning can be either conscious or unconscious. For instance, the location of a teacher's desk at the front of a classroom underscores his authority and positions him as the centre of the class's attention. A school's rigid class schedule may make students perceive learning as an inflexible and authoritative process. The implicit curriculum can also refer to how educational institutions reflect larger social norms. A teacher or lecturer who models a society's dismissive attitude toward a subject, for example, will communicate that attitude to his students. The null curriculum consists of the teaching material, which is not covered, taught, nor included, in the typical curricula; examples include the arts and culture performances of Fort Cox.

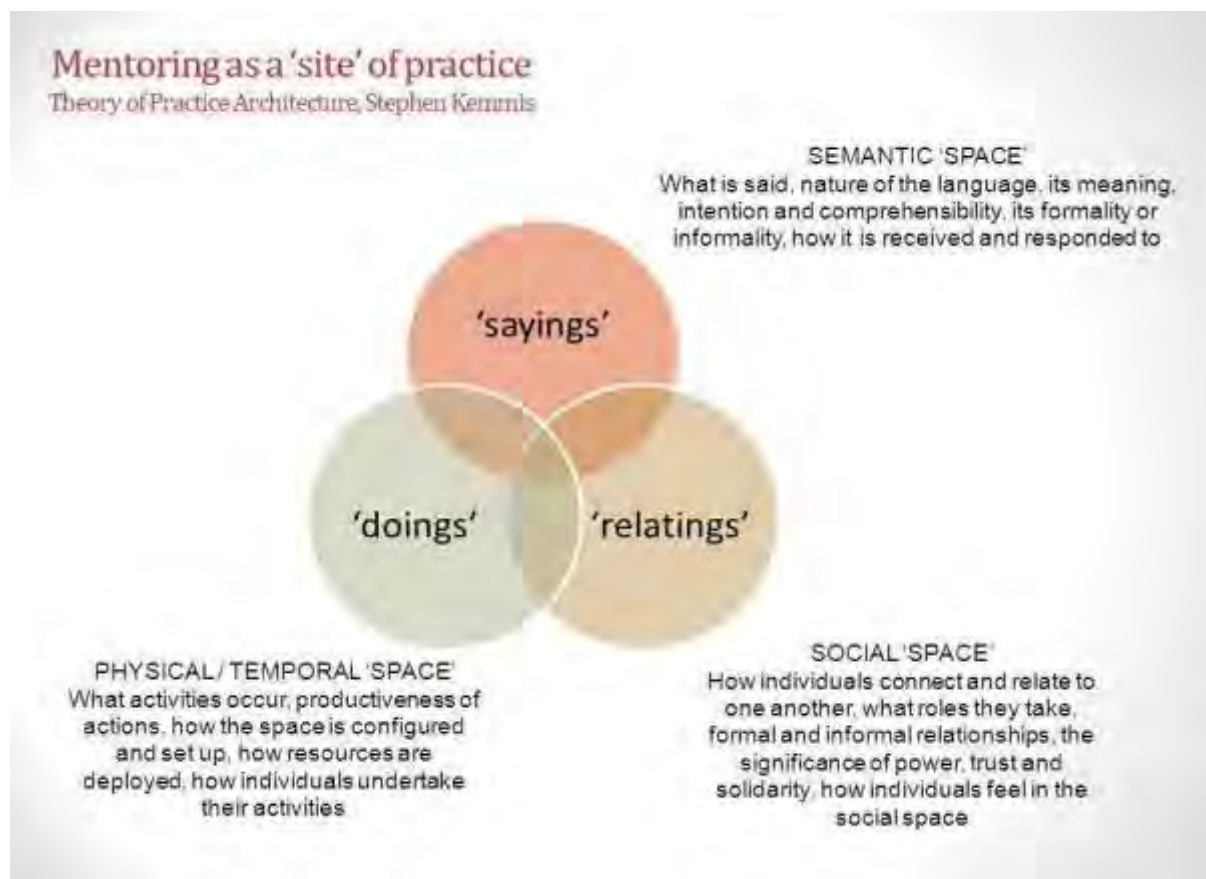
The Fort Cox stated curriculum is structured into two components, 40% theory and 60% practical, which implies that more knowledge is potentially acquired through practical activities. Fort Cox has its own farm component to support the stated curriculum with these practical requirements. The farm is divided into two sections: the crop section where seasonal crops, pastures and fruit trees are cultivated, and the animal handling facility where piggery, broilers, dairy cows and other small stock are kept. Fort Cox also has a Rural Development

Centre which offers agricultural technical skills equivalent to the Technical and Vocational Education and Training (TVET) band through short training courses and outreach programmes to local farmers, emerging farmers (cooperatives) and extension officers from around the Eastern Cape (Fort Cox Prospectus, 2017).

To develop a deeper understanding of a sustainability focus in the water management and curriculum practices of Fort Cox, the current situation and possible responses, this study adopted the Practice Architectures Theory (PAT) by Kemmis (2009) and Kemmis, McTaggart and Nixon (2013) which will be elaborated in the following section (2.5).

### **2.5 Practice Architectures Theory (theoretical framework)**

Practice Architectures Theory (Kemmis *et al.*, 2013) has been identified as the substantive theory for this study in order to understand the water management and curriculum practices of Fort Cox. The theory of Practice Architectures, as developed from Practice Theory by Schatzki (2005) and by Kemmis and Grootenboer (2008), refers to an ontological lens that can help us to understand how different environmental and educational practices emerge in different contexts (cultural, material, and social). Kemmis, McTaggart and Nixon (2013) defined practice as a form of socially established, cooperative human activity in which characteristics of arrangements of actions and activities (doings) are comprehensible in terms of arrangements of relevant ideas in characteristics of discourse (sayings), and when the people and objects are distributed in characteristic arrangements of relationships (relatings). Figure 2.1 shows the model of the theory of Practice Architectures designed by Kemmis (2009) which represents the ideas of the theory regarding the sayings, the doings and the relatings, in relation to the example of mentoring.

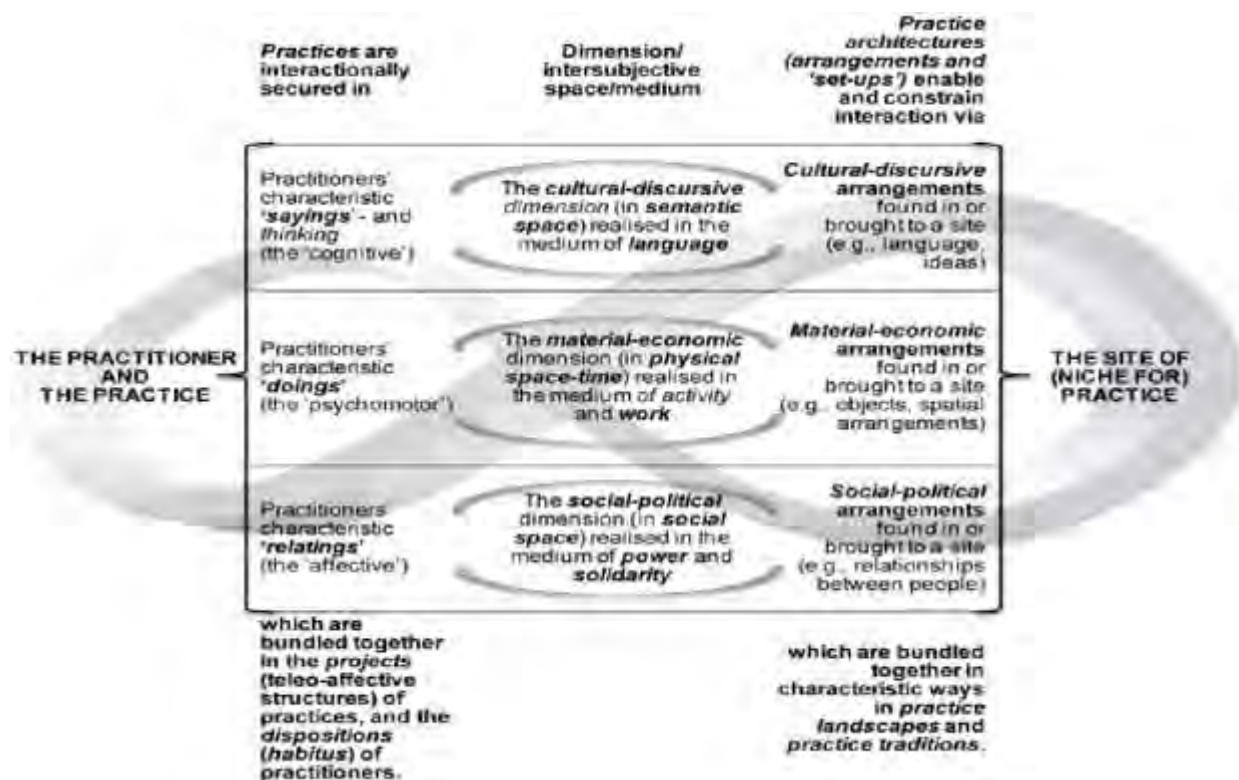


**Figure 2.1: Theory of Practice Architectures model by Kemmis (2009)**

Practice Architectures Theory is concerned with thinking, discussing and writing about practices, and the concept of 'Practice Architectures' refers to the arrangements or 'set ups' that shape what people, groups and institutions do (Kemmis & Grootenboer, 2008). This framework helps researchers to discover the relationship between a practice and the 'architectures' or arrangements that construct that practice (*ibid.*). In this case, in the semantic space, the 'sayings' refer to what the people of Fort Cox would reflect and say about their current water management and curriculum practices. In the physical/temporal space, the 'doings' relate to actions and activities, i.e. how people conduct themselves or do a set of things as an individual or as a collective regarding water and the curriculum at Fort Cox. And in the social space, the 'relatings' refer to the ways in which the people of Fort Cox relate to and comprehend each other and the surrounding environment specifically for water management and curriculum practices, through their sovereignty and working relations.

The theory of Practice Architectures suggests that practices come into being because people do not act alone but collectively, and bring them into being (Kemmis *et al.*, 2013). In practice, individual will, individual understanding and individual action are orchestrated in

collective social-relational projects, such as teaching students to design an irrigation system, or theorising and researching professional practices (*ibid.*). On the other hand, individual and collective participation in practices is prefigured and shaped by the Practice Architectures characteristic of the practice which are the cultural-discursive, material-economic and social-political arrangements (Kemmis & Grootenboer, 2008). The following diagram, Figure 2.2, represents the ideas of practice theory and Practice Architectures (Hemmings, Kemmis & Reupert, 2013) as discussed in this section.



**Figure 2.2: Theory of practice and Practice Architectures (Hemmings et al. 2013, p. 475)**

Chitsinga (2016) argued that according to practice theory, practices are organised bundles of sayings, doings and relatings which, according to Kemmis (2008) ‘hang together’ in a distinctive project. Sayings are in the cultural discursive dimension, while doings are secured in the material and economic dimension, and relatings are in socio-political dimension. These are bundled together in the projects (teleo-affective structures) of practices and the dispositions (or habitus) of practitioners. Teleo-affective structures refer to the purposes or emotions that cause people to act towards possible ends and goals. According to Schatzki (2006), the teleo-affective structures instil a view of practice as the reason why an organisation is more than simply its functioning, but also involves the habitus of practitioners

with general understandings that may be relevant such as their understanding of the nature of their job. Kemmis (2008) further mentioned that by engaging in and through practice:

- Firstly, people construct their self-understandings and their understandings of the world;
- Secondly, people also understand their modes of activity, skills and capabilities;
- Thirdly, people develop an understanding of their roles and patterns of relating to others.

For this research study, cultural-discursive arrangements (**CDAs**) would refer to, for example, language issues. The medium of instruction at Fort Cox is English. Fort Cox is a diverse institution with students from different language backgrounds. The lecturers use English for teaching and learning and particular pedagogical practices for sharing their scientific knowledge, including lectures and demonstrations. IsiXhosa is also common on Fort Cox campus, especially during fieldwork practicals, where the majority of the support staff, while knowledgeable about the work, cannot communicate well in English. Material-economic arrangements (**MEAs**) would refer to, for example, the resources available at Fort Cox to facilitate teaching and learning through theory and practicals. Resources include textbooks, journals, online materials, charts on rainwater harvesting and demonstration sites, and the surrounding biophysical environment. Social-political arrangements (**SPAs**) would refer to, for example, the policies in place and relationships within and between the Fort Cox communities. Policies would include CHE accreditation and the associated norms and standards, for example, on the amount of practical work required in the curriculum. The Total Quality Assurance policy also has a bearing on the lecturer, students and support staff roles towards the curriculum and water management practices of Fort Cox.

Practice Architectures theory helps us understand situations as activity systems (Schatzki, 2012). It is a useful framing because Fort Cox water management and curriculum concerns arise not because of individual actions, but as a collective in the system that is currently in place and, to address the concerns, one needs actions and changes from collectives, not only individuals (Kemmis, 2009). With the support of Practice Architectures theory, this study will seek to understand whether water management and the curriculum practices can complement each other through action learning involving the Fort Cox community as a collective.

The concept of Practice Architectures enables an understanding of the enabling and constraining factors of the practices themselves. According to Kemmis and Grootenboer (2008), practices are not dependent on the experience, intentions and actions of individuals or groups of people alone, but are also influenced by arrangements, circumstances and conditions beyond the individual actor e.g. the educator. In order to be able to change teaching practice, Kemmis (2008) argued for a need to change the Practice Architectures that construct teachers' action possibilities, their self-understanding and their understandings of the world; these Practice Architectures enable or constrain what these teachers do.

## **2.6 Ethics of care and implications of this on environment and water management practices**

Ethics of care is forming and adhering to a set of values or beliefs about what people should do when confronted with moral dilemmas, both as part of an organisation and in an individual capacity (Appelgren, 2004). According to Jennings, Heltne & Kintzele (2009), in the domain of ethics, questions of scientific knowledge come together with aspects of cultural meaning and perception; questions of conservation, sanitation, and health promotion come together with questions of justice, equity, and human rights; questions of sustainability and biodiversity come together with questions of democratic laws and policies. Practising water ethics often requires a change in people's behaviour and attitude towards water. This can be encouraged primarily through education and awareness of the value of water to the ecosystem (Sohail & Cavill, 2006).

According to Pettersen (2011), the ethics of care (as a particular theory of ethics) is not confined to abstract speculation about values, or to collecting idiosyncratic experiences. It reasons neither from the top-down, nor from the bottom-up. Its theory is founded in an ongoing dialogue between the normative and the empirical. Consequently, the ethics of care acknowledges the interplay of context and value: situated people create situated values. To deny or disguise the contextual origin of norms encourages false generalisations. Values and norms from one context can nevertheless be relocated in other contexts. What the moral philosopher can do is to analyse and articulate value systems, draw attention to problems and possibilities, and supply well-founded justification when necessary (*ibid.*).

Practising water ethics often requires a change in people's behaviour and attitude towards water management. Knowing where water comes from, not only that water comes from a tap, but how it becomes safe for consumption and knowing the cost attached to water, was crucial for this study (Sohail & Cavill, 2006).

In the context of water, in addition to an ethic of care, general environmental ethics should also be considered. Brennan and Lo (2008) defined environmental ethics as the philosophical discipline that considers the moral and ethical relationship between human beings and the environment. Human values become a factor in water resource management because there are effects that are important to individuals that they then use to evaluate actions or events. 'Environmental values' brings together contributions from philosophy, economics, politics, sociology, geography, anthropology, ecology and other disciplines, which relate to the present and future environment of human beings and other species. One's value system is shaped by one's virtues or vices. A person's self-discipline is based on the common sense and wisdom of knowing the proper moral rules and discipline, and the amount of willingness to self-correct (Corraliza & Berenguer, 2000). An 'Environmental Value System' is a particular worldview or set of standards that shapes the way individuals or societies perceive and evaluate environmental issues (Rondinelli & Vastag, 2000). It is essential that Fort Cox's institutional water utilisation practices adhere to environmental morals and recognise the socio-economic and ecological values if the goals of sustainable water management and respect of the environment are to be realised.

Water ethics is an important but frequently ignored aspect of water resource planning and infrastructure management. There are basic concerns for the water sector in developed and developing countries. These concerns include the water cycle, quality of life, equity, sustainability, human rights, externalities and governance. They are used to develop ethical principles that should be taken into account by water professionals and decision makers if they are to achieve effective, efficient and ethically acceptable water resource management (Harremoes, 2002).

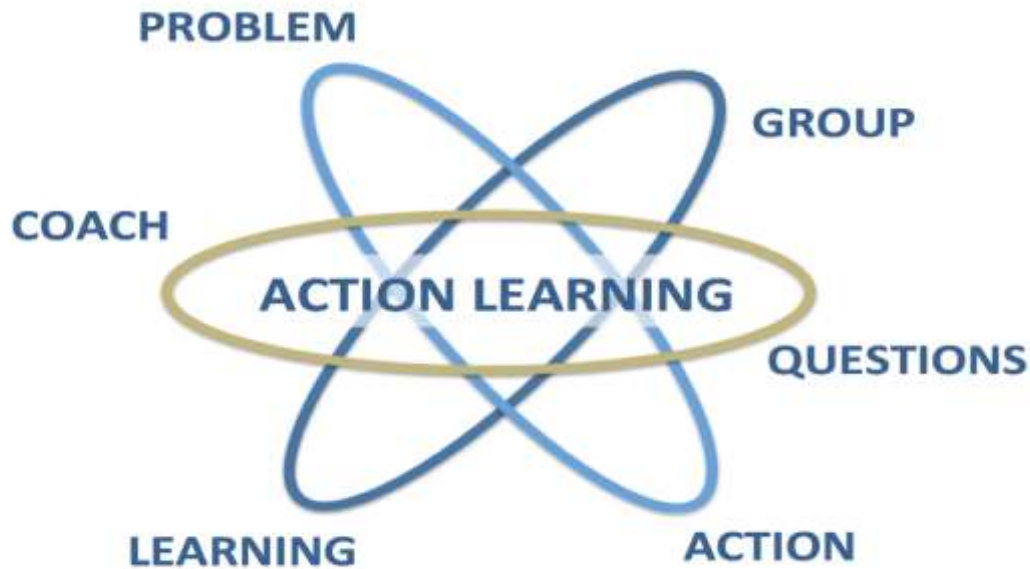
Jennings et al. (2009) highlighted seven critical principles of water management ethics:

- **Human dignity:** There is no life without water and those to whom it is denied are denied life.

- **Participation:** All individuals, especially the poor and women, must be involved in water planning and management.
- **Solidarity:** Water continually confronts humans with their upstream and downstream interdependency.
- **Human equity:** Rendering to all persons their due.
- **Common good:** Water is a common good and, without proper water management, human potential and dignity are diminished for all and denied to some.
- **Stewardship:** An ethical balance between using, changing and preserving water resources and land.

## **2.7 Action learning in educational practice**

Action learning is a process of changing people's practices, their understanding of their practices, and the conditions under which they practice (Marquardt, 2007). Action learning is a meta-practice – a practice that changes other practices by changing people's patterns of what they know and say about a particular practice, what people do to manage a practice and how people use their power and unity to form new patterns of practices (*ibid.*). Action learning is one of the pillars of Practice Architectures theory that has already been proven successful in an agricultural system (*ibid.*). Action learning usually involves small groups of people meeting in the form of workshops or meetings with the focus on a complex problem with the goal of solving that problem while developing themselves and the organisation (Leonard & Marquardt, 2010). Action learning consists of six components that, when operating together, deliver powerful results (see Figure 2.3).



*Figure 2.3: Six components of the action learning process model (Marquardt, 2007)*

Action learning is an educational approach used to solve real problems that involves taking action and reflecting upon the results, which helps improve the problem-solving process, as well as the solutions developed by the collective (Leonard & Marquardt, 2010). Action learning is a problem-solving tool that at the same time builds successful leaders, teams and organisations (Marquardt, 2004). The action learning process includes the following: a real problem that is important, critical, and usually complex; a diverse problem-solving team or ‘set’; a process that promotes curiosity, inquiry, and reflection; a requirement that talk be converted into action and, ultimately, a solution, and a commitment to learning (Marquardt & Yeo, 2012).

Action learning has many educational applications. Action learning has been demonstrated to be very effective in developing a number of individual leadership and team problem-solving skills, therefore it has been used extensively as a component in corporate and organisational leadership development programmes (Zuber-Skerritt, 2002). Because complex problems require many skills, individual team members can develop a customised learning agenda for themselves. This strategy is quite different from the ‘one size fits all’ curriculum that is characteristic of many training and development programmes (curricula).

The action learning approach was intended to be used to structure a process for involving Fort Cox students and staff in developing a better understanding of water management and

the implications for curriculum practices at the institution. This started with interactive workshops and participatory audits, to focus on current water management practices and reviews of curriculum practices. The aim was to start a process in which participants would be invited to design and adopt a feasible approach to, and possible solutions for, water management and curriculum practice requirements that need collective understanding and an action plan for implementation. Such a process would, according to Marquardt's action learning model, encourage an exchange of ideas and reflection on the matters of concern, and hopefully, learning. The group would then, if willing, design a system of action to address the common water management concerns and inform policy and review where possible. The next chapter explains that this process did not play out entirely as planned in the available time, but the study nonetheless identified strong potential for such action learning processes.

## **2.8 Conclusion**

This chapter has introduced existing literature on Education for Sustainable Development in the context of agriculture education as a powerful tool in promoting sustainable water management for agriculture development and food security. The chapter has looked at how Education for Sustainable Development influences sustainable practices in agricultural institutions, concentrating on a sustainable focus in water management and curriculum practices. Since climate change is a driving force in environmental trends, this chapter also discussed climate implications on agricultural water management practices that feed into agricultural curricula. There was also discussion of Practice Architecture theory as it was used in the research to examine water management and curriculum practices of Fort Cox's doings, sayings and relatings as well as the associated arrangements which sought to explore the enabling and constraining factors in relation to water management and curriculum practices. In addition, this chapter has examined the potential action learning process that was brought as a supportive theory of Practice Architecture sayings, doings and relatings for this study.

## **CHAPTER 3: RESEARCH METHODOLOGY**

### **3.0 Introduction**

This chapter discusses the research processes that were followed in the study. This chapter commences with a discussion and elaboration of the research methodology: a qualitative case study research method was used to address the research questions and research goals. This chapter also describes the research participants and the research techniques which were chosen to generate data. The suitability of the data generation techniques in this study context will be explained in section 3.3. In addition, the chapter presents the sequential arrangement of the data generation process, and how the research process unfolded, including the changes that had to be made to the original planned process of this study (see section 3.7).

Furthermore, this chapter describes the analytical framework that was followed during the data analysis phase using the Practice Architectures elements of sayings, doings and relating as well as the associated arrangements, through the inventory of the analytical memorandums and data sources which were presented in tables. The chapter concludes by describing the validity and ethical consideration procedures that were applied throughout this research.

### **3.1 Research methodology**

According to Kothari (2004), research methodology is a systematic way of solving a problem identified either in academia or in a real life context. Essentially, the procedures by which researchers go about their work of describing, examining and explaining phenomena are referred to as the research methodology (*ibid.*). According to Nardi (2018), research methodology is defined as the study of methods by which knowledge is gained to answer specific questions. Different research processes are used to collect data and information for the purpose of making informed decisions in or claims regarding a given phenomenon. This research addresses a real-life problem of water management practices encountered at Fort Cox. In order to explore the water management and curriculum practices at Fort Cox, a case study research method was chosen with qualitative data generation and it will be discussed in the next sections 3.1.1 and 3.1.2 respectively.

#### *3.1.1 Case study research*

This research was a case study informed by the Practice Architectures Theory (Kemmis, McTaggart & Nixon, 2013; Kemmis (2009) and the Action Learning process model (Marquardt, 2007). A case study was the most suitable methodology for this research because

in case study research, the researcher and participants are both involved in the processes of data collection in order to study the case using different methods (Creswell, 2003). A case study refers to the in-depth exploration and analysis of a single or small number of units (Cohen, Manion & Morrison, 2013). Baxter and Jack (2008) defined case study research as an empirical inquiry that explores a phenomenon within its real life context. “A case study is also well-defined as a systematic and in-depth investigation of a particular instance in its context in order to generate knowledge” (Rule & John, 2011, p.4). The case being studied can be a single person, a group of people, an organisation or an institution (Yin, 2013). A case study has the flexibility of allowing the exploration to report the events with their relationships as they unfold (Cohen, Manion & Morrison, 2005). To be specific, a group of participants affected by water management practices of the Fort Cox Institution which were: academic staff, students, field technicians, farm manager and other support staff affected by water management practices formed part of this research process in which the case being studied was the water related practices at the institution. The relevant courses that were key for data generation on water management and curriculum practices were: Irrigation, Soil and Water Conservation, as well as the majority of water dependent subjects from both the Crop Production and Animal Production curriculum.

### *3.1.2 Qualitative research study*

This study has employed qualitative research methodology to generate data. According to Maxwell (2012), qualitative research is primarily exploratory research; it is used to gain an understanding of underlying reasons, opinions, and motivations. Qualitative research is also used to uncover thoughts and opinions, and dive deeper into the problem identified (*ibid.*). Qualitative research provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative research (Slevitch, 2011). Qualitative data collection methods range from unstructured to semi-structured interviews. Some common methods (also called techniques and tools in this study) include focus group interviews (group discussions), individual interviews, and observations. The sample size is typically small to allow for more in-depth analysis, and the respondents are intentionally selected (*ibid.*). Qualitative research is an inductive, subjective process of inquiry done in a natural setting in order to build a complex, holistic picture, described in words, including the detailed views of the informants which are reported in informal and using common language in the interviews (Hatch, 2002).

Qualitative research interviews in this research took the form of conversations where questions were asked to elicit both factual information as well as the viewpoints of the participants, which were therefore useful for accessing the ‘sayings, doings, and relatings’ of the Practice Architectures framework. This research study happened in a real world setting of Fort Cox with the researcher not manipulating the phenomenon under study, but being open to what emerged as the phenomenon unfolded during data generation processes. According to Patton (2002), this gives qualitative research a naturalist feel, enabling it to be classified as a naturalist qualitative study. Qualitative research requires rich data (Maxwell, 2012). To provide this rich data, a mix of interactive workshops, semi-structured interviews, questionnaires, observations using photos and document analysis were used to generate the data.

### **3.2 Research site and participants**

Qualitative researchers study meaning and the quality of research into meanings cannot be ensured simply by following correct procedures (Ezzy, 2002). In this study, quality was ensured through engaging with participants in context and in close proximity to that context, to enable first-hand encounters, in-depth analysis and deeper understanding of their practices in that context.

This research study was conducted within the Fort Cox campus with adults and the researcher was an employee of the institution. This study was funded by Rhodes-Environmental Learning Research Centre (ELRC) in partnership with Fort Cox and the Invoto Bubomi Learning Network (IBLN), supported by a memorandum of understanding. At the start of this study, a letter of access was written to the head of the institution for permission to conduct a study at Fort Cox and this was granted (see Annexure A, letter of access granted). The sample of participants in the study were selected using a Voluntary Participation Technique (VST) across the water management and curriculum practices of Fort Cox. Voluntary Sampling Technique (VST) is a non-probability sampling method that allows the participants to self-volunteer themselves if they are willing to participate (Cohen, Manion & Morrison, 2007). Participants included academic staff, students enrolled in water management subjects, academic field technicians, farm manager and other support staff. All these participants were invited to participate in this study through a consent form which was distributed to the students enrolled in water management subjects, lecturers teaching water management subjects and field technicians assisting in students’ practicals. The participants who were

interested submitted the signed consent form. In addition, an invitation letter and agenda was sent to the participants to ‘kick start’ the study with a workshop (see annexure B). The relevant water management subjects that were key for data generation on water management and curriculum practices were Irrigation, Soil and Water Conservation, as well as water dependent agriculture production courses in the stated curriculum of Fort Cox.

One group of participants consisted of four lecturers working with water management associated curriculum courses. The lecturers were asked to give their own reflections on their knowledge and deeper understanding on the ‘sayings, doings and relatings’ on water management and curriculum practices of Fort Cox. These academics were invited based on their area of specialisation; they responded positively and showed an interest in participating in this study (*see Table 3.1 below*).

A second group of participants consisted of sixteen Fort Cox students enrolled in Irrigation, Soil and Water Management subjects and Agriculture Production water dependent subjects. The student participants included members of educational clubs (Animal and Crop Production clubs members). These club members were active and interested in action learning practices dependent on water (*see Table 3.1*). The educational clubs are self-teaching platforms which have been created by students and are supported by concerned academics in order to build relevant skills among students while they are still on campus. During the workshop, Agriculture diploma students were part of the data generation process. During semi-structured interviews, Crop Production and Animal Production students were interviewed and students enrolled in water dependent subjects participated in the residence survey tool on water management practices. The students also completed the Unit-based Sustainability Assessment Tool (USAT) questionnaire.

A third group of research participants, field technicians who were directly involved in water management and curriculum practice in both Agriculture curricula, were also invited to participate in this study (see Table 3.1 below). Furthermore, other support staff across other water management practices of Fort Cox were also present during some data generation activities to allow them to add their experiences and insights.

Finally, a member from executive management was invited to give guidance on institutional policies and buying in of ideas and proposed action plans to be pooled by this research study.

The farm and Rural Development Centre (RDC) manager took part in the workshop, representing both the management and the farm section of Fort Cox. The farm and RDC manager's presence was key also in the sense that sustainable water management practices were his point of interest in this research and his contribution was important in order to understand the Fort Cox water management practices in the farm context.

All participants' contextual information was gathered at the beginning of this research study when their willingness and availability to be part of this research study was confirmed. This was necessary in order to solicit data related to participant qualification, preferred language, their role at Fort Cox, previous experiences and their current knowledge and understanding of water management and curriculum practices.

**Table 3.1: Research participants' profile**

Number	Participants	Participant profile	Specialisation area of focus
1	Mr Matambo C	Senior lecturer	Irrigation and Agriculture Engineering
2	Mr Landzela B	Senior lecturer	Introduction to Crop Production
3	Mrs Madikiza L	Senior lecturer	Vegetable and Fruit Production
4	Mrs Vele M.T	Senior lecturer	Silviculture and Forest Management
5	Mr Mapipa L	Field technician	Forestry practicals
6	Ms Qampi T	Field technician	Crop Production practicals
7	Ms Gwebushe L	Field technician	Farm
8	Mr Mrubata B	Executive member	RDC and farm manager
9	Dr Mangoale M	Laboratory technician	Botany
10	Dumezweni Z	Nursery supervisor	Forestry and Crop Production practicals
11	Mr Sixoto W	Guest lecturer	Guest lecturer – agriculture extension
12	16 students	Across all subjects	Animal, Crop Production and Forestry

### 3.3 Data generation techniques used

Data was generated using five qualitative data techniques. The following data generation tools were used:

- Workshop
- Semi-structured interviews

- Document analysis
- Observations
- Unit-based Sustainability Assessment Tool (USAT) – a questionnaire for conducting sustainability audits

### *3.3.1 Workshop*

A workshop in an academic platform means an arrangement whereby a group of people learn, acquire new knowledge, perform creative problem-solving, or innovate in relation to a domain-specific issue (Kriz, 2003). According to Berg (2004), the workshop method allows participants to share, analyse and deepen their knowledge on the subject matter. Workshops as a research methodology focus on the study of domain-related cases using the workshop format to generate data. In these studies, the workshop was, on one hand, authentic, as it aimed to fulfil participants' expectations to achieve something related to their own interests. On the other hand, the workshop was specifically designed to fulfil a research purpose: to produce reliable and valid data about the domain in question (Baran, Uygun, Altan, Bahcekapili & Cilsalar, 2014).

An interactive workshop was the first data generation opportunity for this study (see Annexure B showing workshop agenda). Part of the workshop agenda was to introduce the aim of the study and the research questions and research goals, and also to invite participants to further share their thoughts and experiences regarding water management at Fort Cox through other data generation techniques, following the workshop, for deeper understanding of the subject matter. The participants were invited to this action learning event to potentially start working together and learning from each other as a collective towards achieving a particular objective or overcoming a challenging factor, namely water management at both Fort Cox campus and the farm. The workshop discussions were audio recorded and photos were taken with the consent of participants. An audio record of the workshop was transcribed and triangulated in the form of an analytical memorandum (see annexure B).

In the workshop, the participants were four academic lecturers involved in teaching and learning of water management related courses, two field technicians working in related contexts, 11 students who were enrolled in Irrigation, Soil and Water Conservation, Vegetable Production, Fruit Production, Pig Production, Dairy Production and Silviculture courses offered at second-year levels, and two heads of academic departments, one executive manager from Fort Cox farm and Rural Development centre (RDC) and four other support

staff from other Fort Cox supporting sections. Participants in the workshop were invited to reflect on matters of concern and their own experiences related to water management and curriculum practices of Fort Cox. In total, 24 participants attended the workshop excluding the researcher (see picture 3.1 showing participants engaging in the presentation before further engagements). After completion of this study, a second workshop will be organised and used to reflect on the findings of the study including possible contradictions, and to propose possible action plans and implementation of some of the recommendations.



***Picture 3.1: Participants engaging in questions and discussion during the workshop.***

***Photo credit – Siphe***

The workshop was viewed as an ice-breaking session to solicit fundamental insights of the current ‘sayings, doings and the relatings’ of water management and curriculum practices of Fort Cox community (see *Appendix A: Analytical memo 1 of workshop*). The workshop was also used to prepare all participants on the research goals and the research main question and sub-questions. There were no structured questions during the first workshop but a formal presentation by the main researcher prepared the participants on the vision of the study; thereafter a discussion with questions ensued.

### *3.3.2 Semi-structured interviews*

An interview is a conversational practice where knowledge is produced through the interaction between an interviewer and an interviewee or a group of interviewees (Brinkmann, 2014). According to Bertram and Christiansen (2015), interviews involve a discussion between the researcher and the respondent or respondents using a set of pre-planned core questions. Interviews are a flexible instrument for collecting data allowing

multi-sensory channels to be used: verbal and non-verbal (Cohen, Manion & Morrison, 2011).

There are three different types of interviews: structured, semi-structured and unstructured (Chambers, 1997). This study employed semi-structured interviews because this allows one to change the order, rephrase, modify and repeat questions for clarification, and ask follow-up questions. Semi-structured interviews were used to gather more information about water management practices on the 'sayings, doings and relatings' from three Animal Production club members and five Crop Production club members (students) and four individual academic staff about water management and curriculum practices at Fort Cox as indicated in the research sub-questions shown in Chapter 1. The educational club members were interviewed in the form of a group of three Animal Production club members and five Crop Production club members respectively. This qualitative research process involved direct conversations with participants in the form of questions and answers. These questions were asked in order to solicit the required factual information as well as participants' viewpoints on the water management and curriculum practices of Fort Cox. The interviews were captured with their permission through audio recording and transcribed for analysis purposes.

This whole process was useful for accessing the 'sayings, doings, and relatings' regarding water management and curriculum practices of Fort Cox. A set of questions was developed to investigate participants' understanding on water management practices and how the taught curriculum and other water management practices will benefit from this the study (see Annexure C showing lecturer's semi-structured interview questions and annexure D1 and D2 showing semi-structured interview questions for both educational clubs respectively).

### *3.3.3 Document analysis*

Document analysis is a systematic procedure for reviewing or evaluating documents. Like other analytical methods in qualitative research, document analysis requires that data is examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge (Corbin & Strauss, 2008). During this study, information on the explicit curriculum content in water management courses was gathered through analysing the Fort Cox curriculum documents as they appear online and/or in hard copies, as well as teaching and study guides and textbooks. The chosen courses were the second year Irrigation, Soil and

Water Conservation and Agriculture water dependent courses (see annexure F – curriculum outline of water dependent subjects).

#### *3.3.4 Observations*

Observation is another data collection technique useful in case studies. Researchers use all their senses to examine practices in natural settings. Observation usually requires prolonged engagement in a field setting or social situation (Jorgensen, 1989). During field observations in this study, Fort Cox student’s practical demonstration sites were visited, and pictures of water management practices were taken with the consent of participants for ethical reasons. The pictures were captured using a cellphone camera in most cases. Where the photo narratives are not created using the researcher’s photos, credit is given to the participants who contributed their own photo narratives from their respective water management practices.

#### *3.3.5 Unit-based Sustainability Assessment Tool*

The Unit-based Sustainability Assessment Tool (USAT) is a questionnaire that was used in relation to different Fort Cox practices, namely students’ residences at Fort Cox campus and Fort Cox farm as practical laboratories. The USAT is an existing tool that was specifically designed to assess sustainability at tertiary institutions (Togo & Lotz-Sisitka, 2009), to check what is working and what is not working within a current system and specifically an educational institution, through a self-evaluation process (*ibid.*). The tool was adopted to make observations of water management practices in the form of unit-based sustainability surveys, and to examine the current water management practices of participants in their respective context at Fort Cox. The USAT tool has been used for the particular purposes in this study for evaluating students’ residence and technicians’ water management practices (*see Appendices E1 and E2 showing USAT questionnaires for field technicians and students respectively*). Data from the self-evaluation by students and technicians using the USAT tool helped to further understand the ‘sayings, doings and relatings’ regarding Fort Cox water management practices.

#### *3.3.6 Summary of data generation techniques.*

For the purpose of tracking the data source and participant narratives, all participants during the data collection were named and gave written consent to be named during research processes. This helped to identify them with ease during analysis and in the next chapters.

The following Tables 3.2 and 3.3 present an inventory of participants and data source trajectories respectively.

**Table 3.2: Inventory of data sources**

<b>Data Generation Technique</b>	<b>Research participants</b>	<b>Purpose</b>	<b>Annexures</b>
<b>Workshop</b>	24 participants attended: 11 students, 4 lecturers, 2 Heads of Departments, 2 academic field technicians, 1 farm manager and 4 other support staff.	To explore the understanding of participants on water management and curriculum practices of Fort Cox, and the significance of action learning in the respective practices.	<b>Annexure B</b> (Workshop agenda)
<b>Key informant semi-structured interviews</b>	Four lectures teaching water management and related production courses respectively.	Lecturers were interviewed reflecting on their own water management and curriculum practices in their specific teaching and learning context at Fort Cox.	<b>Annexure C</b> (Semi-structured interview questions for academics)
<b>Interviews: students clubs</b>	Student's educational clubs (Animal and Crop Production clubs) and 2018 students enrolled in Soil and water conservation courses.	Students reflect on how water management and curriculum practices of Fort Cox influence their educational patterns through the action learning and stated curriculum in the formal academic programme.	<b>Annexure D1 and D2</b> (Semi-structured interview questions for students clubs respectively)
<b>USAT self-assessment survey</b>	Students enrolled in Soil and Water Conservation courses residing on campus and field technicians responsible for student's practicals at Fort Cox ATI. (USAT questionnaires)	Exploring water management and curriculum practices of students and field technicians, and their understanding of education for sustainable development associated with water management for agriculture production.	<b>Annexure E1</b> (Questionnaire for technician's survey) and <b>Annexure E2</b> (Questionnaire for student survey)

<b>Document analysis</b>	Extracts from Irrigation, Soil & Water conservation curriculum content and relevant agriculture subjects. Summative and formative assessment analysis for water dependent subjects	Evidence and policy guiding framework for teaching and learning. Evaluation of taught curriculum and assessment coverage of environmental education especially water management topics.	<b>Annexure F</b> (Curriculum outline of water dependent courses extracted from 2019 Fort Cox prospectus)
<b>Field observations</b>	Photo narratives by practice lecturers and students during field visits.	Evidence and evaluation of water management and curriculum practices and action learning demonstrations.	Photos during observations presented in Chapter 4

### 3.4. Data analysis

This study follows the principles of a qualitative research approach. According to Cohen, Manion and Morrison (2007), qualitative data analysis involves organising, accounting for and explaining the data, making sense of the data in terms of the participants' accounts, noting patterns, themes, categories and regularities. There is no single correct way to analyse and present qualitative data; how one does it should abide by the issue of fitness for purpose and as guided by the chosen analytical framework. Furthermore, Cohen *et al.* (2007) argued that qualitative data analysis is often heavy on interpretation, and one has to note that there are frequently multiple interpretations to be made of qualitative data. Qualitative data focuses on a smaller number of participants yet the data tends to be very detailed and rich. In this case, the researcher can decide whether to present the data individually and if desired, to merge the key narratives emerging across the participants (Cohen *et al.*, 2007).

There are two approaches for analysing data in research, namely inductive and abductive approaches. In inductive research, the researcher develops classifications and concepts from the data generated and these are related to the research question of the concerned study, while abductive analysis focuses on re-describing the occurrence under study to discover connections and relations that would have possibly been not so obvious (Danermark, Ekstrom, Jakonsen & Karlsson, 2002). Abductive analysis is commonly based on the theoretical framework. This research has followed an abductive approach to generate the data required and analytical memos were developed for each data source.

Data generated for this study were analysed using the Practice Architectures framework to answer the four research sub-questions. The process aimed at surfacing the 'sayings, doings, relatings' regarding water management at Fort Cox across practices on the campus and farm, and the curriculum practices. A highlighter was used to mark the 'sayings, doings and relatings' from the transcribed data techniques in the form of analytical memoranda. This process was used to surface the common and/or contradiction statements from the participants 'sayings, doings and relatings' which were grouped together respectively into the analytical memoranda representing each data technique used. The analytical memoranda were further developed to form analytical statements for analysis purposes to be discussed in Chapter 5 regarding the water management and curriculum practices of Fort Cox.

As mentioned above, the researcher used analytical memoranda to triangulate the 'sayings, doings and relatings' that surfaced from raw data. Triangulation in research is about getting data and insights from different sources. Data is triangulated in order to get many viewpoints and to strengthen validity (Kerfoot & Winberg, 1997). I have grouped the academic interviews together to form one single analytical memo. I also grouped the interviews of both Animal and Crop Production clubs to form a single analytical memo each. The questionnaires were grouped to develop analytical memos for the field technicians and students. Below is Table 3.3 showing an inventory of analytical memoranda developed from the various raw data sources for this research study.

**Table 3.3 Inventory of analytical memorandums for this research study**

<b>Analytic memos</b>	<b>Data sources</b>	<b>Research goal addressed</b>	<b>Data generation technique</b>	<b>Annexure number</b>
<b>Analytical memo 1</b>	Workshop participants	Goal 1, 2 and 3	Workshop session	<b>Appendix A</b> (Analytical memo of workshop)
<b>Analytical memo 2</b>	Lecturers Matambo, Madikiza, Vele and Landzela	Goal 1	Semi-structured interviews	<b>Appendix B</b> (Analytical memo of academic interviews)
<b>Analytical memo 3</b>	Animal Production (3 students) and Crop Production (5) club members	Goal 2	Semi-structured Interview	<b>Appendix C</b> (Analytical memo of student clubs)
<b>Analytical memo 4</b>	Field technicians' USAT questionnaires (3)	Goal 1 and 2	USAT self-assessment survey	<b>Appendix D</b> (Analytical memo of field technician's USAT)
<b>Analytical memo 5</b>	Student's residence questionnaires (16)	Goal 1 and 2	USAT self-assessment survey	<b>Appendix E</b> (Analytical memo of students' USAT)
<b>Analytical memo 6</b>	Water management curriculum outline, assessment documents	Goal 1 and 3	Document analysis	<b>Appendix F</b> (Analytical memo of water management curriculum subjects)

### **3.5 Validity and trustworthiness (research quality)**

Validity is concerned with the meaningfulness of research components (Bollen, 1989). Cohen *et al.* (2011) pointed out that validity is a significant key to effective research. According to Cohen *et al.* (2011, p. 179), validity might be addressed through the honesty, depth, richness and scope of the data achieved, the participants approached, the extent of triangulation and the disinterestedness or objectivity of the researcher. Member checking and triangulation were used to confront the validity concerns during the study with the purpose of comparing data from multiple sources and participants (Wilmot, 2005).

The informed consent form was a significant tool in terms of ensuring transparency and honesty. The participants were made aware that their participation in this study was voluntary. I encouraged willing participants to read the consent form carefully and allowed

them to seek as much clarity as they required before they committed to participate in this research study. Cohen, Manion and Morrison (2005) recommended that anonymity is not advisable for case study research but real names are not mentioned. For the participants who did not understand the consent form language and meaning of particular statements, the form was verbally explained and interpreted in Xhosa. The majority of the participants were comfortable with their real names being used during this research; only one student who was not active in the workshop preferred anonymity. However, during the self-assessment survey process involving students and field technicians, all participants completed the questionnaire anonymously and therefore I decided to give them code names for identification purposes during data presentation and analysis.

### **3.6 Ethical considerations**

Ethical issues are present in any kind of research. The research process creates tension between the aims of the study to make generalisations for the good of others and the rights of the participants to maintain privacy. Ethics relates to doing well and avoiding harm. Harm can be prevented or reduced through the application of appropriate ethical principles. Thus, the protection of human subjects or participants in any research study is imperative (Orb, Eisenhauer & Wynaden, 2001). A letter of access was written and a response was granted from the Principal Office of the institution to allow me to conduct this research within Fort Cox (see Annexure A). It was necessary to request the institution give me access because personnel and other resources were required to assist during my research processes. Beyond this, however, all participants in this study were adults who needed no permission for their roles in this research. I had also sought (and was granted) participants' consent to use their voice recordings during interviews and workshops. I explained the reasons for using audio recording at the beginning of each interview and workshop. Fortunately no one had any problems with the use of any methods of data recordings (audio recordings, videos, and photos).

The access to confidential documents was also part of ethical considerations and as indicated above, the access letter to the executive of the institution which articulated that all information provided by anyone from Fort Cox to assist during this research study would only be used for the purpose of this research study objective and would remain confidential. In addition to maintaining ethical consideration issues in research, an ethical clearance

certificate was obtained from Rhodes University for this study with ethical clearance number of 2018.05.07.03.

### **3.7 Reflection on data generation processes**

During this research, many experiences were encountered through the data generation process journey. Balancing an employer's time and postgraduate study requires very careful planning and extra determination. In the early days of this research study, there were too many ambitions. It was also to balance employers' demands and study demands. Availability of participants was also a challenge though ultimately most did finally honour their commitment to participate in the study.

I had hoped to undertake a series of workshops and action learning events to start tackling water issues on the campus and this did not happen as anticipated. There were a number of constraining factors which included time to bring all participants together. The research participants wanting to all be together in one room or context was not an easy task, which was attributed to workload and different free times to honour the requirements of this research.

### **3.8 Conclusion**

This chapter describes the research data generative methods adopted as the basis for the qualitative case study at Fort Cox. The following data generation techniques were used to solicit the data which will be presented in the next Chapter 4: namely workshop, semi-structured interviews, USAT questionnaire, document analysis and observations of water management and curriculum practices. This chapter has also described the validity and trustworthiness measures and ethical considerations observed in research.

## **CHAPTER 4: DATA PRESENTATION AND FINDINGS**

### **4.0 Introduction**

This chapter presents findings as set out in the research sub-questions described in Chapter 1, viz: What are the current ‘sayings, doings and relatings’ related to water management at Fort Cox? What are the ‘sayings, doings and relatings’ regarding water management in the stated curriculum at Fort Cox? What are the associated arrangements and conditions, enabling and constraining factors of water management and curriculum practices at Fort Cox? What are the implications of the research findings for Fort Cox’s curriculum development?

The findings presented here will be drawn from the following data sources as discussed in Chapter 3: the workshop with lecturers, field technicians, students and support staff, the USAT questionnaires completed by field technicians and students, semi-structured interviews with lecturers and students, observations in the form of photo narratives and document analysis of the stated curriculum and curriculum practices (teachers’ work).

This chapter begins by presenting the findings related to the ‘sayings, doings and relatings’ of water management and curriculum practices at Fort Cox (Research Sub-Questions 1-2) drawing on the multiple data sources listed above. Secondly, the chapter reports on the associated arrangements and conditions that enable or constrain sustainable water management and associated curriculum practices (Research Sub-Question 3).

These findings will be consolidated in Chapter 5, to comment on the remaining research sub-question 4 of the study, regarding implications for curriculum practices at Fort Cox. The analytical memos that were developed will be presented in annexures labelled accordingly.

### **4.1 To understand more fully, what the ‘sayings, doings and relatings’ are regarding the water management and curriculum practices of Fort Cox**

To respond to research sub-question 1 of this study, this section was analysed using analytical memos generated from the data collected. First, I analyse the inputs of the academics, students and field technicians generated from the workshop, semi-structured interviews, USAT questionnaires and photo narratives. Second, I analyse the documents pertaining to the Irrigation, Soil and Water Conservation and agriculture production water dependent subjects offered by the stated curriculum.

To remind the reader, with cross referencing to Chapter 2: Section 2.5, it was stated that in the semantic space of the Practice Architectures framework, ‘sayings’ refer to what the people of Fort Cox would reflect and say about water management and curriculum practices at the institution; in the physical/temporal space, the ‘doings’ relate to how people conduct themselves or do things as an individual or as a collective regarding water and the curriculum at Fort Cox; and in the social space, the ‘relatings’ refer to the traditions in which the people of Fort Cox relate to each other and the surrounding environment specifically for water management and curriculum practices, through their sovereignty and working relations (Kemmis & Grootenboer, 2008).

The findings presented below are based on the raw data taken from transcripts and summarised in the Analytic Memoranda which are included as Appendices.

#### ***4.1.1 The ‘sayings, doings and relatings’ on water management and curriculum practices at Fort Cox from workshop (see Analytic Memo 1 Appendix A)***

Section 3.3.1 lists the 25 workshop participants, namely: academic lecturers, field technicians, students, farm and Rural Development Centre manager and support staff.

##### *4.1.1.1 The sayings from the workshop*

According to a lecturer, Madikiza, the ‘sayings’ of water management and curriculum practices of Fort Cox were described in the Fort Cox prospectus as the explicit curriculum in the academic context. Madikiza further explained that “what has been written down in the course outline in black and white, it’s like one’s bible which one has to follow”. The above interpretations were echoed by another lecturer, Matambo, who added that the given course outline defines the current ‘sayings’ and they were supported by the prescribed textbooks, core notes and other relevant online materials.

According to Matambo, rainwater harvesting topics were frequently mentioned in the current stated curriculum but rainwater harvesting was not the only water management practice relevant to farmers. Matambo indicated that other aspects that can be included in the water management and curriculum practices include groundwater extraction mentioned in some of the agriculture production and engineering subjects. However, he indicated that those topics were not explored in depth. The other topics appearing in water management subjects include

the construction of water ponds and dams which link with rainwater harvesting practices on a larger scale.

#### *4.1.1.2 The doings from the workshop*

In relation to the doings of water management and curriculum practices of Fort Cox, Madikiza revealed that the lecturers involved in water management subjects were covering fundamental water topics that were important for crops in their respective course context. She indicated that “in vegetable production courses, water remains one of the important production factors that was emphasised to facilitate growth for various vegetable crops”. Matambo also explained that teaching and learning of sustainable water management topics at Fort Cox was reinforced by facilitating hands-on practicals relevant to the topics described in the curriculum.

#### *4.1.1.3 Relatings from the workshop*

Regarding the relatings, Matambo argued that Fort Cox required working collaborations within its community to improve much needed communication between support staff, students and lecturers involved in water management and curriculum practices. Matambo was of the view that Fort Cox academic lecturers, students and support staff all have a role to play regarding water management and curriculum practices as a collective and therefore needed to form working collaborations within Fort Cox. Through that process, Matambo said, learning sustainable water practices will happen efficiently because the support staff will be much more knowledgeable and aware of academic and stated curriculum requirements. According to Madikiza, “there may be partnerships that exist in Fort Cox but Fort Cox community may not be aware of them and how effective or useful those partnerships are to the current curriculum, but it’s probably a question of enquiring further into the nature of those partnerships” from relevant offices.

Another workshop participant, Mrubata, echoed the view that there is a lack of collaboration between water management practices and curriculum practices at Fort Cox. He submitted that “after hearing the conclusions that people have made [in the workshop], it goes back to the issue of integration and collaboration, academics are not acting parallel to the activities of the farm”. According to Mrubata, who is a Section Manager of the farm, Fort Cox field pastures do not complement the course content of the cultivated pasture management as it is supposed to. Mrubata suggested that the reason why water management practices of Fort Cox were

going wrong at the farm was because “there is no link between the farm and the academic programme, which is supposed to be corrected, and the support staff need to know what is expected from them in order for Fort Cox to have a productive farm that give[s] quality education to the students”. Mrubata further suggested that academics should add value to the farm and improve the water management and other related practices on the farm.

An example of “relatings” in the form of a disjuncture between management practices and curriculum practices, was shared in the workshop by Madikiza who said “I just want to make an example of grass which is cut maybe at the grounds or around the campus, you use that as learning material for making trench-beds, but there is currently no link or relationship between the people who are cutting the grass and the lecturers, and how do you get that information that interlink, to say this person who is cutting the grass shouldn’t burn it because it is a learning material and it should be preserved somewhere, that link is what we need to establish”. Another example was shared by student Siphe who revealed that “in Irrigation Principles course, students are taught how long to irrigate particular crops, but when they arrive at the fields and share with workers the sustainable methods of irrigation, workers respond mostly by saying they are going to change their practices, but they never do”.

#### *4.1.1.4 Summary of the ‘sayings, doings and relatings’ findings from the workshop*

Lecturers at the workshop noted a number of places where the ‘sayings’ regarding the curriculum could be found, with the latter being described as a Bible that had to be followed. In addition, ‘sayings’ about what should be taught were found in prescribed textbooks, core notes and online materials. Lecturers felt that the topic of water featured in several subjects, but not in any great depth, nor covering the range of relevant topics.

With regard to the “doings”, lecturers reported that they did teach about water, mostly as a production factor. As the workshop was not a conducive space for lecturers to talk about their individual “doings”, this was discussed further in the interviewed data.

With regards to the “relatings”, the majority of lecturers had strong views on the disconnection between how the farm is managed, and the academic programme. They felt that academics should “add value” to how the farm is managed, drawing on their practical knowledge, and that the farm staff should be better informed about the practical requirements of the taught curriculum. This disconnect had at least two outcomes which participants found

problematic. The first was that there were missed opportunities for teaching and learning, and another was that there were water management practices happening at the farm and across the campus uninformed by academic expertise. Both resulted in missed opportunities for the students and the rest of the Fort Cox community to learn sustainable water management and curriculum practices. A clear example of the disconnect between management practices and teaching is cut grass which could be used to demonstrate trench bed construction and mulching; instead the grass was treated as waste and burned.

#### *4.1.2. The 'sayings, doings and relatings' from lecturers' interviews (see Analytic Memo 2 Appendix B)*

As shown in subsection 3.3.2, four academic lecturers were interviewed as key informants using semi-structured interviews to solicit their in-depth understanding and knowledge of the 'sayings, doings and relatings' of water management and curriculum practices of Fort Cox. It was during the individual interviews where more revelations regarding the 'sayings, doings and the relatings' of water management and curriculum practices of Fort Cox were made. This was probably because lecturers were now comfortable to speak their mind regarding this topic. Data from four lecturers was triangulated in the form of an analytical memorandum.

##### *4.1.2.1 The sayings from four lecturers' interviews*

Regarding the stated curriculum, rainwater harvesting topics were the most frequently mentioned water management practices amongst the four academic lecturers. Matambo thought that the curriculum has a significant number of water management topics described in various water dependent agriculture production courses. He believed that the lecturers at Fort Cox were trying their best to include sustainable management topics such as water conservation techniques, farm ponds, trench beds, rooftop rainwater harvesting techniques, and diversion furrows designed to capture water to use for irrigation during dry seasons, in the curriculum. These were among the commonly taught water management topics in his subject. However, Matambo acknowledged that "there was room for improvement in the curriculum point of view especially if Fort Cox can keep pushing the curriculum matters that were pertaining to water management topics, because the climate is also changing, affecting water balance around the world".

In contrast, Madikiza differed with Matambo's interpretations as she thought that "the curriculum composition of water management related topics was not adequate, especially

seeing the water crisis that Fort Cox was experiencing”. Madikiza’s understandings were echoed by a third lecturer, Vele, who noted that, “the curriculum composition on sustainable water management topics were silent since there were few courses which articulate about soil and water conservation topics”. The fourth lecturer, Landzela was in agreement arguing that “Fort Cox curriculum does not cover much of the water management topics”. He revealed that there are those courses like Irrigation and Land Use Planning which fit into the water management topics, but Fort Cox does not have stand-alone courses to cater for water management topics and climate change topics. Landzela thought that the current curriculum was vague on water management topics and suggested that many of the production courses could at least have a chapter addressing sustainable water management practices. On the other hand, Madikiza felt that “there is no need to change the current stated curriculum as such, but incorporate aspects that will strengthen the water management practices in the current taught curriculum”.

#### *4.1.2.2 The doings from four lecturers’ interviews*

Matambo was involved in teaching Farm Machinery and Introduction to Agricultural Engineering at first year level, as well as Farm Structures, Farm Mechanization and Irrigation Principles at second year level. Matambo explained that he was also involved in facilitating and supervising research projects which include greywater harvesting (see Picture 4.1 showing the construction of greywater demonstration system), rainwater harvesting, engineering projects which include hydroponics, and community engagements projects. Madikiza and Landzela were both involved in teaching agriculture production curriculum courses and practices such as the use of organic matter to improve soil drainage and conservation of water, community outreach and research. Vele was involved in teaching silviculture courses in the Forestry department.



***Picture 4.1: Crop Production students and Mr Matambo constructing a grey water harvesting demonstration system. Photo credit - Matambo***

Landzela indicated that he enjoyed most doing field work practical on water production courses with students. Matambo also indicated that lecturers made use of every opportunity to engage students in practicals, for instance he mentioned the case of the rainwater harvesting techniques whereby lecturers ask students to erect or implement some of the taught techniques on the ground with lecturers' supervision. Madikiza confirmed that at Fort Cox "teaching and learning through practice is supplemented through case studies, scenarios, practicals, demonstrations sites, field visits to relevant farms and relevant stakeholders". Picture 4.2 shows Invoto Bubomi Learning Network (IBLN) members working together with contours as a form of rainwater harvesting technique at Amatole village.



***Picture 4.2: Contour line construction by IBLN members at Amatole village***

Matambo and Landzela indicated that Fort Cox had a few sites where lecturers and students can demonstrate water management and curriculum practices like farm water ponds, rainwater harvesting, rooftop rainwater harvesting, greywater harvesting, conservation agriculture, and other water management practices such as the use of trench beds, mulching (see pictures 4.3 and 4.4) and diversion furrows. Matambo indicated that lecturers had been demonstrating these water management practices to students. According to Madikiza “not only in Crop Production courses where sustainable water management topics are encouraged, but there is an effort to address these topics also in agriculture processing courses on how to reduce water wastage and minimise environmental pollution”. Vele concurred and indicated that some of the staff were trying hard to ensure that students had some relevant knowledge and understanding of sustainable water management topics in their respective curriculum contexts.

In terms of student practicals, Madikiza noted that water was managed by using irrigation systems that are water saving, for instance drip irrigation and mulching materials to conserve moisture (see pictures 4.3 and 4.4). Landzela added to this noting that from Monday to Wednesday, students have practical sessions from 08:00 until 10:00 am to complement the taught curriculum by lecturers.



***Figure 4.3: Water conservation practice - Mulching and intercropping demonstration site constructed by Crop Production students. Photo credit – Landzela***



***Picture 4.4: Water conservation practice – Trench beds demonstration site constructed by Crop Production students. Photo credit – Madikiza***

#### *4.1.2.3 Relatings from four academic lecturers' interviews*

There were different views from lecturers regarding the students' practical component, which revealed some insights regarding relatings at Fort Cox. According to Matambo, the students' practical component at Fort Cox was lacking which suggests issues with 'relatings'.

Matambo thought that there were no relevant platforms and structures to help ensure that

lecturers can deliver practicals adequately at Fort Cox. By contrast, Landzela thought that the water management practical component and its delivery mode was sufficiently satisfactory at Fort Cox. However Landzela argued that there was still a lot of work to do regarding a sustainability focus. Matambo felt that there was significant support from Fort Cox staff regarding water management and curriculum practices to benefit students' practical objectives. On the other hand, he felt that the support staff's response to sustainable water management topics was very slow and small, although there were some positive responses from some support staff which needed an integrative approach to avoid tackling water management practices in isolation. Landzela argued that when challenges arise, lecturers and support staff meet each other halfway, because they prioritise the students over the farm; but the farm is the laboratory for students to learn. Landzela further argued that "we are a team here, we do not have situations whereby you will find someone doing his or her own thing at that corner and the other one doing his or hers at the other corner". Vele supported the interpretations by Landzela by suggesting that some of the support staff were doing their best to ensure that students leave Fort Cox with much needed and relevant knowledge on water management.

However, Madikiza proposed that "water management strategies were not aggressively implemented especially in terms of sensitising the Fort Cox community to save water". She further indicated that most of the practicals required close supervision and due to work overload on academics, close supervision does not happen and the Fort Cox does not have enough technicians to take up the load. It was revealed that students were interested in sustainable water management topics, although at times there was some resistance, because some of the water management practices are labour intensive and time consuming at the initial stages of establishment (Madikiza). Matambo echoed Madikiza's views on students' interest in sustainability topics and argued that "for students to show interest, a lecturer has to arouse that interest, because most of the students do not even know what sustainability mean[s], they do not have the awareness, so if you arouse the interest and present it in such a way that they can develop the interest, then that would be the starting point". Matambo further argued that helping students understand a particular concept would stimulate their interest to practise it on the ground.

In relation to partnerships and collaborations, Matambo revealed that working with the surrounding communities that were practising some of the rainwater harvesting techniques,

helped significantly with regard to students' practical experiences (see picture 4.3). Landzela gave an example of some of the students who participated in the workshops offered at Fort Cox with external strategic partners, and some students are sent out to learn and participate in other water management practices undertaken by Fort Cox partners. Landzela explained that Fort Cox has network collaboration with IBLN which has encouraged students to be part of it, and it is relevant to Fort Cox water management and curriculum practices.

#### *4.1.2.4 Summary of the 'sayings, doings and relatings' findings of four lecturers' interviews*

A key finding regarding 'sayings' was that one lecturer felt that the current stated curriculum covers a few significant topics on water management. However, the water management topics were mostly related to production and not enough to address all water management related matters in the agriculture context; global climatic conditions and the impact of climate change on water availability were not adequately addressed. Three of the four academic lecturers argued that water management topics in the stated curriculum did not cover sustainable water management adequately to address the current water challenges in the agriculture context.

A key finding regarding the doings was that teaching and learning at Fort Cox is strongly supplemented by course-centred practical components which students are required to perform physically guided by their respective lectures. The majority of academics tend to make use of available opportunities that will increase students' competencies on water management and curriculum practices through hands-on student practicals. Water management practices such as greywater harvesting, rainwater harvesting, trench beds, mulching and diversion furrows were examples. In addition, case studies, demonstration sites and field visits were also some of the doings said to supplement the practical component of Fort Cox.

However, some interpretations suggest that the students' practicals were not sufficiently executed and there was poor coordination between other water management practices and curriculum practices, an example of an insufficient "relating". Support staff solidarity was viewed as vital in all water management curriculum practices through the respective roles. Partnerships and collaborations were seen as an alternative opportunity for Fort Cox to demonstrate sustainable water management practices that are not possible at Fort Cox. An example is the existing partnership between Fort Cox and IBLN which is focused on sustainable water conservation practices. It was also noted that not all students related that

well to the practicals, maybe due to the labour intensive work associated with some of these practices.

Next, the findings based on the inputs of students are presented.

#### *4.1.3 The 'sayings, doings and relatings' from students' interviews (See analytic memo 3 Appendix C)*

Fort Cox educational clubs are student-run entities. They are meant for developing skills and knowledge among students through real world agriculture experiences. Three members of the Animal Production club and five members of the Crop Production club were interviewed to solicit the students' views on the 'sayings, doings and relatings' in relation to water management and curriculum practices at Fort Cox. The Animal Production club members were interviewed as a group and the same method was used for the Crop Production club members. Data from the two educational club groups was extracted from the audio transcripts and triangulated into respective analytical memoranda (see annexure D1 and D2).

##### *4.1.3.1 The sayings based on students' interviews*

Among the Animal Production club members, students confirmed lecturers' views that not all agriculture production courses offered at Fort Cox cater for water management topics, although some of the courses do consider water as a production factor. "The current curriculum doesn't go deep into water management topics, but students do learn that water is very important in animal production" (Thabete). Khanyisa referred to water as the most important production factor for animal husbandry, suggesting that water plays an important part in digestion and also in the animal's body temperature regulation, therefore without water there will be high mortality in animal production enterprises. Both groups of students made the connection with climate change affecting deteriorating water sources around the world, and livestock also being hugely affected.

Among the Crop Production club members, Mabelies revealed that Fort Cox students are exposed to the various irrigation systems in the Fort Cox, their advantages and disadvantages, the cost of running the system and water saving techniques such as rainwater harvesting, contour ploughing, mulching and trench beds among others. According to one student, Siphe, "Fort Cox stated curriculum needs to expand more on the water management topics in order to address the current water challenges". "Water management topics should have its own

module whereby all water management topics will be covered adequately,” according to Deliwe.

#### *4.1.3.2 The doings based on students’ interviews*

Tabisa explained that the Animal Production club members were involved in raising broilers and piglets under intensive agriculture production systems and in the process; they utilise water for hygiene and consumption purposes, and control of possible disease outbreaks by means of vaccinations made of water and chemical solutions. Animal Production club members also learned that water is very important in their respective enterprises because they had first-hand experience when there was at one point no water on campus, which forced them to collect water from the nearby Keiskamma River and ponds using containers sometimes helped by Fort Cox transport, to supplement the daily water management routine within their enterprises.

From a Crop Production perspective, Mabelies revealed that students were learning sustainable water management topics in the stated curriculum, but were not following the stated curriculum articulations in their own practices. Mabelies and Mdakane differed in their interpretations of the doings regarding practicals and theory at Fort Cox. Mabelies felt that students were more often exposed to practicals than being in the classroom. In contrast, Mdakane argued that students were spending more time in the classroom than doing practicals in the field.

#### *4.1.3.3 The relatings based on students’ interviews*

According to Tabisa, there is significant support for students’ educational clubs from both lecturers and field technicians whereby supervision is offered on handling farm system operations. Students get supervision on how to vaccinate livestock and organise scheduled animal feeding. Tabisa and Thabethe agreed that water quality and water availability are both problematic at Fort Cox and that this has the potential to compromise their production enterprises. Tabisa explained that “after finishing cleaning and using the water at the piggery, the water is channelled outside and fertilises the surrounding grass, but there is no place where this water can be stored for reuse for other agricultural necessities”.

From the Crop Production club perspective, Mdakane indicated that there is poor communication between water management and curriculum practices of Fort Cox, which

results in poor implementation of water management strategies. According to Siphe, poor communication and dissemination of information is the reason why students are not aware of the bulk water supply system that Fort Cox built during the year 2018. Mabelies argued that while students are aware of some of the sustainable water management strategies, they do not implement them in their own practices as per the stated curriculum practice guidelines which suggest a theory-practice gap to be discussed next in Chapter 5.

#### *4.1.3.4 Summary of the 'sayings, doings and relatings' findings identified in students' interviews*

Animal Production club members mentioned many times that the current curriculum does not cover many water management topics. However, students are made aware of the importance of water in the animal production context. In contrast, the Crop Production club members believe that water management topics are catered for in the Crop Production curriculum; however, there is a need to strengthen the current stated curriculum to address growing water management challenges to agriculture.

With regard to the doings, Animal Production club members during bad days when water is not available, have to improvise or face a high mortality rate. Among the Crop Production club members, there were differences of opinion or perhaps experience regarding the balance between practicals and theory components of the current stated curriculum of Fort Cox.

Regarding the relatings, Animal and Crop Production members were confident that support for practicals was satisfactory from their lecturers and field technicians. On the other hand, Crop Production club members identified poor communication and awareness as compromising water management practices of Fort Cox. According to Crop Production club members, Fort Cox water management and curriculum practices are not working together for one common goal of teaching and learning.

#### *4.1.4 The 'sayings, doings and relatings' from field technicians' USAT questionnaires (See Analytic memo 4 Appendix D)*

Three academic field technicians involved in assisting with student practicals for Animal Production, Crop Production and Forestry diploma options, participated in this study through completing a USAT questionnaire in their respective contexts (or unit). The three field technicians used the questionnaire to conduct an audit on water management practices in their

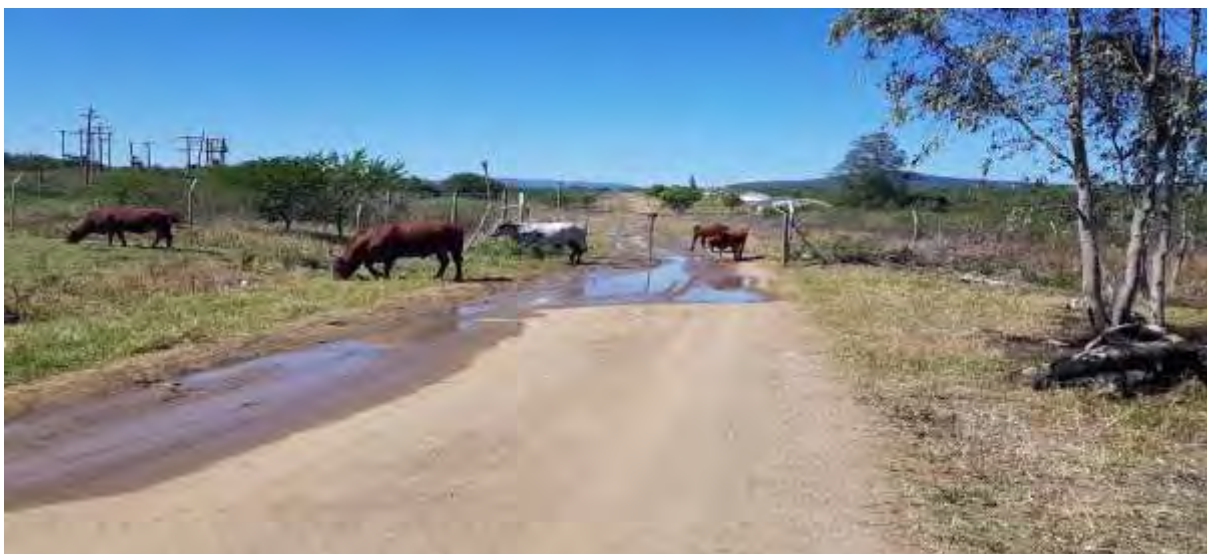
operational areas (see appendix D: *Analytic Memo of USAT audit by field technicians*). The USAT was completed anonymously, therefore I gave them the code names FTQ1, FTQ2 and FTQ3.

#### *4.1.4.1 The sayings from field technicians' USAT questionnaires*

FTQ1 defined water as a scarce resource which needs to be preserved. FTQ1 also indicated that to boost sustainable water management practices at Fort Cox, there may be a need to introduce more curriculum content or subjects on water conservation practices. FTQ3 suggested that “wastewater has a value and it should not be wasted”. FTQ3 also argued that “leaking pipes significantly increase the vulnerability of pipelines to contamination, especially where the supply is intermittent or pressure fluctuation can lead to infiltration of contaminated water into the distribution system”.

#### *4.1.4.2 The doings from field technicians' USAT questionnaires*

FTQ2 proposed that innovative teaching of Fort Cox students on the methods of harvesting and saving water at an early stage will help reduce the water wastage at Fort Cox. She also suggested that this approach would help the students to apply the water saving techniques at their homes and spread the knowledge gathered on sustainable water management. According to FTQ3, turning off the taps when brushing the teeth should be encouraged to save water in the students' residence. FTQ2 also argued that monitoring and maintenance of infrastructure should be given priority to save water loss from breakages and leaks (see Picture 4.5)



***Picture 4.5: Water gushing from infrastructure damage at Fort Cox campus***

#### *4.1.4.3 The relatings from field technicians' USAT questionnaires*

According to both FTQ2 and FTQ3, Fort Cox needs to develop a culture of awareness campaigns and information sharing through posters and flyers around the Institution; FTQ3 added that there was a need for a water harvesting policy. FTQ3 further suggested that water conservation awareness and education among employees and students will not only save water, but it can also save money on operational and production costs. That is, the technicians were clearly relating water conservation with economic aspects (savings).

#### *4.1.4.4 Summary of 'sayings, doings and relatings' based on field technicians' USAT questionnaires*

Field technicians acknowledged that water is very important for both the agriculture practices and the curriculum of Fort Cox. The field technicians felt that Fort Cox's stated curriculum needs to be strengthened to cover relevant and sustainable water management topics to help address challenges associated with water wastage.

Regarding the doings, Fort Cox field technician's evidence from the USAT survey shows that they do improvise innovative ways during teaching and learning to cater for the gaps left by the current stated curriculum regarding water management practices. Through this process, students will gain the necessary knowledge and skills to change their water related behaviour within Fort Cox and back at their home communities. The field technicians further added that water saving practices within the Fort Cox community will help reduce and prevent water wastage in both domestic use and agricultural practices around campus.

With regard to relatings, the field technicians believe that awareness campaigns and educational forums will help address water challenges of Fort Cox whereby sustainable water management practices can be discussed and shared amongst Fort Cox end users, and result in financial savings for the Institution.

#### *4.1.5 Field technicians' responses to the USAT (see Analytic memo 5 Appendix F)*

The summary of the USAT responses in Appendix F shows two important findings. Firstly, the technicians lacked adequate information to be able to rate Fort Cox's performance on most of the areas covered by the USAT. Secondly, where they did venture an opinion, they mostly rated the performance poor or adequate. Only in three instances did they rate the performance good; this was in the repairing of damaged and/or leaking infrastructure,

rainwater harvesting activities and water pollution reduction practices (although there were also mixed views as to whether these areas were actually well addressed). There were no areas in which they rated Fort Cox as “Excellent”.

#### *4.1.6 The ‘sayings, doings and relatings’ regarding water management and curriculum practices based on students’ USAT questionnaires (see Appendix E)*

Sixteen students anonymously completed questionnaires with regard to their water management practices within the campus including the student’s residence. The results are presented in this section (*see Appendix E: showing analytical memorandum of student’s USAT audit in the residence*). Similar to the field technicians, I decided to give all students who completed questionnaires codes for identification as follows: SQ1 to SQ16 (namely, student questionnaire 1 to 16), labelled in numeric order according to their date of submission. The 16 included the students who participated in the workshop and educational club interviews; some were also enrolled in Irrigation, Soil and Water Conservation and various agricultural production courses.

##### *4.1.6.1 The sayings based on students’ USAT questionnaires*

According to SQ1, Animal Production students should also be involved in water management curriculum practices because water is an essential resource for animals. SQ5 and SQ12 indicated that students who are exposed to water management topics are learning about how to conserve water and good water management strategies to use. The majority of students from the Forestry curriculum indicated that they were exposed to water management topics through an existing module Soil and Water Conservation (SQ2, SQ6, SQ13, SQ14 and SQ15).

##### *4.1.6.2 The doings based on students’ USAT questionnaires*

The domestic water uses on campus identified by the majority of students included washing of laundry and showering which contribute to high water wastage, reportedly because there were no water use restrictions around their premises. According to SQ10 and SQ11, students leave the water taps leaking and untended with little or no care of the wasted water. However SQ3 revealed that Crop Production club members are involved in water management practices which help them learn the value of water in their daily activities. SQ16 also revealed that during practicals, students were exposed to activities and tasks promoting

sustainable water management. These practicals include building of water storage ponds to support irrigation and advocating water saving strategies.

#### *4.1.6.3 Relatings practices based on students' USAT questionnaires*

According to SQ1 and SQ3, Fort Cox has no orientation programme around water management on campus. According to SQ7, there is no water signage (posters) to remind the water users about the 'dos and the don'ts'. Like the technicians did, SQ2 also indicated that awareness on sustainable water management for students is lacking at Fort Cox. SQ1 and SQ3 noted that students in their respective clubs have ideas on water management strategies, but find themselves discouraged from acting on their ideas by lack of support from the institution and delayed approvals.

#### *4.1.6.4 Summary of 'sayings, doings and relatings' based on students' questionnaires*

The majority of students from Crop Production and Forestry indicated that they were exposed to water management curriculum topics through their lecturers in different courses. By contrast, Animal Production students indicated that they were not exposed to water management topics, despite water being a production factor for animal husbandry.

There was consensus amongst students that water is wasted in the residence because there were no water restriction strategies or monitoring of water use. Students felt that they do learn sustainable water management practices during course related practicals, but interestingly enough, they do not practise these in their own living space on campus.

With regard to relatings, the majority of students point to the lack of interaction between students and Fort Cox management as the main cause of the current poor water management practices. Students regarded a lack of water management awareness, lack of orientation programmes on Fort Cox water management strategies, and ignorance, to be the main contributing factors resulting in water wastages across their residence.

#### *4.1.6.5 Summary of frequency ratings of the 16 students' USAT*

With regard to student academic societies or other student groups with an environmental education or sustainability emphasis, the majority of students who participated in this study believe that Student academic societies or other Student Group(s) with an environmental education or sustainability emphasis were performing well at Fort Cox. In relation to the

students' USAT survey on environmental knowledge support centre, the majority of students rated the practice poorly performed whilst only two other students believed the practice was adequately accomplished. Concerning the water management practices in the student residences or dormitories by students (e.g. recycling), six students of 16 believed there was poor performance on this practice while three students and a further two believe that the practice was adequately and substantially accomplished, respectively. In relation to the orientation programmes on sustainable water management for students, eight students believe the practice is poorly performed and only two students believe orientation programmes were adequately accomplished while six students feel there is a lack of evidence about the existence of orientation programmes at Fort Cox. Concerning the student environmental and sustainable water management awareness programmes at Fort Cox, the majority of students believe this practice shows poor performance. In relation to career counselling focused on work opportunities related to environmental education and sustainable water management topics, six students believe the practice shows poor performance at Fort Cox while only two students believe career counselling was adequately and/or substantially accomplished at Fort Cox. Three students believe that voluntary community service by students related to sustainability issues and concerns was adequately performed whilst the majority of students indicate that they do not have knowledge of the practice.

Regarding the involvement of student groups on the campus in sustainable water management initiatives, seven students indicated that the practice is poorly performed while only two students argued that sustainable water management was a substantial accomplishment. With regard to student representative council involvement in the environmental and sustainable water management initiatives, two students believed that the practice was substantial while six students argued that this practice is poorly performed. Concerning student collaboration with management in the area of environmental and sustainable water management, the majority of students believed that there was little evidence or poor performance on this practice. In relation to environmental and sustainable water management activities initiated by students themselves, five students argued that the practice is poorly performed at Fort Cox whilst the majority of the students had no knowledge about the practice. The majority of students believed that students' willingness to take responsibility in the environmental education and sustainability space at Fort Cox was poorly accomplished. Finally, 15 of the 16 students believed that more information was required regarding the above water management opportunities and practices.

#### *4.1.7 The 'sayings, doings and relatings' regarding water management and curriculum practices based on document (curriculum) analysis*

The Fort Cox prospectus covers both the academic rules and regulations, and the approved course layout or outline for each course offered by the respective diploma curriculum. Therefore, the 2019 prospectus of Fort Cox was used to assess the current outline of water dependent courses, representing the stated curriculum (or in Eisner's (1994) terms, the explicit curriculum). Extracts from the water dependent courses (*see Appendix F*) were identified and analysed to substantiate the sayings regarding water management practices surfaced in the interviews and other data sources, and gain further clarity on them. The sample of courses chosen for analysis was informed by the workshop, where academics indicated that there were several water dependent courses recommended for the purpose of this study, more than the researcher had initially identified.

The workshop participants recommended the following curriculum documents to be analysed for the purposes of this study:

- Introduction to Crop Production (CS111),
- Fruit Production 1 (CS213),
- Vegetable Production (CS221),
- Irrigation; Soil and Water Conservation (AE221) from Crop Production curriculum
- Rangeland and Pasture Management (PS322),
- Dairy Production (AS223),
- Pig Production (AS213) from Animal Production curriculum

In addition to the course layout of each subject assessed, the formative assessments and the 2019 examination papers were also analysed to identify the current 'doings' regarding water management practices of Fort Cox. Whereas the published course outline in the prospectus represents the 'sayings', what is included in the instructional offering of each subject through the assessments and examinations constitute the 'doings' because they present a good indication of what lecturers actually teach. Examination papers were secured from the participating lecturers. Water management related topics were identified through a simple thematic analysis (i.e. identification of the topic as a theme related to water conservation practices, climate and water relationship topics, irrigation and plant propagation topics associated with water, and animal hygiene topics associated with water).

**Table 4.1: Extent of water management topics in the selected courses from the current stated curriculum (Fort Cox Prospectus 2019)**

<b>Course names and codes</b>	<b>Water management topics /content identified</b>
<b>Crop Production water curriculum courses</b>	
Irrigation, Soil and Water Conservation (AE221)	Substantial water management topics covered in the course outline
Introduction to Crop Production (CS111)	Course outline silent on water management topics
Fruit Production 1 (CS213)	Course outline silent on water management topics
Vegetable Production (CS221)	Water management practices appear within chapters of the CS221
<b>Animal Production water curriculum outlines</b>	
Rangeland and Pasture Management (PS322)	Course outline silent on water management topics
Dairy Production (AS223)	Course outline silent on water management topics
Pig Production (AS213)	Course outline Silent on water management topics

*4.1.7.1 The sayings practices based on Fort Cox curriculum documents*

Five of the seven water dependent courses in Table 4.1 were found to be silent on water management topics: based on their respective course outlines, there was reference to water management topics in only three of the seven sampled courses. The absences apply especially to the Animal Production curriculum, and also to some extent to the Crop Production curriculum. This backs up those lecturers who indicated in interviews that the current curriculum does not adequately cover water management topics to address contemporary global and locally relevant water issues in agriculture. It should be stated, however, that lecturers argued that they are at liberty to stretch water management content during theoretical and practical practices; i.e. the doings of the taught curriculum may have more

water management related content than the stated curriculum. Both course outline and formative assessments were evaluated per course.

Irrigation, Soil and Water Conservation (AE221) emerged as the only course offered in Crop Production covering water management topics abundantly. The following topics are shown in the AE221 course outline representing the sayings: “Soil moisture relationship: soil water capacity; available moisture; evapotranspiration. Sources of water: rainfall; run-off; underground water. Irrigation scheduling: water consumption determination; allowable depletion; moisture deficit; irrigation schedule. Flood irrigation: wild flooding or basin irrigation; furrow irrigation; border strip irrigation. Sprinkler irrigation: uses and secondary irrigation; components of a sprinkler system; types of sprinkler systems; design and layout. Micro-sprayer irrigation and drip irrigation: advantages and disadvantages; micro-sprayer irrigation systems; the drip systems; management” (Fort Cox Prospectus: Crop production curriculum, 2019).

According to my analysis of the Fort Cox Prospectus (2019), two Crop Production curricula, namely: Introduction to Crop Production (CS111) and Fruit Production 1 (CS213), were silent on water management topics. However, the CS213 course outline does mention climatic condition factors associated with fruit production topics where water conservation practices are taught as underlying topics. The Vegetable Production (CS221) course outline also mentions water management for vegetables and environmental factor topics, which includes rainwater harvesting and water conservation practices (trench beds, mulching and infiltration pits).

The AS213 Pig Production course outline was silent on water management topics although, as students indicated, water is required for the animals’ nutrition and temperature control, the cleaning of pens, and very clean water is needed for vaccination (animal health and disease control). Although PS322 Rangeland and Pasture Management deals with cultivated pastures and rangeland management, in which water is an underlying production factor, water management topics were not in the course outline. AS223 Dairy Production was found to have water management topics (Fort Cox Prospectus: Animal Production curriculum, 2019).

#### *4.1.7.2 The doings based on Fort Cox students' assessments and examination papers*

According to extracts from Irrigation, Soil and Water conservation (AE221) instructional offerings, the doings required from lecturers and students include the following: “testing of irrigation uniformity of chosen surface and overhead irrigation, design irrigation system and produce a schedule under specific conditions, visits to farms that use mechanised irrigation systems, mulching, gully control, soil moisture measurements, construct water conservation structures” (Fort Cox Prospectus, 2019).

The examination papers were also scrutinised to further solicit the doings as to understand how the academic lecturers were complementing water management topics in their teaching and learning context. The majority of the examination papers of these water dependent courses were found to be silent on the questions related to water management topics. Only the following courses at least recognised water management topics.

In the AE211 November 2019 examination paper, the following questions represent the doings on how teaching and learning on water management topics were catered for during formative assessments (*see appendix G1 - 2019 AE211 examination paper*). In the AE211 paper Question 1(a) asks students the following: “*What do you understand by the following terms as they apply to irrigation? Namely: Effective rainfall (2 marks) (ii). Crop water requirement (2 marks)*”. Question 2 of the same paper asks: Question 2 (a) “*What instruments would you use to measure the following? Namely: (i) Evaporation (2 marks) and (ii) Irrigation depth (2 marks)*”. Question 2(c) “*Give two disadvantages of each of the following irrigation systems: (i). Centre pivot (2 Marks) and (ii). The big gun (2 marks)*” and Question 2 (d) asks the following “*Discuss any factors that influence the choice of an irrigation system (6 marks)*”. On the same paper, Question 4(d) asks students to “*Explain any five (5) water conservation practices (10 Marks)*”. The other exam papers of other subjects analysed did not assess students on the direct water management content.

#### *4.1.7.3 Summary of the 'sayings and doings' related to water management and curriculum practices in the Fort Cox stated curriculum and assessments*

The above interpretations confirm what most academics and students indicated during their interviews: there are inadequate water management related topics within the current curriculum. Irrigation, Soil and Water Conservation alone cannot cater for all the topics, but the broader range of water dependent courses could, if they included more water management

related topics. There were a few water management topics in some of the courses listed above. Regarding the doings, the stated curriculum confirms that Fort Cox curriculum is practical based and all courses were found encouraging students' practicals. Practical projects of students were observed during field observation and confirmed that water was an indeed underlying production factor for many courses. Apart from the Irrigation, Soil and Water Conservation (AE221) was found to be the only course assessing students on water related questions in the formative assessments. The other water dependent courses listed above in Table 4.1 were found to be silent on water management and the curriculum extracts from Fort Cox stated curriculum.

#### *4.1.8 The associated arrangements and conditions that enable or constrain the water management and curriculum practices of Fort Cox*

With cross referencing to Chapter 2 (section 2.12), Schatzki (2006) argued that in practices, sayings are enabled or constrained in what is known as the cultural-discursive dimension, while doings are enabled or constrained in the material-economic dimension and relatings are enabled or constrained in the socio-political dimension of activity systems like an agricultural college. These are bundled together in the projects (teleo-affective structures) of practices and the dispositions or (habitus) of practitioners. Teleo-affective structures refer to the purposes or emotions that cause people to act towards possible ends and goals. In the next section, the associate arrangements that enable or constrain water management and curriculum practices of Fort Cox are presented. The data for this section was drawn from semi-structured interviews, workshops and Unit-Based Sustainability Assessment Tool questionnaire.

##### *4.1.8.1 Cultural-discursive arrangements*

In relation to how support staff do not complement the academics in their practices, in the workshop Madikiza noted that “there might be a gap in terms of knowledge of support staff personnel, they don’t know that the grass they cut is supposed to be preserved. Even if we have to look around just an example of the admin offices every time there are visitors they want to take every leaf that has fallen on the ground and hey they want to clean the grounds and leave the soil exposed to wind erosion”. This suggests that the cultural-discursive arrangement for the support staff is to “keep things clean” rather than to “preserve plant material that can be reused”. Based on the inputs of students like Khanyisa, Fort Cox farm personnel do not have the same knowledge and understanding of sustainable water management and curriculum practices as academics and students.

Siphe argued for another cultural-discursive arrangement in the form of “clear signage around the Institute” which can help the Fort Cox community to conserve water and use it wisely. Students in their USAT questionnaires similarly called for signage, posters and other arrangements to raise awareness about water conservation, e.g. in the residence as they noted that they do not carry what they learn about water management in their practicals, over to their place of residence. A lecturer in an interview suggested that “the initiatives of sustainability topics should evolve from within the academic sections because academics there are the ones that drive the ideologies and the strategic direction of teaching and learning” (Matambo).

A student noted that “Animal club is a student-run entity meant for developing skills and knowledge for students and further capacitates student’s experiences which can be hands-on and help them understand the production systems better” (Thabethe). The existence of the clubs is clearly an arrangement that does or potentially can enable more learning about water management practices, given how practical they are. Farm staff use knowledge and practices that are contrary to that depicted in the current stated curriculum (Khanyisa).

According to the academic technicians, knowledge sharing helps disseminate important information amongst those who need it (FTQ1). FTQ3 suggested that Fort Cox must include the concerns regarding sustaining water in the induction of new employees and students to help improve current and future water management practices – for example, that wastewater has a value and can be reused under careful considerations.

While SQ16 suggested that not all students are willing to participate and or are interested in sustainable water management practices, SQ16 was satisfied that some students are showing greater interest and willingness to change their water handling behaviours. USAT questionnaires (SQ1 and SQ3) revealed that the students have plenty of *ideas* on water management strategies, but they do not put them in practice because of lack of motivation and financial support from Fort Cox Management. This is also a finding on material-economic arrangements, which is presented next.

#### *4.1.8.2 Material-economic arrangements*

In a lecturer's interview, Madikiza argued that resources including water are a major constraining factor to perform student's practicals. Siphe echoed this noting that students' practicals become compromised when water is inaccessible for irrigation of their crops. Water was acknowledged to be the most important production factor for many students' practicals performed at Fort Cox. Matambo also noted that Fort Cox is at a better geographical position than other parts of the province, because there is perennial Keiskamma River adjacent to the campus which means that if proper infrastructure is put in place and efficiently managed, water concerns can be addressed. Regarding water management and curriculum practices, Matambo noted that Fort Cox has few demonstration sites. Matambo also noted that there are financial constraints, time constraints, human resource constraints and environmental constraints regarding water management and curriculum practices of Fort Cox. For instance, if one wants to implement rainwater harvesting practices and there is no rain, it will then not be possible to implement the planned practice which may force academics to opt for more theory than hands-on practicals.

Fort Cox has different irrigation systems which include sprinklers, drip irrigation and centre pivots. Siphe noted that the centre pivot is however expensive to maintain and it does contribute to waste of water during windy days and sometimes broadcast water to areas where there are no crops. Mangoale assessed that Fort Cox water taps are leaking continuously thus wasting water; maintenance of infrastructure is therefore a material-economic arrangement of concern. Khanyisa assessed that wastewater from the piggery is an important resource that can be reused or recycled to benefit other enterprises to save costs and promote sustainability.

Other material-economic arrangements that could be considered for improving water management included quotas. This was introduced by FTQ1, who suggested that allocating Fort Cox residential areas with monthly or weekly quotas for use will help reduce water wastage by the residents. FTQ2 had a similar suggestion, arguing that water tariffs may help reduce water wastage and cost attached to it. FTQ3 also suggested the installation of water metres and regular water audits to manage water consumption amongst the Fort Cox residences. None of these material-economic arrangements for managing water usage currently exist at Fort Cox, suggesting that there was perhaps a time of abundant water supply, which is now over. That is, the conditions have changed, and it seems appropriate to

change practices accordingly. According to FTQ3 “groundwater resources could provide a valuable contribution to overcoming climate variability and meeting demands during extended dry periods”. According to this respondent, a technician, developing the water maintenance section, and budgeting for water infrastructure maintenance at the Institution, will go a long way in managing Fort Cox’s water resources (FTQ3).

From the students’ USAT questionnaires, it was clear that students have many ideas and recognise available material-economic resources which could be utilised through better arrangements, e.g. SQ8, SQ9 and SQ12 all indicated that Fort Cox has standing infrastructure such as rooftops, gutters and storm water drainage systems which can be used for rainwater harvesting if taken into consideration.

#### *4.1.8.3 Social-political arrangements*

In relation to social-political arrangements, Matambo suggested that Fort Cox students often do not pay attention to water management practices, maybe because they believe those practices have nothing to do with them or do not affect them but in reality, such practices have had everything to do with everyone around campus.

Matambo further advised that there are water management practices at Fort Cox where irrigation is not controlled resulting in over irrigation. This can be seen as a social-political matter because, according to Matambo, the reason for the over irrigation is possibly that the staff responsible do not pay much attention to their own practices – and, it can be added, there is little oversight of these practices. Mrubata revealed that there are so many water management practices around the campus without any consultation with the academics – thus, a social-political arrangement is in place in which entities have their own roles and there is no platform for consultations, or taking joint decisions. Mrubata indicated that “there is no link between the farm and the academic programme, which is supposed to be corrected, and support staff need to know what is expected from them in order for Fort Cox to have a productive farm that gives quality education to the students”. In speculating as to why there is poor implementation of sustainable water management on the ground, Mabelies supported Mrubata’s views by suggesting that there is a lack of communication amongst the various Fort Cox staff in their water management practices.

Matambo attributed students' interest in water management practices as being aroused by lecturers. If lecturers are committed and passionate, students are encouraged to engage in better water management practices. According to Madikiza, Fort Cox students are interested in sustainable water management topics although are sometimes resistant because of labour intensive practices and time spent establishing a new practice. Madikiza further considered that the support from staff for water management and curriculum practices is encouraging, but that Fort Cox needs to develop an integrative approach to water management practices and curriculum practices. Vele, on the other hand, noted that not all support staff are interested in water management and curriculum ideas. From the Animal Production Club point of view, Fort Cox academics and field technicians were regarded as very helpful in guiding the students in their respective enterprises (Tabisa).

At the workshop, Mangoale and Gwebushe pointed out the need for workshop sessions similar to the event that kick-started the research, which can be used for awareness campaigns on sustainable water management practices around campus. These suggestions were echoed by FQ2 and FQ3 in the USAT questionnaire. SQ1 also suggested community voluntary services regarding water conservation practices. According to SQ7, student clubs have the responsibility for awareness campaigns on matters concerning curriculum practices, but not all students honour the call when invited for dialogue.

#### **4.2 Bringing Fort Cox community in an action learning process aiming at advancing a sustainable focus on water management and curriculum practices**

As defined in Chapter 2, section 2.7:

Action learning is an educational approach used to solve real problems that involves taking action and reflecting upon the results, which helps improve the problem-solving process, as well as the solutions developed by the collective. (Leonard & Marquardt, 2010)

Although this kind of process did not happen as initially planned as part of this study, action learning was proposed by this study as one of the supporting theories involving the Fort Cox community in sharing and learning sustainable water management practices relevant to their own context. Research that involves a collective action learning process did not effectively happen because of time constraints in 2019 and Covid-19 related disruptions in the 2020 academic year. However, the study did probe participants' views regarding action learning.

The following were participants' views about action learning and examples of action learning which has taken place at Fort Cox.

Vele (a lecturer) understood action learning as “a process that involves a small group working on real problems, taking action, and learning as individuals, as a team and as an organisation”. To complement theory via practice, Vele argued that one has to make sure that the students are invested with the knowledge from theory in class and they are able to practice it in the form of action learning within their working groups. Landzela's understanding of action learning as a teaching approach was that “the students do much of the work and they gather as much information as possible as it gives students opportunities to experience a lot of practices”. Landzela acknowledged that action learning also requires guidance from lecturers while students do much of the work by themselves. Madikiza felt it would be helpful for the Fort Cox community to take advantage of action learning but currently there was still more to do in relation to discovering the action learning approach and how it benefits teaching and learning. According to Matambo, action learning is the best teaching approach in a set-up like Fort Cox where the focus is on vocational training. Matambo noted that, at Fort Cox, lecturers are expected to be less theoretical and more practical in their teaching approach. Matambo enthused that “action learning has a huge impact if all that is taught in the curriculum context becomes practicable, then it means students will leave this institution with more than just theory but with knowledge of practice, therefore action learning is the way to go”.

During the workshop, action learning was discussed as the best teaching and learning approach to discover a deeper understanding of sustainable water management topics offered by the taught curriculum through practice. In the workshop Matambo explained that “Fort Cox experiential projects involve students coming up with their own ideas with lecturers guiding them on what to do and how to do it. Yes, experiential projects are a very effective way of learning. It is just like that, you cannot implement it alone but coming together to teach is very effective”. The above views were supported by Gwebushe, who suggested that “it will be good that in the next workshop session you invite more students, support staff and other members of the management, I'm learning a lot here and I wish that others could also come and learn, these sessions might assist the management on reducing cost of water and sustainable use of water”. Gwebushe's input was supported by Mangoale who submitted that “I think all of us at Fort Cox need this kind of education because we are really missing a lot

of important things, from the principal to students, we all need this information and education. I wish we could call everyone in the hall and you teach us those things, we need them so we can save this bill of water. We should encourage seminars in the curriculum and there should be continuity of these types of workshops”.

In another example of action learning at Fort Cox, Thabethe said, “Animal club is a student-run entity and is meant for developing skills and knowledge for participatory [participating] students and building their experience so that they can be hands-on and understand the production systems better on their own”. In addition, Tabisa explained that “Animal club is meant to educate students and gain more experience through self-management of enterprises using knowledge they get from Fort Cox stated curriculum such as raising of chicks and piglets under intensive production systems”. In relation to how students feel about action learning as a teaching and learning approach, Khanyisa said that action learning is the most important for students; lecturers are trying to give students different strategies and let the students watch videos to see how certain practices are done before they go to experiment with them on the ground. According to Mabelies, “when you do something practically you will remember it forever and it will be a skill you have forever”.

#### **4.3 Implications to inform the next review of the stated curriculum at the institution**

The findings from the workshop conducted at the beginning of this study, from lecturers’ individual interviews and from the interviews with student club members, have revealed that water management subjects of Fort Cox should take into account strengthening sustainability topics in the future reviews. Landzela proposed introducing a water management chapter during internal curriculum review within the respective water dependent subjects (see section 4.2.2.1). This chapter could cover much needed sustainable water management topics that would help address current challenges. Students who were educational club members indicated that there was a need to strengthen current water management topics in the Crop Production curriculum, to address real issues like the drought experienced in the region between 2015 and 2020 and especially in the Eastern Cape Province where Fort Cox is situated. Animal club members felt it was necessary to incorporate relevant sustainable water management topics in the Animal Production curriculum as well, since livestock farming depends highly on water availability to succeed and sustainable water management topics are essential in the Animal Production curriculum.

Data presented in this chapter also confirmed a practice disconnect between water management and curriculum practices of Fort Cox. The disconnect lies mainly between teaching and learning and other practices across the campus. The workshop revealed a lack of awareness about and poor links with the water management practices compromising what the stated curriculum advocates for teaching and learning sustainability topics. The other supporting practices were mentioned as not having adequate knowledge of curriculum competences and requirements on the sustainable water management topics.

#### **4.4 Conclusion**

This chapter has presented data collected from the workshop, six interviews, document analysis through stated curriculum accounts and assessments, observation through photo narratives of water management and curriculum practices and USAT questionnaires completed by sixteen students and three academic technicians. The interviews were conducted amongst four lecturers and the members of two educational clubs. This chapter described the findings according to the Practice Architecture theory framework, as the ‘sayings, doings and relatings’ regarding water management practices and related curriculum practices. In addition, the associated arrangements that enable or constrain the noted ‘sayings, doings and relatings’, were presented as cultural-discursive arrangements, material-economic arrangements and socio-political arrangements. The next chapter discusses the findings in the form of analytical statements developed to answer the research goals and questions of this study.

## CHAPTER 5: DISCUSSION OF FINDINGS

### 5.0 Introduction

In this chapter I interpret and discuss the findings presented in Chapter 4 as guided by the research main question, sub-questions and research goals of the study. I discuss the key inferences of this study in the form of analytic statements which are in turn based on the analytic memoranda appended to the thesis. Chitsinga (2016), quoting Bassy (1999), explained that analytical statements are meaningful statements that are developed to give clear answers in the research question. The analytical statements are discussed based on some of the literature shared in Chapter 2.

### 5.1. Summary of analytical statements

The analytical statements are first simply listed below as responses to the research goals. They are discussed in the next section.

**Research goal 1:** To understand more fully, what the ‘sayings, doings and relatings’ are concerning the water management and curriculum practices of Fort Cox.

- **Analytical statement 1:** Sustainable water management topics are fundamental for both Crop Production and Animal Production and therefore, associated topics should be included in the design of these courses during associated curriculum review.
- **Analytical statement 2:** Fort Cox stated curriculum is both an enabling and constraining factor on water management and curriculum practices, as it does encourage practical learning, but not enough content dealing with current water-related issues like climate change and water scarcity.
- **Analytical statement 3:** There are contradictions or practice disconnects between water management and curriculum practices at Fort Cox which compromise or fail to support the teaching and learning objectives.
- **Analytical statement 4:** There are inadequate resources and practical support for the students’ action learning experiences at Fort Cox.

**Research goal 2:** To bring members of the Fort Cox community and stakeholder partnership together in an action learning process aimed at advancing a common understanding of current water management and curriculum practices as a form of Education for Sustainable Development.

- **Analytical statement 5:** Academics, students and support staff support a proposal of capacity building for all staff including those responsible for water management
- **Analytical statement 6:** Academics, students and support staff experience a need for better communication and collaboration between the different water management role players.

**Research goal 3:** Out of this process, the research findings seeks to stimulate improved sustainability focus of water management practices for both agriculture curriculum and community awareness.

- **Analytical statement 7:** Academics, students and support staff support proposals for awareness campaigns

#### *5.1.1 Analytical statement 1*

***Sustainable water management topics are fundamental for both Crop Production and Animal Production and therefore, associated topics should be included in the design of these courses during associated curriculum review.***

According to Tilman et al. (2002), as discussed in Chapter 2, sustainable water management in an agriculture institution was supported because much can be achieved by adopting the key improvements within the curriculum through increasing the knowledge capacity on sustainability related topics. Findings from Van Staden's (2020) study indicated that the agriculture curriculum over the years has been re-developed to withstand the rapid changing demands and changing environmental trends. In additional evidence, Pretty et al. (2011) showed that sustainable water management and curriculum practices in eco-schools, universities and agricultural colleges can enable students to understand the sustainable socio-economic and ecological imperatives associated with ESD goals. Further evidence discussed by OECD (2008) shows that sustainable water management for agriculture covers a wide range of agricultural systems such as climate adaptability and water conservation practices.

Taylor (2014) has illustrated that learning how to manage water resources optimally and sustainably would meet the goals of Education for Sustainable Development which involves the knowledge, skills, attitudes and values necessary to shape a sustainable future. The above findings were evident from the four academic lecturer's interviews, educational clubs and curriculum document analysis which were fundamental to ascertain the extent to which sustainable water management topics in the taught curriculum of Fort Cox were covered to

promote ESD. This evidence was in line with the ‘sayings’ of the water management and curriculum practices of Fort Cox.

There is evidence from section 4.1.2 from four interviewed lecturers who did not only share their common understandings on the context of water management topics but the lecturers also differed in various aspects of water management and curriculum practices of Fort Cox. It is evident from the majority of lecturers who participated in this study that sustainable water management topics in the stated curriculum of both agriculture curriculum of Fort Cox were there but not sufficiently to answer all the current water management challenges of Fort Cox and the region associated with the continuous climate change challenges. It is evident from Matambo’s interview that the ‘sayings’ on water management practices are present in the current curriculum but they were not explored in depth. However, Matambo also shared that sustainable water management topics need to be strengthened to answer global agricultural encounters exacerbated by climate change. His evidence was backed by both Madikiza and Landzela who agreed that water management topics were not sufficient. It was also evident from Landzela's interview that lecturers could add water management chapters or include relevant topics within existing content.

To support the findings above, students’ understanding of sustainable water management topics were also tested during educational club interviews. There was strong evidence from Animal Production club interviews that sustainable water management topics in the Crop Production curriculum were present in some courses but these topics were inadequate to address all the water management encounters in the agricultural setting of Fort Cox. For example, climate adaptability topics were not explored in depth to prepare the college and students’ teaching and learning environment.

Within the Animal curriculum, it is evident that water management content did not appear in all the subjects even though some of these subjects were water dependent. Examples were courses such as Pig Production, Dairy Production and Pasture Management courses which are all water dependent for their daily management. This evidence was supported by the Animal Production club during the interviews which revealed that water management topics were neither there nor described in the Animal Production curriculum even though water was evidently a significant factor in Animal Production management in topics such as hygiene, health and feeding performed in animal handling husbandry. The findings from Animal Club

students were backed by Loucks (2000) who argued that the concept of sustainable water management emphasises the need to consider the long-term future as well as the present water resource systems that are managed to satisfy the demands placed on them now and into the future, without system degradation.

There is evidence that some of the agriculture curriculum courses do feature water and sustainability related topics, as shown in the prospectus of Fort Cox. However, as shown in Chapter 4 section 4.1.6, it is evident that the majority of the courses from both Agriculture curricula did not have sustainable water management topics in the stated curricula. In the Crop Production curriculum (Annexure F), there is evidence from Irrigation, Soil and Water conservation curriculum content that water management topics were catered for in the Fort Cox course outline. However, there is further evidence that other water dependent subjects in the same Crop Production curriculum, for example in Vegetable Production, show little water management content in the course outline (see Annexure F). Other Crop Production courses were also scrutinised for water management content. Evidence from the Fort Cox Prospectus concluded that other water dependent courses did not show any water content in their course outlines.

This study also scrutinised the examination papers of water dependent subjects. It is evident from the majority of examination papers that water management content was not assessed. However, the Irrigation, Soil and Water Conservation course did assess students on water management content which contributed 28% of the 2019 final examination paper as shown in Annexure G. Although the Vegetable Production course mentioned water management topics in the course outline, it was noted that the 2019 examination paper did not assess students on water management topics (see Annexure H)

### *5.1.2 Analytical statement 2*

***Fort Cox stated curriculum is both an enabling and constraining factor on water management and curriculum practices, as it does encourage practical learning, but there is not enough content dealing with current water-related issues like climate change and water scarcity.***

As defined by Marsh and Willis (2003), curriculum is a planned sequence of instruction, or a view of the student's experiences in terms of the educator's or institutional instructional offerings. In an academic context, this sequence of instruction is defined in the institutional

prospectus embedded in the course outline of each subject. Kopnina (2012) showed that the pedagogical approaches that educators can follow to achieve their teaching and learning objectives include critical reflection on practice, systemic thinking and an analytical approach, and developing participatory and collaborative learning approaches to answer real world challenges. To remind the reader, Fort Cox has three sections: an academic division, a farm and a Rural Development Centre (RDC). Fort Cox does not only offer a diploma curriculum but also certificates at NQF level 1 to level 4 through the RDC section supported by the farm as a practical laboratory.

As presented in Chapter 4 section 4.1.1.1, Madikiza described the stated curriculum as a Bible which is a guiding document on what one has to do in the teaching and learning environment. It is therefore evident from Madikiza's evidence that the stated curriculum of Fort Cox can be a constraining factor regarding water management topics within the taught subjects. This evidence is limiting efforts which may help strengthen the sustainable water management topics outside the curriculum review processes. It therefore means teaching and learning at Fort Cox has to be directed by the current stated curriculum as outlined by the institutional prospectus. In my view, a Bible is a document which does not change in a short period of time and therefore associating Fort Cox stated curriculum with the Bible will mean lecturers and students have to adhere to prescripts of the course outline unless internal curriculum review and external curriculum review advise otherwise. Similar sentiments were expressed by Matambo in the same deliberations above. There is evidence from Matambo in the workshop expressing that the sayings of the curriculum are prescribed by the course outline and they are backed by the library materials, for example textbooks, lecturers' notes and study guides and online sources (MEAs). Madikiza and Matambo's evidence present the constraining factors within the stated curriculum which have the potential to limit the lecturers and students to explore recent content regarding water management topics.

Matambo and Landzela also saw a potential opportunity within the current structure of the curriculum which can be an enabling factor to strengthen the water management and curriculum practices. There is evidence from Matambo and Landzela, also discussed in section 5.1.1, which suggests that introducing a water management topic within a chapter or a complete chapter in water dependent subjects will not harm curriculum instructional offerings. This evidence presents an enabling factor which may allow topics such as climate

smart agriculture and water conservation practices to be squeezed into the instructional offerings.

The Fort Cox curriculum has the potential to enable the lecturers' and students' doings according to the weight structure of the theory content versus practical. There is evidence in section 2.4 that the Fort Cox curriculum is weighted with 40% theory and 60% practicals (Fort Cox Prospectus, 2019). The majority of lecturers and students believe that practicals are the relevant platforms to accommodate water management topics which are left out by the stated curriculum if the 60% practical mandate is implemented correctly. In this regard, the curriculum of Fort Cox structure becomes an enabling factor to strengthen sustainable topics through practical exposure to students without affecting current instructional offerings. There is evidence that students do learn sustainable water management practices during practicals, but they do not practise these in their own living space on campus which becomes a constraining factor for a sustainability focus in the water management.

The Rural Development Centre (RDC) at Fort Cox is an enabling factor for water management and curriculum practices of Fort Cox. The RDC can be used to uplift the skills and knowledge capacity of support staff where necessary. This evidence was suggesting that the RDC has the potential to upskill support staff who need the knowledge in relation to a particular practice they are working with at Fort Cox which will therefore benefit the teaching and learning and the institution.

### *5.1.3 Analytical statement 3*

***There are contradictions or disconnects between water management and curriculum practices at Fort Cox which compromise or fail to support the teaching and learning objectives.***

The theory of Practice Architectures explains that practices come into being because people do not act alone but collectively, and bring them into being (Kemmis *et al.*, 2013). Drawing from literature narratives, evidence from Kemmis (2008) argued that practice concerns do not arise because of individual actions, but as a collective in the system that is currently in place and, to address the concerns, one needs actions and changes from collectives, not only individuals. Further evidence from OECD (2008) suggests that the scope of sustainable water management in agriculture is concerned with the responsibility of water managers and users to ensure that water resources are allocated efficiently and equitably and used to achieve

socially, environmentally and economically beneficial outcomes. In this research, several participants expressed strong views on the disconnection between the farm and curriculum practices to support teaching and learning through practice.

There is evidence that there is contradiction or disconnect between water management and curriculum practices at Fort Cox which compromise the teaching and learning objectives. Several participants noted that there was a practice disconnect between Fort Cox water management and curriculum practices which was in accordance with the relatings of this research. This was also evident from the deliberations of the workshop, where it was expressed that academics and the farm were not working together as one team for a common purpose. Several participants in the workshop noted that there was poor coordination in the Fort Cox community between water management and curriculum practices. As presented in section 4.1.1, there was very strong evidence from Mrubata that there was no link between the farm and academic programme of Fort Cox which compromises the objective of teaching and learning and quality of education Fort Cox offers to its students.

Further evidence from the workshop showed there was disconnection between water management and curriculum practices of Fort Cox as was evident in the pasture fields at the farm which does not complement the needs of the taught curriculum. One lecturer indicated frustration with support staff's lack of knowledge on water conservation techniques which leads to incorrect disposal of waste material, techniques which could be useful for water management practices such as mulching and trench beds. Also Khanyisa argued, Fort Cox farm personnel do not have the same modern knowledge and understanding of sustainable water management and curriculum practices as academics and students (CDAs). It was also evident from Mrubata in the workshop that there are so many water management practices happening around the campus without consultation with the academics – in a social-political arrangement in which entities have their own roles and there is not a platform for consultations, nor for taking joint decisions (SPAs). This was backed by evidence from FTQ3 in section 4,1,7,1 where it was proposed that Fort Cox must embark on the induction or orientation of new employees and students to help improve current water management practices. This evidence shows the practice mismatch of the Practice Architecture 'sayings and doings' of water management and curriculum practices of Fort Cox. The evidence also portrays a gap in the 'relatings' between water management and curriculum practices. In hindsight, this evidence shows that the supporting practices of Fort Cox were not

complementing the stated curriculum needs specifically towards efficient and relevant agricultural knowledge.

#### *5.1.4 Analytical statement 4*

***There are inadequate practical resources to supplement the students' action learning experiences at Fort Cox.***

There is evidence from section 4.2 that action learning can be the most suitable teaching and learning approach to discover the potential of students in teaching environments similar to Fort Cox. This was backed by Leonard and Marquardt (2010) where it was evident that action learning was a process that involved at least small groups of people interested in a common focus to solve complex problems while also developing themselves and the organisation.

Three of four lecturers believed that action learning can help to discover the potential of students because it requires the students to be hands-on and drive their own practices with the guidance from their respective lecturers. Further evidence from one lecturer also showed that there is still much to do in relation to the discovering action learning benefits at Fort Cox. From the Practice Architecture material-economic arrangements (MEAs) point of view, evidence from the majority of lecturers illustrated that resources were a major constraining factor to perform student's practicals at Fort Cox.

These views from lecturers were also supported by evidence from students in the Crop Production Club interviews who felt discouraged by the lack of relevant resources which compromises student practicals and action learning since most of the curriculum practices they perform are water dependent. Further evidence from the student USAT questionnaires regarding the MEAs shows that there is a process of securing much needed resources for practicals but delays due to long approval processes jeopardise the support of student initiatives on water management practices. In addition to MEAs, human capacity and time allocated for practicals were expressed by both lecturers and students as a possible cause behind poor water management and curriculum practices at Fort Cox. This evidence doesn't suggest that there is no process of facilitating goods but it is evident from students that it takes a long time to get approvals and this can lead to delays or total collapse of the planned projects. Therefore the majority of participants from both students and lecturers were dependent on poor financial support mentioned many times in Chapter 4 as an underlying problem that compromises student water management and curriculum practices.

### 5.1.5 Analytical statement 5

#### ***Academics, students and support staff lack capacity building for all staff including those responsible for water management.***

According to Lotz-Sisitka, Pesanayi, Weaver, Lupele, Sisitka, Denison and van Staden (2016), it is important that newly appointed staff in agricultural colleges do not necessarily have an academic background in agriculture nor practical experience only, 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. Polk (2011) also noted that many organisations are facing extreme challenges regarding their ability to plan for sustainability of their own practices. Capacity building in educational institutions is the process by which individuals or groups of people in the organisation are supported to obtain and improve the skills, knowledge, tools, equipment, and other resources needed to do their jobs competently. Capacity building therefore allows employees in the institution and organisations to perform at a greater capacity. Kemmis (2000) stated that people understand their modes of activity, skills and capabilities and develop an understanding of their roles and patterns of relating to others.

The practice disconnect that was discussed in section 5.1.3 was shown to be affected by lack of knowledge by personnel working with water management. It is evident when Matambo stated that learning sustainable water practices will happen efficiently when the support staff of Fort Cox are equipped with more knowledge defined by the stated curriculum requirements. Madikiza supported this, stating that most of the students' practicals require close supervision and a particular skill, therefore contributing to work overload of technicians and lecturers; students will have to be at the farm on their own or with field workers. It is therefore evident that field workers will need effective skills. Exploring opportunities to study new teaching and learning patterns and practices from other institutions, attending professional conferences and work-based experience learning will help initiate ESD in the Fort Cox teaching and learning goals as mandated by the stated curriculum. There is also evidence that the Rural Development Centre (RDC) at Fort Cox offers short skills programmes or courses. Employees with skills gaps related to their work practices can use the opportunities afforded by the RDC to upskill themselves through the institutional arrangements and skills development policy funding. I am a good example of someone who was exposed to Rhodes University through a partnership between Fort Cox with ELRC and

IBLN; through this I was given the opportunity to study for a Master's of Education which will benefit the institution immensely in water management and curriculum practices.

#### *5.1.6 Analytical statement 6*

##### ***Academics, students and support staff support the need for better communication and collaboration between the different water management role players.***

Pesanayi and Weaver (2016) stated that learning together in mediated voluntary networks can mobilise skills and innovations that help to facilitate learning and uptake of rainwater harvesting and conservation practices. This boosts extension capacity while at the same time growing farmer capabilities, tapping on distributed cognition. There was evidence in the workshop and student and lecturer interviews that there are poor working relations between water management and curriculum practices of Fort Cox. Evidence presented from section 4.1.1.3 under the relatings showed that the majority of participants during the workshop share the common understanding that Fort Cox lacks pivotal working collaboration specifically on water management and curriculum practices focused on in this study. Evidence from two technicians present in the workshop have stated the need for holding many workshops and seminars like the one used for this study for sharing ideas and dissemination of relevant information amongst the Fort Cox community.

There is evidence of partnerships and collaborations from Matambo who noted that the surrounding communities were practising some rainwater harvesting practices which helped with students' practical experiences. It is evident from the Matambo interview that there were alternatives that can boost students' knowledge and skills of Fort Cox through existing partnerships. Fort Cox is in a partnership with Rhodes University, ELRC and IBLN collaboration driven by Amanzi for Food. The partnership is particularly relevant for this study since it focuses on water sustainability practices in agriculture. Matambo evidence shows that working with stakeholder partnerships addresses certain limitations Fort Cox has with certain practices that cannot be achieved within the institution in terms of ability and resources (such as MEAs).

Further evidence from several participants in the workshop illustrated that working together between support staff, students, management and lecturers will play a vital role towards supporting Education for Sustainable Development especially in terms of water management and curriculum practices at Fort Cox. It was evident that working together between different

practices will help improve water management practices of Fort Cox through better understanding of a common goal. Evidence from Mrubata illustrated that working together and investing in working relationships amongst the Fort Cox community would benefit both water management and curriculum practices of the institution. In addition, several participants noted that educational workshops involving everyone on the campus would help in the process to improve the current water management and curriculum practices at Fort Cox.

#### *5.1.7 Analytical statement 7:*

##### ***Academics, students and support staff support the need for awareness campaigns.***

In this study, awareness campaigns were often mentioned by both students, lecturers and support staff. In my view an awareness campaign is a sustained effort to educate people as an individual or group about emerging issues within an organisation. Awareness campaigns can be used for information sharing and they can help strengthen relations and improve the sustainability focus in the water management and curriculum practices. There are many ways in which awareness can be achieved, such as through seminars, workshops, posters, and group or individual consultations.

There was evidence from the workshop and interviews with lecturers and students of a general lack of awareness amongst the majority of Fort Cox community members regarding sustainable water management and curriculum practices. It is evident from the workshop that there is a gap between water management curriculum practices exacerbated by lack of knowledge by supporting practices at Fort Cox. Madikiza in the workshop gave an example of support staff who were not aware of the curriculum; they burned the grass and leaves collected during campus cleaning as an example of the lack of achieving common objectives of teaching and learning. This evidence shows the need for awareness of support staff to understand the purpose of the curriculum doings in relation to sustainable water management and other practices.

Sixoto in the workshop suggested that seminars on relevant matters pertaining to water management and curriculum practices could be an available platform for information sharing to the college community on matters affecting their own practices. The seminars could also be backed by the Rural Development Centre (RDC) section of Fort Cox, to disseminate relevant information to the Fort Cox community through public lectures or presentations from

staff or guest presenters that target matters which affect college practices. Academic conferences can be also helpful to expand staff's knowledge of affected practices through professional engagements. Further evidence from Chapter 4 also shows that support staff who are working with water management practices may benefit from short courses offered by the RDC section which may be helpful to bridge the knowledge gap between curriculum and supporting practices. It is evident from several participants that awareness can help strengthen the 'doings' and improve the sustainable focus of water management at Fort Cox. This was raised to help strengthen the sustainability focus in the water management and curriculum practices of Fort Cox across all the related contexts.

## **5.2 Conclusion**

This chapter has discussed the key findings as presented in Chapter 4 of this study. The discussion of the findings followed the research questions and research goals of the study. The findings were backed by literature narratives presented in Chapter 2 of this study. The study discovered that sustainable water management topics in the stated curriculum of Fort Cox were fundamental in the teaching and learning of both Agriculture curricula. The study also shows that the stated curriculum of Fort Cox can be an enabling and constraining factor on water management practices on campus. Also emerging in this chapter was evidence of inadequate resources for sustainability purposes, and disconnect between water management and curriculum practices of Fort Cox. The study further shows the need for staff development to align skills and knowledge with the needs of the curriculum which can be supported by improved community awareness and collaborations with relevant stakeholders. Some of these findings will be further discussed in the next chapter on recommendations and possible future research recommendations.

## CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

### 6.0 Introduction

The previous chapter discusses the findings of this study in-depth and subsequently this chapter provides a narrative summary of the entire study and summarises the key findings. In conclusion, recommendations based on the key findings are presented in this chapter. The recommendations will be in line with whether the action learning process can address the water management and curriculum practices of Fort Cox.

### 6.1 Summary of the findings

To understand the current water management and curriculum practices at Fort Cox, and the underlying enabling and constraining arrangements, towards making recommendations with regard to more sustainable water management and related curriculum practices at Fort Cox, including action learning, it is useful to look at the following findings.

#### *6.2.1 The academic and staff's (lectures and technicians) 'sayings, doings and relatings' and associated arrangements*

The academic staff noted that water management at Fort Cox was not adequately supporting the curriculum. As to whether the given curriculum allowed for teaching and learning related to sustainable water management, there were mixed views among the staff, depending on which subject they were describing. On the whole, they felt that there were some opportunities for teaching about sustainable water management, but not enough. The same applies to action learning in the curriculum, in the form of practical projects: there was room for practical learning in the curriculum, as evidenced in some of the photographs shared, as well as support from technical staff. There is, however, a lack of resources such as equipment required for practicals due to financial constraints which contribute to non-implementation of desired action learning projects in the curriculum, and sometimes limited enthusiasm when projects are labour intensive.

The Fort Cox curriculum caters for sustainable water management topics to a greater or lesser extent. Although these water management subjects did not cater to water management topics in their respective course outlines, several academic staff members acknowledged that sustainable water management topics are infused in relevant chapters and during field practicals.

Several staff members noted that they related to the curriculum as a 'Bible' or a very prescriptive document that guided what they taught completely and how they taught this, which can be a constraining factor. Others seem to be more flexible in that context of following the prescribed course outline which can be limiting in terms of new knowledge which is an enabling factor. The academic staff on the whole related well to the topic of sustainable water management and it was clear that they would value it being improved at Fort Cox. They indicated that relationships between academic staff and farm and campus management needed to improve, because there were often environment and water related actions that could have been used for curriculum purposes, had academic staff been included in the decision making. Material-economic arrangements such as lack of financial support for student's self-run projects was a major constraint for action learning objectives among students and lecturers.

#### *6.2.2 The students' 'sayings, doings and relatings' and associated arrangements*

The students expressed that sustainable water management was important, that they would like to see more of it being taught in the classroom and more related practical work as well. Several students were keen to get involved in practical environmental activities. The students expressed a high level of valuing of water, environmental sustainability and sustainable water management, which bodes well for curriculum changes in this regard. They also valued practical work, as they saw this enabling them to be effective at work once they completed their studies. The students thus related their studies and practicals, to the practical situation in the Eastern Cape and other parts of the country and region where they anticipated using their knowledge. For the students, relevance was therefore of great importance.

#### *6.2.3 The curriculum 'sayings, doings and relatings' with regard to sustainable water management and related topics, and action learning*

Three of ten water dependent courses presented in Table 4.1 showed at least water management topics in their course outlines. The majority of these subjects were silent regarding sustainable water management topics, however there was room to cater for these topics within the chapters and during field practicals.

#### *6.2.4 Institutional, arrangements that enable and constrain sustainable water management at Fort Cox*

It would seem that sustainable water management at Fort Cox was constrained by poor interaction between curriculum and other water management practices, lack of financial support from the management and long delays in budget approvals. Students do not only learn in classes with their lecturers; the surrounding environment is a good space for students to reference and implement some of the curriculum deliberations.

It would seem that some academic staff are constrained by following the curriculum very closely and then do not find adequate opportunities and direction for teaching about sustainable water management, in the curriculum nor in the textbooks in use; academic staff are further constrained by a lack of relevant knowledge; and by being left out of practical water and wider environmental management activities on campus, which they could have used for teaching or demonstration purposes. Some academics do however manage to teach about sustainable water management, and the enabling factors for them include being part of partnership initiatives such as the Amanzi for Food project led by Rhodes University. The latter gave them access to knowledge and practical resources such as demonstration sites and lead farmers in the surrounding communities of Amathole district under the Invoto Bubomi Learning Network (IBLN). Such projects should clearly be continued and expanded, alongside curriculum changes in the next reviews.

There is considerable interest in action learning among staff and students at Fort Cox. However, their participation in the intended action learning component of this project was constrained by time, lack of interest from some, and lack of resources.

### **6.3 Reflection on the study findings**

After going through the key research phases such as literature review, research methodology of this study and choosing the relevant theory, I found it necessary for the proposed topic of the study to be amended to cater for what transpired during the study without losing work already done. Practice Architectures theory by Kemmis (2009) and Kemmis, McTaggart and Nixon (2013) was helpful in soliciting the ‘sayings, doings and relatings’ and the associated arrangements for management and curriculum practices at Fort Cox.

The research methodology could be regarded as a success although the data collection process did not happen at the speed that was anticipated. Challenges that arose during data collection include repeated rescheduling of appointments because of unavailability of participants due to time and workload. Although action learning was viewed as one of the supporting theories to complement Practice Architectures theory in this study, due to challenges mentioned above, the intended action learning process as part of the research, did not happen as anticipated. However, the workshop that was conducted and the students' educational clubs were found to be good examples of elements of an action learning process that could be a benchmark to other processes to follow up after this study.

#### **6.4 Recommendations**

After careful scrutinising of the data presented in Chapter 4 and discussed in Chapter 5 in the form of analytical statements, a number of recommendations have been drawn from this study to help strengthen a sustainability focus in the water management and curriculum practices of Fort Cox. The recommendations were also drawn in line with the Practice Architectures Theory's 'sayings, doings and relatings' together with the associate arrangements. This study therefore recommends the following:

##### *6.4.1 This study recommends coordinated links between water management and curriculum practices of Fort Cox*

This recommendation addresses the practice mismatch concern that was found between the water management and curriculum practices around the campus. Chapter 4 also presents that the academic section and the farm at Fort Cox were showing a practice disconnect in various water management practices which therefore compromises the quality of education given to students. Coordinated links between curriculum and supporting practices will be beneficial and could be created through knowledge exchange platforms like seminars and workshops, and through joint monitoring and evaluation of Fort Cox practices e.g. through regular and joint completion of a questionnaire like the USAT.

##### *6.4.2 This study recommends the introduction of seminars*

The idea of seminar culture was raised in the workshop by Mr Sixoto (guest lecturer). This study recommends that Fort Cox adopt the culture of academic seminars where the Fort Cox community will participate in knowledge and information sharing on water management and other relevant information; focusing on aspects that need improvement and looking for

solutions together. Such events can also work as an action learning process. Through these seminars, new ways of doing things can be shared and endorsed, problems can be identified, and discussion takes place with constructive criticism. If a culture of seminars is cultivated, guest experts would find it easy to share their sustainable water management experiences to benefit both teaching and learning and the water management practices around campus. These seminars can also be used to self-introspect on the current doings related to water management and curriculum practices. For example, students mentioned that although they were exposed to sustainable water management practices, the majority of students do not practise them on campus.

#### *6.4.3 The study recommends the prioritisation of teaching and learning resources*

This is viewed as part of the solution to giving attention to and prioritising teaching and learning needs for lecturers, students and field technicians. Most student practicals are seasonal and cannot be delayed for days or weeks; should there be breakages in the water infrastructure and other challenges which require financial approval, the prioritisation of teaching and learning needs should step in to assist and help prevent total collapse of the project in question.

#### *6.4.4 The study also recommends a second workshop to provide feedback on the findings of this research*

It will be beneficial for a second workshop to provide feedback and follow up on the research findings, to discuss the way forward based on the recommendations put forward in this chapter. The second workshop can also be used to engage more academics and other staff at Fort Cox and its wider community, to review their own practices towards sustainable focus on water management and curriculum practices to benefit the institution and the region.

#### *6.4.5 This study recommends the strengthening of staff development programme*

Evidence from section 5.1.5 of this study motivates for a recommendation that staff development programmes for academics and associate support staff working with water management practices be introduced at Fort Cox. This will help staff to discover new knowledge and build relevant skills in their respective contexts, to benefit teaching and learning. These initiatives can be achieved through conferences, work-based experience learning attachments and qualification improvements through the RDC and other relevant institutions.

#### *6.4.6 The study also recommends the centralisation of all collaborative partnerships*

Fort Cox has existing collaborations which can be helpful in strengthening the relations between Fort Cox, stakeholder partnerships and the surrounding communities as well as the internal water management and curriculum practices around campus. Examples given of some of these working collaborations include a partnership between Fort Cox, IBLN and Rhodes University – ELRC and Amanzi for Food, which was said to be an effective partnership (by students and lecturers). Platforms such as the recommended seminars could also be used to increase the transparency and general awareness of all working collaborations at Fort Cox. This will benefit future staff and students who are interested in expanding their teaching and learning scope outside Fort Cox context.

#### **6.5 Possible further research recommendations**

- The scope of the study was small and it can be expanded for future research involving a large sample size of participants for a post master's qualification.
- The study was conducted at Fort Cox Agriculture and Forestry Training Institute; this can be expanded to other agriculture colleges to stimulate the sustainability focus in water management and curriculum practices across South Africa's agriculture colleges.

#### **6.6 Conclusion of the study**

This study has been important in that it has helped the Fort Cox community discover a sustainability focus in water management and curriculum practices in their context. This study further helped the researcher and other participants to develop deeper understanding on the current 'sayings, doings and relatings' of water management and curriculum practices of Fort Cox which were informed by the Practice Architectures Theory by Kemmis (2009). The findings and recommendations of this study can be used to strengthen the current 'sayings, doings and relatings' on water management and curriculum practices of Fort Cox.

The information gathered during this study process will be shared with the role players in the affected practices, possibly in a follow-up workshop in order to highlight and collectively explore the contradictions between water management and curriculum practices at Fort Cox. A copy of the thesis will be shared with the institution's library for those interested in understanding the Fort Cox water management and curriculum practices, and to inform future sustainable water management practices.

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## Annexures

### *Annexure A: Letter of access issued for research study permission*



***Annexure B: Invitation to research workshop***

You are kindly invited to participate in the research workshop to be held at the Fort Cox conference centre (Gymnasium) on 18 June 2018. The workshop will be on the topic: **sustainable focus of water management and curriculum practices at Fort Cox: A case of Fort Cox Agriculture and Forestry Institute**. Your attendance and participation in this workshop will be highly appreciated.

**Date: 18 June 2018**

**Venue: Gymnasium**

**Draft AGENDA for first workshop**

1. Opening and welcoming
2. Apologies
3. Adoption of credentials
4. Purpose of the workshop
  - 3.1 Background presentation (main researcher)
  - 3.2 Clarity seeking
5. Discussion and questions
6. Presentation of the way forward
7. AOB
8. Next workshop date proposal
9. Announcements and vote of thanks
10. Refreshments
11. Closure

*Annexure C: Semi-structured interview questions for academic lecturers*

<b>Name of the interviewer</b>	Ramphinwa Azwindini Edson
<b>Name of the interviewee</b>	
<b>Place of interview</b>	Fort Cox Institute
<b>Date of interview</b>	
<b>Questions</b>	
<ol style="list-style-type: none"> <li>1. What is your role at Fort Cox Institution?</li> <li>2. Can you tell me the things you like the most about the work you are currently doing?</li> <li>3. How is the current water management of Fort Cox Institution in general?</li> <li>4. To what extent do you know about current water management practices?</li> <li>5. How do you feel about the curriculum composition on sustainability topics at the Institution especially on water management?</li> <li>6. Is the practical for students adequately delivered to your satisfactory and curriculum requirement?</li> <li>7. How do you understand action learning as a teaching technique and what are the benefits of it to learners?</li> <li>8. Are you involved in any sustainable water management practices in the form of teaching and learning or through action learning at your workplace?</li> <li>9. What extent do you cover or encourage sustainability topics in your area of focus?</li> <li>10. Does the curriculum composition adequately address sustainability topics on water management?</li> <li>11. How do you complement teaching and learning through practice?</li> <li>12. Are there any challenges between teaching and learning, and practice on sustainability topics between activities at campus?</li> <li>13. If there are challenges, what do you think should be done to address them?</li> <li>14. How do staff members respond to sustainable water management ideas?</li> <li>15. How are students responding (interested) to sustainability topics?</li> <li>16. Do you feel there is a need to do more to understand sustainable water management practices at Fort Cox activity practices through an action learning approach?</li> <li>17. How is the response from other support staff to water management and curriculum practice ideas?</li> <li>18. Do you feel there is a need to change the current water management and curriculum practices?</li> <li>19. What benefits action learning on water management practices will have at the Institution?</li> <li>20. What else do you want us to discuss on this topic of water management and curriculum practices at the Institution?</li> </ol>	

***Annexure D1: Semi-structured interview questions with the students who were enrolled in the Crop Production curriculum and were also members of the Crop Production club at Fort Cox***

**Semi-structured questions**

1. Are there any practicals you guys were doing this semester in relation to water management practices?
2. Were you guys exposed to different irrigation systems and so forth around campus?
3. What exactly where you doing there?
4. Was the main aim to make you aware of an irrigation system that doesn't waste water and manage water efficiently at low cost?
5. What were you really involved in, which type of irrigation practices were part of your practicals?
6. Were you hands-on or directly involved when installing the irrigation system?
7. So did you enjoy the practicals since you guys were exposed to it?
8. Do you advise other water users or farmers at home to use this type of irrigation system for irrigating their crops for water conservation purposes?
9. Then what were the benefits of drip irrigation?
10. Is the centre pivot expensive?
11. Does the centre pivot save water?
12. In your own understanding of this context of water management discussion thus far, do you know where Fort Cox gets its water from?
13. Where and how Fort Cox does get its water from?
14. Does the water come to Fort Cox at free cost or are there some expenses attached?
15. Have you ever seen or visited the new Fort Cox water purification plant?
16. Where the water for irrigation does come from, is it the same water as drinking water?
17. Do you know the concept of climate change and if yes how much is covered in your curriculum?
18. Are there any water management guidelines at fort cox current activity practices?
19. Any other inputs on that topic?
20. Have you ever heard of rainwater harvesting or involved in rainwater harvesting practices?
21. Are you practicing rainwater harvesting practices at the college?

22. When you are in class you are taught mulching and water harvesting techniques, then you go to the field to do practicals? Do you find some good responses from general workers when you conduct the water conservation practicals?
23. What could be the problem of not applying the sustainable water management techniques all around the college as per the sayings in the stated curriculum?
24. Are you engaging general workers in these water saving techniques?
25. Do support staff have sufficient skills and knowledge on sustainable water management in your opinion?
26. What you are taught in the curriculum by respective lectures in other courses, do they talk about saving the water and are the topics on saving water fairly addressed or are they left hanging?
27. Do you guys see the importance of water management in the general agriculture practices?
28. Do you guys see the needs for this aspect of sustainable water management to be emphasised? Or is the curriculum enough or do we need to expand more?
29. Are these rainwater harvesting topics part of the curriculum?
30. Except rain water harvesting, what other water management related topics did you do?
31. Do you know how to construct contour ploughing or can you advise someone who wants to construct them on their importance to conserve water?
32. What could be the reasons for you guys not being exposed to too much practicals?
33. How do you guys feel about action learning?
34. How do guys want to be distinguished from Rhodes students or elsewhere if I may ask?
35. Do you think that there is a need to change or amend the current curriculum to cater more water management topics?
36. Last semester there was a course you guys did which was hands on and students were complaining that they are being exploited through action learning. Won't that be action learning to open up old wounds if infused within the curriculum?
37. What else can you share about sustainable water management practices so we can close this for today?

THE END

***Annexure D2: Semi-structured interview questions for the students enrolled in Animal Production curriculum and were also members of the Animal Production club at Fort Cox.***

**Semi-structured questions**

1. What do you really do in an Animal club and what exactly the club is meant for?
2. Do you get support from lecturers and Fort Cox staff? Are they on a daily basis involved in these practices, what kind of support do you receive if there is one?
3. Do you see water as one of the strong pillars to make your production successful?
4. In general how do you see water management if Fort Cox is in a good one state where production is maximized without any shortage of water?
5. Do you think all the practicals you have done were adequate or satisfactory, were they complimenting with what you were taught in the classroom?
6. Does what you see at the farm resemble what you are taught in the classroom?
7. Referring to the current practices, do you all have doubt or confidence that the exercises you conduct through practice were taught in the classroom?
8. Are you saying support staff members do not have all the knowledge which theory says?
9. During the crisis of water you recently experienced; how did you try to address the problems in your own activity practice?
10. You mean, you were harvesting water from the nearby pond or dam?
11. What lessons did you draw from all these problems you were facing under this recent water crisis?
12. In general perspective, how do you explain current water management practices in the college?
13. When you see individual behaviour handling of water, do you find it as water wastage and how do you handle such cases. What do you suggest to manage water at the residence?
14. The water that you are currently using for consumption purposes, where does it come from?
15. If this water with pig waste can be used in a good way, it can make a lot of difference because back from our homes we normally use pig waste as fertilisers to our crops.
16. What are the advantages that can be drawn from that?
17. If one wants to start a piggery or a broiler; what comes to your mind first?

18. So you are saying we are moving from better to worse. Have you heard about climate change before?
19. Do you think the curriculum is doing enough or the composition of the curriculum covers enough to address water management towards your production knowledge?
20. Do you think there is a need to learn more about water management in agriculture?
21. What do you think could be the better solution for such cases?
22. Do we use rain water conservation techniques such as rainwater harvesting systems in college?
23. Anything else to add around our discussion feel free to raise and we can discuss.

The End

**Annexure E1: USAT questionnaire for academic field technicians**

Unit-based Sustainability  
 Assessment Tool for Fort Cox water management and curriculum practices  
 Field technicians

**Assessment Criteria**

- X** = **Don't know** no information concerning the practice  
**0** = **None** there is total lack of evidence on the indicator  
**1** = **A little** evidence show poor performance  
**2** = **Adequate** evidence show regular performance  
**3** = **Substantial** evidence show good performance  
**4** = **A great deal** excellent performance

(Add a tick (✓) for key project areas and where more information is needed)

<b>Fort Cox Water management activity practices</b>	<b>Rate</b>	<b>Key project</b>	<b>Inadequate information</b>	<b>Reasons for implementing the practice</b>	<b>What can be done to improve the sustainability of the practice?</b>
Sustainable water management practices					
Water recycling practices – grey water and waste water recycling					
Repairing of damage and/or licking infrastructure associated with water wastage					
Water wastage reduction practices					
Indoor water use standards and					

practices/water saving techniques					
Water infrastructure maintenance					
Rainwater harvesting activities/methods					
Water pollution reduction practices					
Awareness campaigns and outreach programs on sustainable water management					
Landscaping maintenance (emphasizing native plants and reduce the use of chlorinated water for lawn maintenance)					
Integration of other operations into the educational and scholarly activities concerning sustainable water management practices of the Institution					
Other (please specify):					

*Annexure E2: Students' USAT questionnaire around campus*

**Assessment Tool for Fort Cox water management and curriculum practices for students**

**Assessment Criteria**

Rate activities and opportunities in the water management, environment and sustainability area.

- X = Don't know no information concerning the practice
- 0 = None there is total lack of evidence on the indicator
- 1 = A little evidence show poor performance
- 2 = Adequate evidence show regular performance
- 3 = Substantial evidence show good performance
- 4 = A great deal excellent performance

(Add a tick (✓) for key areas and where more information is needed; briefly outline key activities in the area of sustainability)

<b>Water management opportunities</b>	<b>Rate</b>	<b>Key Area</b>	<b>Inadequate information</b>	<b>Outline of activities (what exactly is being done?)</b>
Student's academic societies or other Student Group(s) with an environmental education or sustainability emphasis				
Student Environmental knowledge support centre				
water management practices in residences or dormitories by students (e.g. recycling)				
Orientation program(s) on sustainable water management for students				
Student environmental and sustainable water management awareness programmes				
Career counselling focused on 3 work opportunities				

related to Environmental Education and Sustainable water management topics				
Voluntary community service by students related to sustainability issues and concerns				
Involvement of student groups in the campus in sustainable water management initiatives				
SRC involvement in environmental and sustainable water management initiatives				
Student collaboration with management in the area of environmental and sustainable water management				
Environmental and sustainable water management activities initiated by students themselves (independent of departments, lecturers, management etc.)				
Students' willingness to take responsibility in the environmental education and sustainability space				
Others (please specify):				

**Annexure F: Extracts from water dependent course outline (sayings)**

Instruction: 3 lectures & 1 practical/week (nursery production practices, pruning and training, regulation of fruit load, scouting, rain water harvesting and conservation practices for orchards, excursions to temperate and nut crops farms and pack houses, soil and leaf analyses, top working)

Assessment: Two major tests, one- 3 hour examination, practical reports and assignments

Credits: 12

Pre-requisite: CS 213CP

**CS 221CP VEGETABLE PRODUCTION**

Objective: To provide students with an understanding in principles of vegetable crops production.

Course Outline: Vegetable production systems, classification of vegetable crops, environmental factors, seedling production, soil fertilisation & water management for vegetable production, management practices of selected vegetable crops plus indigenous vegetables, controlled environment vegetable production

Instruction: 2 lectures and 1 practical/ week (planning and layout of a vegetable garden, seedling production, crop establishment: transplanting, direct field seeding, seed germination and viability tests, plant population estimation, cultural practices for selected vegetable crops under conventional and controlled environment, selected indigenous vegetable production, rainwater harvesting & conservation practices (french beds, mulching, infiltration pits).

Assessment: Two major tests, one 3 hour examination, practical reports, assignments

Credits: 12

Pre-requisite: None

**AE 222 IRRIGATION, SOIL AND WATER CONSERVATION**

Objective: To equip students with the understanding of soil-plant and water dynamics and relationships.  
To understand and demonstrate water application methods and irrigation scheduling

Course Outline: Soil Moisture Relationship: Soil water capacity, Available moisture, evapotranspiration  
Sources of water: Rainfall, Run-off, Underground water  
Irrigation scheduling, Water consumption determination, Allowable depletion, Moisture deficit, Irrigation schedule

Flood irrigation, Wild irrigation, Basin irrigation, Furrow irrigation, Border strip irrigation,  
 Sprinkler irrigation, Lateral and secondary irrigation, Components of a sprinkler system, Types of sprinkler systems, Design and layout,  
 Micro-irrigation and drip irrigation: Advantages and disadvantages, Micro-irrigation systems, The drip system, Management

**Instruction** 3 Lectures / week, 1 practical/ week (test the irrigation uniformity of chosen surface and overhead irrigation, design irrigation systems and produce a schedule under specific conditions, visits to farms that use mechanised irrigation systems, mulching, gully control, soil moisture measurements, construct water conveyance structures.

**Assessment** Two major tests, one 3-hour examination paper, practical work, research presentations and assignments

**Credits** 16

**Pre-requisite** AE121

**AB 221 BUSINESS MANAGEMENT**

**Objectives** To provide students with knowledge and understanding of business and processes. Introduce students to decision making, planning, implementation and control across the functions of business.

**Course Outline** Introductory concepts; functions of management, roles of managers, characteristics and styles of management. Entrepreneurship in business, functions of entrepreneurships, forms of business ownership, the business plan. Strategic management, strategic management process, types of business strategies, strategy implementation, strategic control. Financial Management: financial statements, enterprise budget, cash flow budget, capital expenditure budget. Operations Management: the transformation model, operations decisions, type of operations, productivity challenge, competitive advantage. Marketing Management: market analysis, market segmentation, marketing strategy, marketing mix; Risk management

**Instruction** 3 lectures/week; Practical - Case studies

**Assessment** 2 tests, Practical/Assignments, Examination, Reports

**Credits** 8

**Pre-requisite** None

**AB 223 ENTREPRENEURSHIP**

**Objectives** This course introduces students to entrepreneurship as a vehicle for developing business ideas and creating wealth. The course will introduce the student to the art of innovation, business decision making and administrative roles of entrepreneurs.

**Course Outline** Understanding entrepreneurship in farming, Entrepreneurial Responses, Introduction to entrepreneurship, Creativity, innovation and opportunity finding, franchising, business growth, Entrepreneurial process, formalisation of your business, Small business management skills across

**Annexure G: Extracts from Irrigation, Soil and Water Conservation examination paper (doings)**

ANNEXURE G: AE211 Examination paper (2019)

**Question 1 [20 marks]**

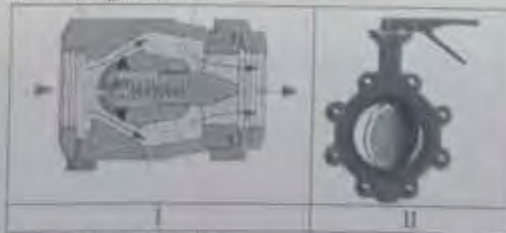
- a) What do you understand by the following terms as they apply to irrigation?
- Effective rainfall [2]
  - Crop water requirement [2]
- b) Consider a 1.2ha plot in Alice (Eastern Cape), on which peas is planted under a movable quick coupling sprinkler irrigation system. Peas has a total growing period of 90 days and grows well over the spring (planting date -1 August) during which its crop factor ( $f$ ) varies. Given an effective rainfall of 42.6mm for the growing season, pan coefficient ( $K_p$ ) of 0.8, calculate
- The crop evapotranspiration,  $ET_c$ , for the growing season [11]
  - Total volume of water required for the growing season in  $m^3$  [5]

**Question 2 [20 marks]**

- a) What instruments would you use to measure the following?
- Evaporation [4]
  - Irrigation depth [4]
- b) Draw a well labelled sketch diagram showing how you would measure irrigation depth when irrigating green pepper whose root depth is at a particular growth stage is 120mm. Your diagram should show the root zone, measuring instruments and the dimensions. [6]
- c) Give two *disadvantages* of each of the following irrigation systems
- Centre pivot [2]
  - The big gun [2]
- d) Discuss any factors that influence the choice of an irrigation system [6]

**Question 3 [20 marks]**

- e) The following questions refer to irrigation plumbing materials
- State two advantages of uPVC pipes [4]
  - State the four nominal diameters of uPVC pipes above 50mm [2]
  - Distinguish between LDPE and HDPE pipes [4]
- f) Consider the figure below



- Identify I and II [2]
  - Explain the function of I [2]
- g) Explain why a suction pipe needs to be reinforced with a steel coil [2]
- h) Discuss the challenges associated with the use dragline irrigation systems [4]

## Annexure A: AE211 Examination paper (2019)

### Question 4 (40 marks)

- a) Define natural resource in your own words [1]
- b) State four (4) reasons for the degradation of natural resources [4]
- c) What will happen to food security if the natural resources do not sustain productivity [5]
- d) Explain any Five (5) water conservation practices [10]
- e) Explain any Five (5) soil conservation practices [10]
- f) State five (5) aims of soil conservation practices [10]

END

**Annexure H: Extracts from Vegetable Production (CS221) examination paper (doings)**

ANNEXURE H (2019 CS 221 Examination paper)

25 Marks)

**QUESTION 1**

1.1 Match the statements in table 1.1A with the terms in table 1.1B pended below. [10]

No	Table 1.1A
1.1.1	A term that refers to the growing plants using mineral nutrient solutions without soil.
1.1.2	Refers to a term for living vegetative plant material extracted for tissue culturing on appropriate medium.
1.1.3	Refers to fungal disease that affects seeds and new seedlings characterised by the rotting of stem and root tissues at and/or below the soil surface.
1.1.4	Refers to a way of regulating plant density in rows and in holes.
1.1.5	Refers to yield of the edible portion of the plant.
1.1.6	Refers to a method of vegetative propagation in which a part e.g. tubers are made to form adventitious shoots.
1.1.7	Refers to a branch of horticulture that deals with the cultivation of plants for their aesthetic purposes.
1.1.8	Refers to the cultivation of fruits such as sweet oranges, grape fruit and lemons.
1.1.9	Refers to the process of preparing plants to withstand adverse weather condition when taken from nursery to field conditions.
1.1.10	Refers to total yield of plant biomass which includes parts used and not used for consumption.

Table 1.1B Terms			
A) Pomology	B) Seedling	C) Floriculture	D) Transplanting
E) Explant	F) Vegetative	G) Pericarp	H) Endocarp
I) Vigour	J) Slips	K) Citriculture	L) Economic yield
M) Flavonoid	N) Thinning	O) Hydroponics	P) Damping off
Q) Agronomy	R) Biological yield	S) Hardening off	T) Ornamental

1.2 Indicate whether the following statements are true or false, if false provide the correct answer. [15]

1.2.1 The main three groups of pigments found in plants are chlorophyll, carotenoids and flavonoids.

1.2.2 A term that refers to soil condition when all pores are filled with water resulting in high CO<sub>2</sub> content is drought.

1.2.3 The term that refers to crops that are not affected by day length are called long day plants.

1.2.4 Companion planting refers to the planting of different vegetable crops in proximity for the purpose of pest control, pollination, providing habitat for beneficial insects, maximizing use of space, and to increase crop productivity.

1.2.5 Seedbeds should not exceed 1.2 meters in width and length.

1.2.6 A vegetable is a mature ovary of plants with their seeds.

4.1.3 If the farmer wishes to apply chicken manure to the vegetable garden, how much chicken manure will be needed, if the recommended rate of application is 4 kilograms per square meter? [5]

4.2 Calculate the number of seedlings that the farmer require, if the vegetable is planted at inter-spacing of 500 mm and intra-spacing of 400 mm? [5]

4.3 Discuss briefly five harvesting procedures which you may use to reduce postharvest losses in vegetables. [5]

## Appendices

### Appendix A: Analytical memo 1: Workshop

<p><b>A workshop exploring academics, students, field technicians and support on the sustainable focus of water management and curriculum practices of Fort Cox Agriculture and Forestry Training Institute as informed by Kemmis's (2009) Practice Architectures Theory model.</b></p>	
<p>Participants</p> <ul style="list-style-type: none"> <li>● Researcher: Mr Ramphinwa</li> <li>● Lecturers in the Workshop: Matambo C, Madikiza L and Vele M.T</li> <li>● Field Technicians in the Workshop: Mangoale M. Gwebushe L and Qampi T</li> <li>● Sectional Manager – Mrubata B</li> <li>● Guest lecturer – Sixoto W</li> <li>● Students participants in the workshop - 11 students</li> <li>● Other support staff in attendance</li> </ul>	
<p><b>LEVEL 1 ANALYSIS:</b> <i>What are the sayings, doings and relatings of academic staff, students, field technicians and support staff at Fort Cox on sustainable water management on the campus and in the curriculum?</i></p>	<p><b>LEVEL 2 ANALYSIS:</b> <i>What are the associated arrangements and conditions that enable or constrain sustainable water management and associated curriculum practices?</i></p>
<p><b>Sayings</b></p> <ul style="list-style-type: none"> <li>● The sayings you are looking for are in the explicit curriculum. What you can see for example in the prospectus: <b>Madikiza</b></li> <li>● The prospectus has indicated in black and white that as first years these are the things you are going to do and within that you have a portion where you say this is how you are going to be assessed and these are the guiding sayings: <b>Madikiza</b></li> <li>● The given course outline, course content which is the notes, textbooks: <b>Matambo</b></li> <li>● What has been written down in other words, it's like your bible, you are supposed to follow it including your course outline: <b>Madikiza</b></li> <li>● In our curriculum, there is quite a bit of mention of rainwater harvesting but rainwater harvesting is not only water management. There are other aspects that you can involve, for instance groundwater</li> </ul>	<p><b>Cultural-discursive arrangements</b></p> <ul style="list-style-type: none"> <li>● But there might be a gap in terms of knowledge on support staff personnel, they don't know that the grass they cut is supposed to be preserved, even if we have to look around just an example of the admin offices every time there are visitors they want to take every leaf that has fallen on the ground and hey they want to clean the grounds and leave the soil exposed to wind erosion: <b>Madikiza</b></li> <li>● There should be signage around the college which could help us conserve water and use it wisely: <b>Siphe</b></li> </ul>

<p>extraction, there is a mention of it in some courses that I teach but it's not explored in depth. It also talks of the issue of construction of dams, it is rain water harvesting but on a larger scale: <b>Matambo</b></p> <ul style="list-style-type: none"> <li>● We teach water factors that facilitate the growing, harvesting and processing of vegetables per-se. For it to actually be explicit, in order for it to be in the black and white, you need to apply the section where production factors are required: <b>Madikiza</b></li> <li>● Production factors could be light, water, climate, we may save water but there are different sources of water and in this case we are using water from rain, snow, so that section which is talking about different sources of water needs to be put in black and white and how to manage it. That's what I'm thinking the sayings are: <b>Madikiza</b></li> </ul>	
<p><b><i>Analysis of the sayings findings</i></b>  <i>A key finding regarding the sayings from this workshop was that, the water management and curriculum practices are documented in the prospectus and that is a guiding document of the sayings in the stated curriculum. The sayings are supported by the Fort Cox library materials either in hard copies or online materials (Matambo and Madikiza). However, Matambo argues that water management topics are not enough, though there is a bit of mention within some chapters. For example, there are rainwater harvesting topics and other topics such as ground water harvesting and construction of water pongs which are not explored in depth. Madikiza further argues that water management topics pop out in other water dependent production courses such as vegetable production, but those topics are not captured in the stated curriculum.</i></p>	<p><b><i>Analysis of Cultural-discursive arrangements findings</i></b>  <i>A key finding regarding cultural-discursive arrangements out of this workshop was, there is lack of sustainable water management knowledge and poor information sharing or dissemination between Fort Cox staff which affects the water management and curriculum practices: Madikiza. For example, there is no visible signage to communicate the dos and the don'ts regarding sustainable water management practices: Siphe.</i></p>
<p><b>Doings</b></p> <ul style="list-style-type: none"> <li>● Students do practical water management topics: Matambo</li> </ul>	<p><b>Material-economic arrangements</b></p> <ul style="list-style-type: none"> <li>● We let our structures deteriorate. There was a proper drainage system at the staff quarters which was making water run</li> </ul>

<ul style="list-style-type: none"> <li>● We teach sustainable water management, for example in vegetable production, water is one of the production factors emphasized. We teach factors that facilitate the growing, harvesting and processing of vegetables per-se. For it to actually be explicit, in order for it to be in the black and white, you need to apply the section where production factors are required: <b>Madikiza</b></li> <li>● If you talk about rainwater harvesting because we have been dealing with it for a number of years now: <b>Matambo</b></li> <li>● In irrigation principles we were taught how long to irrigate but when you arrive at the fields and tell the workers that you are allowed to irrigate only for certain hours, they respond mostly by saying they are going to change their practice due to what you are telling them: <b>Siphe</b></li> </ul>	<p>through smoothly and now they are no longer there because of poor maintenance, so the water from the runoff has eroded the soil away: <b>Mangoale</b></p> <ul style="list-style-type: none"> <li>● To save water, the first thing is to change the taps because some are leaking: <b>Mangoale</b></li> </ul>
<p><b>Analysis of the doings findings</b>  <i>With regard to the doings, this workshop has discovered that Fort Cox is a practical based learning Institution where students are taught most of the theoretical topics and thereafter expected to practice what was taught on the ground by applying all the production factors in the form of experimental projects: <b>Matambo and Madikiza</b>. In addition, <b>Siphe</b> argues that students have current knowledge on the agriculture production factors gained from the taught curriculum, but when they attempt to share and implement some of the innovative sustainable water management techniques such as irrigation time frames during practicals, the support staff working with the identified water management practice don't want to change from their old practices.</i></p>	<p><b>Analysis of material-economic arrangements findings</b>  <i>A key finding regarding cultural-discursive arrangements out of this workshop was, Fort Cox water infrastructure is dilapidated because of poor maintenance and that include loss of water through leaking taps and pipes, increased cost attached to water bills. There is also a strong feeling that poor maintenance of infrastructure amongst the drainage system results in runoff which causes erosion: <b>Mangoale</b>.</i></p>
<p><b>Relatings</b></p> <ul style="list-style-type: none"> <li>● The first step in bridging the gap is by identifying the cause of the gap and then look at the opportunities that you have for bridging those gaps. If you are going to be teaching groundwater extraction in Fort Cox,</li> </ul>	<p><b>Social-political arrangements</b></p> <ul style="list-style-type: none"> <li>● I just want to make an example of grass which is cut maybe at the grounds or around the campus, you use that as learning material for constructing or making trench-beds but there is currently no link or</li> </ul>

what opportunities does it have to make it practically possible or should it be theory at high scale: **Matambo**

- There may be partnerships that exist but we may not be aware of how effective or useful those partnerships may be to the current curriculum. They may be partnerships that exist but it's probably a question of enquiring further into the nature of those partnerships: **Madikiza**
- I wouldn't say it covers all because there seems to be emphasis on some of the water management aspects while there is less emphasis on other aspects of water management and there also seems to be some silence in some cases in other water management aspects: **Matambo**
- There is a need for that collaboration I can say, a common understanding on the objectives of an institution such as this are, like to say every support staff there is a need for that collaboration on whatever they do; to say what this thing is and how to manage it: **Matambo**
- Students and lecturers have got a role also to see to it what is happening on the farm and it is also well communicated with the support staff and the support staff are also quite aware of the academic regulation so that there is that collaboration. In that way you will find that learning happens efficiently because the support staff will be available: **Matambo**
- I just want to make an example of grass which is cut maybe at the grounds or around the campus, you use that as learning material for constructing or making trench-beds but there is currently no link or relationship between the people who are cutting the grass and the lecturers and how do you get that information that interlink to say this person who is cutting the grass shouldn't burn it because it is a learning material and it should

relationship between the people who are cutting the grass and the lecturers and how do you get that information that interlink to say this person who is cutting the grass shouldn't burn it because it is a learning material and it should be preserved somewhere. That link is what we need to establish: **Madikiza**

- Those are the practices that affect water management in Fort Cox practices like irrigating. People are irrigating but there is no control, water is just gushing out and no one is attending to anything. We are just losing water. No one is paying attention to when, how much and how to irrigate: **Matambo**
- There are quite a number of things that are happening in the college that students think they have nothing to do with. But as a matter of fact they have everything to do with it. Irrigation is going on all around in different places and students don't know how to operate the systems. Involving students in agricultural activities will make learning and teaching easier. All activities at the college should involve learning and probably educate those that are working in the other sections: **Matambo**
- The farm is supposed to produce what the academic is anticipating in teaching the students. Academics should add value to the farm and improve practices: **Mrubata**
- You will find that there is no link between the farm and the academic programme which is supposed to be corrected. Our general staff need to know what is expected from them in order for us to be a productive farm and give quality education to our students: **Mrubata**
- Farming requires water and also you find that there are programmes that are moving far without even making the proper consultations with academics. There is also

be preserved somewhere. That link is what we need to establish: **Madikiza**

- I think that it will be a great idea for students and academics to be a part of workshops and training places in RDC: **Mrubata**
- After hearing the conclusions that people have, it goes back to the issue of integration and collaboration, academics are acting parallel to the activities of the farm. For instance, a farmer is busy with dairy production but is also managing pastures at the very same time we have to get courses on pasture management. Look at the quality of pastures that we have; they don't talk to the course content of cultivated pasture management: **Mrubata**
- Academics should add value to the farm and improve practices. The reason why things are happening so wrongly is because there is a lack of basic information on practices for the quality of teaching and learning we need to apply information from academics on the farm: **Mrubata**
- You will find that there is no link between the farm and the academic programme which is supposed to be corrected. Our general staff need to know what is expected from them in order for us to be a productive farm and give quality education to our students: **Mrubata**
- The other one may be planned and the other one they can go to for demonstrations. I can make an example using those new projects that are being done, if communicated to academics those water projects can be used for demonstration for students. A smaller project would be advisable for students to be part of, where they can do the practical hands-on and be assessed in the form of practicals manual or presentation: **Vele**
- There should be a signage in the college to remind us not to dump rubbish everywhere and pollute water: **Mangoale**

fencing that is taking place in the RDC for the new structure that is going to be constructed; no consultation was done to the engineers to say are we on the right path. We are our common sense; it proves the way we operate: **Mrubata**

- Experiential projects involve students coming up with their own ideas by lecturers guiding them on what to do and how to do it. Yes, experiential projects are a very effective way of learning. It is just that you cannot implement it alone; coming together with others to teach is very effective: **Matambo**
- I think there are no such platforms where students can be taught values but that needs to be considered, it also shows in a way the students conduct themselves. Life values need to be taught to students because barbaric actions are shown by some of our students: **Mrubata**
- We also need to develop an institutional culture as academics to understand that Fort Cox is an academic institution and it therefore means that whatever activities that will be done here must compliment the curriculum: **Sixoto**
- I think it's the system that is failing us because usually in the other institutions at around 6 o'clock you see sprinkler irrigation but they stop at a certain time. The recent water management systems are not applied and known here: **Mangoale**

<ul style="list-style-type: none"> <li>● Irrigation principles should be taught and it will also help the community to be knowledgeable enough about water saving irrigation methods: <b>Zizipho</b></li> <li>● I think all of us in Fort Cox need this kind of education because we are really missing a lot of important things. From principal to student, we all need this information and education. I wish we could call everyone in the hall and you teach us those things, we need them so we can save this bill of water. We should encourage seminars in the curriculum. There should be continuity of these workshops: <b>Gwebushe</b></li> </ul>	
<p><b><i>Analysis of the relatings findings</i></b>  <i>A key finding regarding relatings out of this workshop, was a strong feeling among several participants that there was a practice disconnection at Fort Cox between academics on the one hand and farm management on the other hand. This disconnect had two at least two outcomes which participants found problematic. One was that there were missed opportunities for teaching, and the other, is that there were management practices on the farm uninformed by academic knowledge. Both resulted in missed opportunities for learning on the part of the students and other support staff: <b>Mrubata</b> “You will find that there is no link between the farm and the academic programme which is supposed to be corrected to serve the common purpose”:</i> <b>Madikiza</b>. <i>In addition, implementation of other small water management projects can be used for student practical learning purposes: <b>Vele</b>. In the current curriculum practices, it is the academics responsibility to bridge the gap left by theory to address sustainable water management practices, they are at liberty to include relevant topics and demonstration in the respective practices to cater for important water production factors, <b>Matambo</b>. Some of the curriculum and water management practices cannot be catered within Fort Cox context, but</i></p>	<p><b><i>Analysis of social-political arrangements findings</i></b>  <i>An important finding from this workshop on social-political arrangements was, poor linkage between academics and support staff on the ground. You find that support staff on the ground dispose of the grass residues and leaves during cleaning which are key for curriculum delivery practices such as mulching for moisture conservation: <b>Madikiza</b>. The other important finding relates to ethics of care whereby the Fort Cox community really does not take extra precautions to prevent water wastage during both water management curriculum practices and domestic usage. For instance, many activities are happening in the water management practice at Fort Cox context and students feel it has nothing to do with them if not part of their stated curriculum but in fact it has to do with them the most: <b>Matambo</b>. <b>Mrubata</b> also added that the working relations between the farm, students and the academics is key to building the functional water management and curriculum practices system. This will help discover values associated with water and curriculum practices in the Institution.</i></p>

*through collaboration with other educational Institutions and learning networks, partnership with relevant stakeholders, other sustainable water management practices can be shared: **Madikiza and Matambo.** Another key finding was, poor dissemination of information regarding sustainable water management practices which is hampering the connectivity between taught curriculum and supporting practices. For example, make available signage to communicate sustainable water management practices across the compass: **Mangoale.***

*Appendix B: Analytical memo 2: Four academic staff interviews*

<p><b>An interview exploring the academic staff members on the sustainable focus of water management and curriculum practices of Fort Cox Agriculture and Forestry Training Institute as informed by Kemmis (2009) Practice Architectures Theory model.</b></p> <p><b>Participants: Madikiza, Matambo, Vele and Landzela</b></p>	
<p><i>LEVEL 1 ANALYSIS: What are the sayings, doings and relatings of academic staff at Fort Cox on sustainable water management on the campus and in the curriculum?</i></p>	<p><i>LEVEL 2 ANALYSIS: What are the associated arrangements and conditions that enable or constrain sustainable water management and associated curriculum practices?</i></p>
<p><b>Sayings</b></p> <ul style="list-style-type: none"> <li>● From the curriculum point of view we are trying to implement some rain water harvesting practices especially for irrigation. We are trying to include water conservation techniques in the curriculum which are farm ponds, trench beds, roof top rain water harvesting techniques, diversion farrows which captures water and used it for irrigation during dry seasons: <b>Matambo</b></li> <li>● The current curriculum has got quite significant aspects in some of the courses that relate to rain water harvesting, water conservation and looks at the water extraction from the rivers, water extraction from underground sources and the construction of dams: <b>Matambo</b></li> <li>● The current curriculum has significant content that relates to water management: <b>Matambo</b></li> <li>● There is room for improvement from all directions, in the curriculum point of view especially if we can keep pushing in the curriculum matters that pertain water management because the climate is changing: <b>Matambo</b></li> <li>● Curriculum composition of water management topics is not adequate especially seeing the water crisis that we are currently experiencing: <b>Madikiza</b></li> <li>● No need to change the current stated curriculum as such but incorporate aspects that will strengthen the water management</li> </ul>	<p><b>Cultural-discursive arrangements</b></p> <ul style="list-style-type: none"> <li>● I think these initiatives of sustainability topics should evolve from within the academic sections because academics there are the ones that drive the ideologies and the strategic direction of teaching and learning: <b>Matambo</b></li> </ul>

<p>practices in the taught curriculum: <b>Madikiza</b></p> <ul style="list-style-type: none"> <li>● Propose a stand-alone course on water management, diversification of water management practices e.g. possibility of installing roof rainwater harvesting tanks around the campus for visibility, collecting/directing rainwater run-off to a reservoir and also developing a policy towards water management: <b>Madikiza</b></li> <li>● The curriculum composition on sustainable water management topics is silent since there are few courses which articulate about soil and water conservation: <b>Vele</b></li> <li>● In my area of focus as an example in forest engineering II (timber harvesting), if you are harvesting pine or eucalyptus trees, you are not allowed to harvest them close to the streams or the riparian zones since you need to conserve the water as a scarce resource: <b>Vele</b></li> <li>● Our curriculum does not cover much of the water management topics, but there are those courses like irrigation and land use planning they just fit in the water management topics, and we do not have stand-alone courses to cater for climate change topics: <b>Landzela</b></li> <li>● The curriculum is vague on water management courses: <b>Landzela</b></li> <li>● I indicated that the topic is broad, each and every course can have a chapter including water management topic, and it is possible: <b>Landzela</b></li> </ul>	
<p><b><i>Analysis of the sayings findings</i></b> <i>A key finding from Matambo interview regarding the sayings was that, the current stated curriculum on irrigation principles mention a quite significant number of sustainable water conservation techniques which includes farm ponds, trench beds, roof top rainwater harvesting techniques, water</i></p>	<p><b><i>Analysis of cultural-discursive arrangements findings</i></b> <i>Under cultural-discursive arrangements, the interview with Mr Matambo has discovered the importance of using videos, community engagement platforms and posters or pictures to narrate untold stories which are not captured in the stated curriculum as a means of sharing</i></p>

extraction from the river, underground water harvesting and diversion of farrows. There are still many other water management topics that can be included in the future which are quite important, this include climate related water management topics.

A key finding regarding the sayings from this interview with **Madikiza** was that, Fort Cox stated curriculum composition does not cover sustainable water management topics adequately to address current water challenges in the agriculture context:

**Madikiza**. In addition, **Madikiza** argues that no need to panic on the inclusivity of sustainable water management topics at this stage because lectures are at liberty to introduce the topics within their respective scope of teaching and learning through practicals and water management topics can be catered in the next curriculum review.

A key finding of the sayings from this interview with **Vele** was, there is not much water management topics in forestry curriculum except the soil and water conservation course in the forestry curriculum. The other finding from **Vele's** interview was that, other forestry courses have opportunity to address sustainable water management topics at practice and legislatives application context

A key finding of the sayings from this interview with **Landzela** was, the current stated curriculum of Fort Cox does not cover much needed sustainable water management topics to address the challenges that are currently encountered in the Institution and wide agriculture context. **Landzela** also revealed that, although there are few courses which focus on water management topics, that is not enough. Examples of the courses

knowledge and information. Another key finding was that academics the ideology of sustainable water management topics across the water management and curriculum practices lies around academics section guidance.

The key finding from this interview with **Madikiza** regarding cultural-discursive arrangements was that group work is a feasible practice to work with in large classes during water management practicals but it poses other challenges during assessment criteria.

An important finding from cultural-discursive arrangements from this interview with **Vele** was, ethical values associated with sustainable water management is key to protect scarce water resource needs and prevent unforeseen health risks.

*are soil and water conservation, irrigation principles and land use planning.*

**Doings**

- The courses that I am teaching are Farm machinery and introduction to Agricultural engineering at first year level. Farm structures, farm mechanization and irrigation principles on second year level. Research projects which includes grey water harvesting, rain water harvesting which also involves community engagements and engineering projects which included hydroponics: **Matambo**
- The unprocessed water from the Keiskamma-river is sent for irrigation and also is diverted to cleaning of facilities which is the piggery, dairy and for irrigation of crops at the old college plots: **Matambo**
- The domestic purified water is used by students, lecturers and everyone else within Fort Cox for domestic use: **Matambo**
- Fort Cox also has few demonstration sites where we can demonstrate things like farm pond, rain water harvesting, rooftop rainwater harvesting, grey water harvesting and conservation and other practices like the use of trench beds, mulching, diversion farrows etc., we have been demonstrating those to students but I feel there is a room for improvement in that direction: **Matambo**
- We make use of every opportunity to engage students with practicals, like I was mentioning the case of the rain water harvesting techniques whereby we ask students to erect or implement some techniques: **Matambo**
- Teaching and learning; community outreach and research: **Madikiza**

**Material-economic arrangements**

- The good thing about the Keiskamma River is that it is a perennial river which is getting its water from Sandile dam which is fed by the significant flow of water from the Hogsberg Mountains: **Matambo**
- When the water level is low during dry seasons in the Sandile dam we would get water from the Keiskamma-river because they always ensure that the downstream users of the dam get a significant portion of the water that is coming from Hogsberg: **Matambo**
- Depending with the course that you are teaching like the course that involves irrigation a lot of emphasis is put under water management because water management is everything to irrigation, as you cannot irrigate without water: **Matambo**
- Fort Cox also has few demonstration sites where we can demonstrate things like farm pond, rain water harvesting, rooftop rainwater harvesting, grey water harvesting and conservation and other practices like the use of trench beds, mulching, diversion farrows etc., we have been demonstrating those to students but I feel there is room for improvement in that direction: **Matambo**
- There is always a temptation to be giving more theory than practical in every teaching scenario but also because of the lack of resources and other constraints like time and finances you will find that you do not always implement what you would have planned in terms of action learning: **Matambo**
- We are getting more water scarce as a country and it becomes more difficult to access water so it is important that more material is added to the content: **Matambo**
- Before you even go to the technicalities of irrigation which include the design, irrigation

<ul style="list-style-type: none"> <li>● Most of the practicals are done in groups which makes it difficult to assess individual competencies: <b>Madikiza</b></li> <li>● In terms of student practicals, water is managed in form of using irrigation systems that are water saving for instance drip irrigation, use of mulching to conserve moisture: <b>Madikiza</b></li> <li>● Addressing sustainable water management though both teaching and learning in Crop production courses and through practicals such as use of mulching, trench beds, use of organic matter to improve soil drainage and conservation of water: <b>Madikiza</b></li> <li>● Not only in Crop production courses where sustainable water management topics are encouraged. There is an effort to address this topics also in processing to reduce water wastage and minimise environmental pollution: <b>Madikiza</b></li> <li>● Teaching and learning through practice is complemented through case studies scenarios, practicals, demonstrations, field visits to relevant farms and industries: <b>Madikiza</b></li> <li>● In my area of focus as an example in forest engineering II (timber harvesting), if you are harvesting pine or eucalyptus trees, you are not allowed to harvest them close to the streams or the riparian zones since you need to conserve the water as a scarce resource: <b>Vele</b></li> <li>● Some staff members are trying by all means to ensure that the students have some knowledge on the water management issues: <b>Vele</b></li> <li>● Teaching crop production courses: <b>Landzela</b></li> <li>● I enjoy a lot being in the field doing some field work for water production courses and of course lecturing is part of that but the most important thing is to be at the field: <b>Landzela</b></li> </ul>	<p>scheduling and installation, you start by addressing the water issues, where do you get water? How do we conserve water and how do we ensure that we have more options for sourcing water? That is more important than irrigation: <b>Matambo</b></p> <ul style="list-style-type: none"> <li>● There are financial constraints, time constraints, human resource constraints and environmental constraints, e.g. if you want to implement rainwater harvesting and it is not raining, you may go through the semester without implementing the lesson objectives: <b>Matambo</b></li> <li>● In my own thinking resources are the major challenge to satisfy curriculum needs: <b>Madikiza</b></li> <li>● Other resource challenges are for example tanks to collect rainwater; secondly maintenance of practices and also natural disaster occurrence such as drought: <b>Madikiza</b></li> <li>● Benefits of action learning on water management practices will have at the Institution include saving water and therefore costs attached to water: <b>Madikiza</b></li> <li>● The water management at Fort Cox Institution is not good at all since they have stopped the utilisation of the water from the Amatole water and purify their water from the nearby river: <b>Vele</b></li> <li>● The only challenge is the limited resources where you would find that the farm wants to use a tractor whilst we also intended on using it parallel to them: <b>Landzela</b></li> <li>● The Finance department of the Institute is also assisting where necessary so support and other support staff members in general are also supporting these programs even in designing these students projects like for example rainwater harvesting. We do not have a problem when it comes to support from other staff: <b>Landzela</b></li> </ul>
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<ul style="list-style-type: none"> <li>● You will find out that each and every day from Monday to Wednesday, we have practical sessions from 08:00am until 10:00am. So I can confidently say, yes it is administered in a right way as far as the curriculum is concerned and as far as our education is concerned: <b>Landzela</b></li> <li>● I am involved in teaching and learning in sustainable water management as I have mentioned that we offer some projects to students so some of the topics that students are to deal with sustainability agriculture especially water management: <b>Landzela</b></li> <li>● Things like where students compare mulched fields with un-mulched fields in terms of water conservation and weed control. So we do have such projects that deal with water management. We are also involved in grey water harvesting practices: <b>Landzela</b></li> </ul>	
<p><b><i>Analysis of the doings findings</i></b>  <i>An important finding from Matambo interview on the doings was that, teaching and learning through practice at Fort Cox covers few water management practices such as greywater harvesting, rainwater harvesting, trench beds, mulching and diversion farrows which are constructed by students guided by lecturers. In addition to this regard, Matambo reveals that Fort Cox students' learning is practical based more than theory and academics make use of every opportunity available that will increase students' competencies on water management and curriculum practices.</i></p> <p><i>This interview regarding the doings with Madikiza has found that the students are quietly involved in a number of water management and curriculum practices and community outreach engagement programmes. This includes water management and curriculum practices such</i></p>	<p><b><i>Analysis of material-economic arrangements findings</i></b>  <i>A key finding from Matambo interview on the material-economic arrangements was that Fort Cox is fortunate to have situated on the peripheral zone of Keiskamma river on the foot of Amatole mountains. With the climate change effect taking its toll on us, Fort Cox must take advantage of other sustainable water management practices for supplementing its curriculum activities. In addition the interview with Matambo finds that lack of physical resources and poor funding affects the curriculum practices in a negative way where sometimes temptations to give more theory than practicals are profound. It was also discovered that through investing in high technological and refined irrigation techniques, water management practices will be efficient and reliable.</i></p> <p><i>A key finding regarding the material-economic arrangements from this interview with Madikiza was a strong mention of lack of resources</i></p>

<p><i>as mulching, trench beds and drip irrigation. In addition, <b>Madikiza</b> reveals that teaching and learning is facilitated through case studies, field demonstrations and visits. A key finding regarding the doings from the interview with <b>Vele</b> was, respective lectures are including sustainable water management topics to complement the gap left by the stated curriculum during teaching and learning. This topics includes: environmental legislations designed to protect water and catchment areas within the forestry context.</i></p> <p><i>A key finding of the doings from the interview with <b>Landzela</b> was, there is still a lot to be done on water management practicals but so far there is some progress or effort made to improve some water management and curriculum practices. For example rainwater and grey water harvesting, comparison of mulch and un-mulched plots practices and weed management. This interview with <b>Landzela</b> also discovered that Fort Cox is the right space for students to do the actual farm work hands-on with academics and field technician supervision.</i></p>	<p><i>required to supplement water management and curriculum practices. These resources include availability of physical materials such as tanks, pipes to determine the curriculum set objective and possible saves water.</i></p> <p><i>A key finding from material-economic arrangements from the interview with <b>Vele</b> was, the current water management and curriculum practices, and water quality at Fort Cox is undesirable.</i></p> <p><i>A key finding of material-economic arrangements from the interview with <b>Landzela</b> was, lack of resources remains a challenge whereby there is limited equipment needed for water management and curriculum practices, for example is shortage of tractors to work land and for practicals. In addition, the finance department is doing its best to support ideas and some water management and curriculum practices.</i></p>
<p><b>Relatings</b></p> <ul style="list-style-type: none"> <li>● The practical component is lacking very widely for some reasons we do not have relevant platforms and structures that ensure that we can deliver practical's in that direction adequately but you may find that as you work with communities that are practicing some rain water harvesting practices we can take our students to practicals to see what they are doing: <b>Matambo</b></li> <li>● There is significant support that we are getting from various sections within the Institute so where there is opportunity for integration of courses we make use of those opportunities: <b>Matambo</b></li> </ul>	<p><b>Social-political arrangements</b></p> <ul style="list-style-type: none"> <li>● For students to show interest you have raised that interest yourself as a lecturer because most of the students do not even know what sustainability is, they do not have the awareness, so if you arouse interest and present it in such a way that they can develop the interest then that would be the starting point. Make them understand the concept then the will show interest: <b>Matambo</b></li> <li>● Sustainable water management topics or strategies not aggressively implemented especially in terms of sensitising Fort Cox community to save water: <b>Madikiza</b></li> <li>● Rain water is not harvested adequately because there buy-in from the management has been very little: <b>Madikiza</b></li> </ul>

<ul style="list-style-type: none"> <li>● For students to show interest you have raised that interest yourself as a lecturer because most of the students do not even know what sustainability is, they do not have the awareness, so if you arouse interest and present it in such a way that they can develop the interest then that would be the starting point. Make them understand the concept then they will show interest: <b>Matambo</b></li> <li>● That would be the starting point. Then share the results of the research and also mobilize other academic sections to be part of this initiative. I will more interested on the outcomes of this study of which I believe this is huge topic with a PHD potential: <b>Matambo</b></li> <li>● Opportunities like taking students out in communities to show them how other have done on the ground to demonstrate how we can also do it, but also in class you can bring in other teaching techniques like presenting pictures and videos to students so that they see these things being done in practice and that they will have a better understanding and a bit of motivation for them to implement the various practices: <b>Matambo</b></li> <li>● Seeing students I have taught progressing in their studies, successful at the workplace because tangible results of practical work e.g. when they produce agricultural products that are marketable: <b>Madikiza</b></li> <li>● Water management strategies are not aggressively implemented especially in terms of sensitising Fort Cox community to save water: <b>Madikiza</b></li> <li>● So far, there is effort in addressing water management through practices that collect and conserve water especially in crop production courses: <b>Madikiza</b></li> </ul>	<ul style="list-style-type: none"> <li>● Make an aggressive approach to water management through posters, awareness and also solicit a buy-in from the management so that resources are allocated towards water management practices: <b>Madikiza</b></li> <li>● The students are interested in sustainable topics although sometimes there is some resistance especially that some of the water management practices are labour intensive and time consuming especially at the initial stages of establishment: <b>Madikiza</b></li> <li>● The response of other support staff to water management and curriculum practices is positive, it just need integrative approach so that staff do not tackle water management practices in isolation: <b>Madikiza</b></li> <li>● I like interacting with the students in class and also check their personal interaction socially: <b>Vele</b></li> <li>● You make sure that the students with the knowledge they have gained in class will be able to do action learning by themselves in the form of working in groups: <b>Vele</b></li> <li>● There is a need for the institution to do the focus interviews with the community within Fort Cox and then try to get the inputs from the community and see a way to address them: <b>Vele</b></li> <li>● Other support staff are less interested to water management and curriculum practice ideas: <b>Vele</b></li> <li>● The community should utilize the water with caution and will be able to use it sparingly: <b>Vele</b></li> <li>● Students does much of the work and can gather as much information as possible as it gives students the chance to experience a lot of things and of course with guidance from the lecturer but the student does a lot of work in this space of teaching and learning approach: <b>Landzela</b></li> <li>● There are however challenges in between, out of those challenges we do meet half way with</li> </ul>
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<ul style="list-style-type: none"> <li>● The staff response to sustainable water management topics is very slow and little: <b>Madikiza</b></li> <li>● The students are interested in sustainable water management topics although sometimes there is some resistance especially that some of the water management practices are labour intensive and time consuming especially at the initial stages of establishment: <b>Madikiza</b></li> <li>● The response of other support staff to water management and curriculum practices is positive, it just need integrative approach so that staff do not tackle water management practices in isolation: <b>Madikiza</b></li> <li>● Most of the practicals require close supervision. Due to work overload, close supervision does not happen and Fort Cox does not have enough technicians to take up the load. One technician the whole department is not enough: <b>Madikiza</b></li> <li>● I like interacting with the students in class and also check their personal interaction socially: <b>Vele</b></li> <li>● There is a need for the institution to do the focus interviews with the community within Fort Cox and then try to get the inputs from the community and see a way to address them: <b>Vele</b></li> <li>● Some are trying by all means to ensure that the students have some knowledge on the water management issues: <b>Vele</b></li> <li>● They are having a passion and zeal to know more on the water management: <b>Vele</b></li> <li>● Water management do not have to be tampered with without taking health risk issues and water needs to be conserved since is a scarce resource: <b>Vele</b></li> <li>● It is a very nice experience watching crops grow otherwise you become unhappy once you see that there is</li> </ul>	<p>each other because we prioritize the students more than the farm because we take the farm as the lab for students to learn: <b>Landzela</b></p> <ul style="list-style-type: none"> <li>● We interact in whatever we are doing here as I have mentioned that there are grey water plots, grey water harvesting that we are all involved in as staff members in all the departments at Fort Cox: <b>Landzela</b></li> <li>● We are going to start a new program maybe next year on Engineering. Engineering is another course that also deals with water management, so if this information can be available in time for such courses it will be nice: <b>Landzela</b></li> <li>● We are a team here, we do not have situations whereby you will find someone doing his or her own thing at that corner and the other one doing his or hers at the other corner: <b>Landzela</b></li> </ul>
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<p>something that is not well with your crops: <b>Landzela</b></p> <ul style="list-style-type: none"> <li>● The practical is sufficiently satisfactory and its delivery mode too. I mentioned that, around that space of water management there is still a lot to be done there: <b>Landzela</b></li> <li>● When challenges arises, we do meet half way with each other because we prioritize the students more than the farm because we take the farm as the lab for students to learn: <b>Landzela</b></li> <li>● We are a team here, we do not have situations whereby you will find someone doing his or her own thing at that corner and the other one doing his or hers at the other corner: <b>Landzela</b></li> <li>● Some of the students are forming part of the workshops that we offer here and some of the students are sent to learn other things with our strategic partners, e.g. we have a network collaboration which is called Invoto Bubomi Learning Network, so in that network students are encouraged to be part of it since it is relevant to our curriculum and water management practices: <b>Landzela</b></li> <li>● Other support staff members in general are also supporting these programs even in designing these student projects like for example rainwater harvesting. We do not have a problem when it comes to support from other staff except few who won't necessary impact our practice: <b>Landzela</b></li> </ul>	
<p><b><i>Analysis of the relatings findings</i></b>  <i>A key finding of this interview with Matambo regarding the relatings was that there is still a lot more to do regarding practicals of students within the campus related to water management practices. Nonetheless, with the partnerships and relations Fort Cox has with surrounding communities and private farms, some of the practices which are not available</i></p>	<p><b><i>Analysis of socio-political arrangements findings</i></b>  <i>A key finding of this interview with Matambo regarding the social-political arrangements was that, as a country we shall be more cautious and act decisively on current water management related challenges as we are becoming more vulnerable to droughts and other water concerns for agriculture development. In addition, this</i></p>

at Fort Cox can be performed at those areas of focus respectively. Another finding was that support staff is vital in all curriculum practices through their respective participation. In addition, self-interest is key in a water management practice, when a lecturer facilitate some practical task with enthusiasm in a certain curriculum practice; it positively impact on the students' interest and stimulate hard work: **Matambo**

A key finding regarding the relatings from this interview with **Madikiza** was that the success of students after Fort Cox is our main priority and it is satisfactory to see them prosper in their respective careers. Therefore **Madikiza** suggests that there is a need for an aggressive approach towards sustainable water management of Fort Cox though through curriculum practice to address current water management and curriculum practices encounters. Another key finding from **Madikiza** regarding the relatings was that other students are also cooperative to learn more on water management topics and do labour intensive work. In contrast, other students are resistant to work during practicals.

A key finding regarding the relatings from this interview with **Vele** was, students are passionate and willing to learn more on sustainable water management and curriculum practices. In addition, **Vele** also revealed that lecturers are helping to supplement knowledge required on best water management practices in their respective teaching and learning context.

This interview regarding the relatings with **Landzela** finds that student's practice is conducted in the manner that is satisfying at Fort Cox though sometimes challenges arise

study can benefit Fort Cox curriculum and water management practices if the outcomes are shared to the affected practices. Another finding from **Matambo's** interview was that there is poor students' interest and willingness to work towards some of the sustainable water management and curriculum practices which may be the result of current teaching and learning strategies.

A key finding from this interview regarding the social-political arrangements with **Madikiza** was that there are not enough sustainable water management strategies to be understood by everyone as living principles of the Fort Cox community. Another finding from **Madikiza** was that there are water management and curriculum practices that are labour intensive and physically demanding which are relevant in the agriculture curriculum context, but through experience, not every student is willing to undergo a labour intensive learning system.

This interview with **Vele** regarding the social-political arrangements finds that continuous interaction with students and allowing them to take charge of their lessons works better to establish their knowledge weakness and strength. This interview with **Vele** also finds that not everyone at Fort Cox is passionate and interested in sustainable water management and curriculum practices.

A key finding of socio-political arrangements from this interview with **Landzela** was, the relationship between students, academics and support staff is satisfactory to support curriculum and water management activity practices. **Landzela** also reveals that, even though challenges arise they are overwhelmed to address the challenges at hand with the aim to deliver a common goal of teaching and learning. There is a working relation between academics

*but lectures do meet each other halfway to address the challenges at hand with the aim to deliver a common goal of teaching and learning because they work as one team. **Landzela** further revealed that, to achieve the above it is possible because there is working solidarity with other support staff involved in water management and curriculum practices and procurement processes. A good example is, students' experimental projects which require financial support and the finance department is helping to purchase the necessary materials required.*

*and other support staff especially where the practices are overlapping to each one's needs.*

**Appendix C: Analytical memo 3: Animal Production Club and Crop Production Club interviews**

<p><b>An Interview involving Animal production club and Crop production club students' members on the sustainable focus of water management and curriculum practices of Fort Cox Agriculture and Forestry Training Institute as informed by Kemmis (2009) Practice Architectures Theory model.</b></p>	
<p>Three Animal club students who participated in this interview: Khanyisa, Tabisa and Thabethe Five Crop production club students who participated in this interview were: Mabelies Audrey, Deliwe Khanyisa, Mrubata Siphenkosi, Mdakane Xhanti and Mfithelo Ntisana.</p>	
<p><i>LEVEL 1 ANALYSIS: What are the sayings, doings and relatings of students at Fort Cox on sustainable water management on the campus and in the curriculum?</i></p>	<p><i>LEVEL 2 ANALYSIS: What are the associated arrangements and conditions that enable or constrain sustainable water management and associated curriculum practices?</i></p>
<p>Sayings</p> <ul style="list-style-type: none"> <li>● Water is one the most important aspects in animal production or in agriculture. Without water there is no survival in animals. Water plays an important part in digestion and also in an animal's body temperature. Yes; water is a strong pillar. Without water there will be high mortality in our production: Khanyisa</li> <li>● Some of the courses do complement and some were not mentioning water management at all: Thabete</li> <li>● We are taught about vaccination and at the farm we were able to vaccinate livestock's ourselves successfully: Thabete</li> <li>● Climate change is the most impactful factor in farming. Change in the climate causes disruption in production. On hot days we are faced with a higher mortality rate than normal</li> </ul>	<p>Cultural-discursive arrangements</p> <ul style="list-style-type: none"> <li>● Animal club is student run entity and it is meant for developing skills and knowledge for students and build their experience so that they can be hands on and understand the production systems better on their own: Thabete</li> <li>● The farm staff lack modern knowledge which we were taught in the class: Khanyisa</li> <li>● If this water with pig waste can be used in a good way, it can make a lot of difference because back from our homes we normally use pig-waste as fertilisers to our crops: Khanyisa</li> <li>● Most of the farm staff uses outdated knowledge to manage and raised livestock, and they do not use so much of advanced and current knowledge</li> </ul>

<p>summer days. Climate change impact negatively in our production: Tabisa</p> <ul style="list-style-type: none"> <li>● In hot days like 40 degree Celsius and above, we experience high mortality of chickens in short period of time: Thabete</li> <li>● Curriculum doesn't go deep into water management but we learn that water is very important in animal production: Thabete</li> </ul>	<p>available in the stated curriculum: Tabisa</p>
<p><i>Analysis of the sayings findings</i></p> <p><i>A key finding regarding the sayings from this interview was that water is a strong pillar and an important resource for running a successful animal production enterprise. Water should be valued and managed accordingly to avoid mortality of livestock: Khanyisa. In addition, another finding was animal production courses are silent on water management topics, however there is a bit of mention of water management in some courses. For example, students are taught vaccination procedures and water comes out very strong since the vaccines themselves require water mixture to be effective: Thabete. Another finding was a mention of climate change impact on animal production which negatively affects broiler production due to high mortality rate in very hot days: Tabisa. Thabete echoes the same sentiments with Tabisa, where he mentioned that in some days, temperature can rise to above 40 degree Celsius which is the reason for the unprecedented mortality rate.</i></p>	<p><i>Analysis of cultural-discursive arrangements findings</i></p> <p><i>A key finding of cultural-discursive arrangements was that, Animal club is a student run club and it is established to self-taught skills and gather knowledge on the animal production related enterprises and further give awareness to the communities in need: Thabete. Another finding was that, the farm staff do not have the current knowledge in animal production and water management requirements in line with the taught curriculum: Tabisa</i></p>
<p>Doings</p> <ul style="list-style-type: none"> <li>● In the Animal club, we raised chicks and piglets under intensive production systems. The club is meant to educate students and gain more</li> </ul>	<p>Material-economic arrangements</p> <ul style="list-style-type: none"> <li>● We get our waters from the taps that are here at school: Thabete</li> </ul>

<p>experience through self-management of enterprises using knowledge they get from fort cox stated curriculum: Tabisa</p> <ul style="list-style-type: none"> <li>● We use water for hygiene purpose and also we control the internal and external diseases by supplying vaccination made up of water and chemicals for livestock: Tabisa</li> <li>● We are taught about vaccination and at the farm we were able to vaccinate livestock's ourselves successfully: Thabete</li> <li>● We had to use water tanks that they were using at the farm. When water tanks were empty, even the reservoirs, we used water from the nearby pond which we fetch using water containers: Tabisa</li> <li>● We have learned that water storage is very important. We even learn bad and good lessons, losing the chicks was a bad lesson because of lack of water. But good lessons came out, we learned that on hot days, more water is needed or used by livestock. We learn the importance of water to our enterprises: Tabisa</li> <li>● We used college transport and we collected water using water containers. In the piggery, water it helped so much in cleaning and feeding procedure: Thabete</li> <li>● When it comes to dairy, piggery, we use a lot of water: Tabisa</li> <li>● After finishing cleaning and using this water at the piggery, they flow and fertilise the grass to become green. But there is no place where we can take this water to, so that we can reuse water again: Tabisa</li> </ul>	<ul style="list-style-type: none"> <li>● Water is one the most important aspects in animal production or in agriculture. Without water there is no survival in animals. Water plays an important part in digestion and also in an animal's body temperature. Yes; water is a strong pillar. Without water there will be high mortality in our production: Khanyisa</li> <li>● We use water for hygiene purpose and also we control the internal and external diseases by supplying vaccination made up of water and chemicals for livestock: Khanyisa</li> <li>● We had to use water tanks that they were using at the farm. When water tanks were empty, even the reservoirs, we used water from the nearby pond which we fetch using water containers: Thabete</li> <li>● If this water with pig waste can be used in a good way, it can make a lot of difference because back from our homes we normally use pig-waste as fertilisers to our crops: Khanyisa</li> <li>● This water from the piggery makes our soil fertile and we can re-use it for irrigation and for recycling for another enterprise: Khanyisa</li> <li>● Enough water must be considered for cleaning and drinking of our animals. They require a lot of water. Water it is a need and a must have: Khanyisa</li> </ul>
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	<ul style="list-style-type: none"> <li>● We should have water reserves and store water and the farm can provide water storage tanks: Thabete</li> <li>● The College should educate students on how to manage water efficiently in order to save and cut costs of water: Khanyisa</li> <li>● I don't understand why we do not have tanks because when we vaccinate we do not use tap water instead we collect water from the river: Khanyisa</li> </ul>
<p><i>Analysis of the doings findings</i></p> <p><i>A key finding regarding the doings from this interview was, water is highly used at animal production enterprises for hygiene purposes and for vaccination mixing since some of the vaccines require water content for their effectiveness: Tabisa. Thabete added that these vaccination procedures are demonstrated by lecturers and technicians and students have to practice the similar procedures on their own under these enterprises administered by the Animal club. Another key finding from the doings was, Animal club members are daily involved in managing their own enterprises of which during the days where there is no water, it is upon their responsibility to improvise water from the nearby Keiskamma river to supplement the livestock and perform other hygiene procedures such as cleaning: Thabete and Tabisa</i></p>	<p><i>Analysis of the material-economic arrangements findings</i></p> <p><i>A key finding regarding material-economic arrangements from this interview was that, Water is key and regarded as the basic animal production resource which in its absence, no agriculture will happen because it helps in regulation of body temperature and digestion (metabolism) of livestock: Khanyisa. In addition, water is also critical for hygiene of farm enterprises and other disease control measures such as vaccination in any animal farm management: Thabete and Tabisa. Another key finding was related to waste water which can be recycled and reused in other agriculture enterprises: Khanyisa. Thabete and Khanyisa added that, they need water storage tanks to store water for utilization during times of water crises</i></p>

<p>Relatings</p> <ul style="list-style-type: none"> <li>● Fort Cox staff support us a lot when it comes to handling the farming systems. They provide us with information. Example; they show us how to vaccinate, schedule for feeding and their input is highly appreciated by us because without their input the production would have gone down without success: Tabisa</li> <li>● In the first semester, there were no water problems. But in the second semester the water problems escalates to the worse and the water is dirty: Tabisa</li> <li>● Lack of water is bad for farm management: Thabete</li> <li>● The College should educate students on how to manage water efficiently in order to save and cut costs of water: Khanyisa</li> <li>● To establish a successful agriculture enterprise, one must first check the environmental condition you are living under and the resources that you have if they are enough to carry on with these activity practices. Also the availability of water is important. Is water going to last your activity practice forever, if not what other alternatives do I have going forward: Tabisa</li> <li>● After finishing cleaning and using this water at the piggery, they flow and fertilise the grass to become green. But there is no place where we can take this water to, so that we can reuse water again: Tabisa</li> </ul>	<p>Social-political arrangements</p> <ul style="list-style-type: none"> <li>● Fort Cox staff support the Animal club when it comes to handling of the farming systems. They provide us with information. Example; they show us how to vaccinate, schedule for feeding and their input is highly appreciated by us because without their input the production would have gone down without success: Tabisa</li> <li>● The water in the college is a crisis. At some point we had to spend a week without water and we had a high mortality rate in our enterprise. And the quality of water is very poor and it is also affecting the health of students: Tabisa</li> <li>● The problem started when the college moves to purify its own water itself because last year (2018), we didn't have poor quality of water: Khanyisa</li> <li>● The College should educate students on how to manage water efficiently in order to save and cut costs of water: Khanyisa</li> </ul>
<p><i>Analysis of the relatings findings</i></p>	<p><i>Analysis of social-political arrangements findings</i></p>

<p><i>Regarding the relatings, a key finding from this interview was that the support staff, academics involved with water management curriculum practices, farm employees and technicians are very helpful to give guidance and information necessary to the Animal club when required: Tabisa. Another key finding from this interview was that, the surrounding environment plays a vital role in making informed decisions regarding what challenges and opportunities surrounding water availability are presented in the specific agriculture context: Tabisa</i></p>	<p><i>An important finding regarding the social-political arrangements findings was, there is a good relationship between Fort Cox supporting staff and Animal club members where information and resources required are furnished when needed: Tabisa. Another finding from this interview was the poor quality of water at Fort Cox which began since Fort Cox changed from Amatole waters to its own bulk water supply system, which is negatively affecting both agriculture at the farm and human livelihoods: Khanyisa and Tabisa.</i></p>
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*Appendix D: Analytical memo 4: Field technician’s USAT questionnaires*

<p><b>Field technician’s knowledge of sustainable focus on water management and curriculum practices of Fort Cox Agriculture and Forestry Training Institute as informed by Kemmis (2009) Practice Architectures Theory model.</b></p>	
<p>Three field technicians participated in the USAT through anonymity questionnaire: FTQ1, FTQ2 and FTQ3</p>	
<p><b>LEVEL 1 ANALYSIS:</b> <i>What are the sayings, doings and relatings of field technicians’ staff at Fort Cox on sustainable water management on the campus and in the curriculum?</i></p>	<p><b>LEVEL 2 ANALYSIS:</b> <i>What are the associated arrangements and conditions that enable or constrain sustainable water management and associated curriculum practices?</i></p>
<p><b>Sayings</b></p> <ul style="list-style-type: none"> <li>● Water is a very scarce and limited resource. FTQ1</li> <li>● Introduction of an additional Water Conservation subject for all curriculums at Fort Cox. FTQ1</li> <li>● Climate change and the hydrological variability of water’s distribution and occurrence are natural driving forces that when combined with the pressures from economic growth and major population change, make the sustainable development of our water resources a challenge. FTQ3</li> <li>● Implementation of some rainwater harvesting techniques. FTQ2</li> <li>● Grey water is non-toxic and low sodium, salt and personal care products are required to protect vegetation when reusing grey water for irrigation. FTQ3</li> <li>● Leaking pipes significantly increase the vulnerability of pipelines to contamination, especially where the supply is intermittent or pressure fluctuation can lead to infiltration of contaminated water into the distribution system. FTQ3</li> </ul>	<p><b>Cultural-discursive arrangements</b></p> <ul style="list-style-type: none"> <li>● Knowledge sharing helps disseminate key information. FTQ1</li> <li>● Promote indigenous plants and other alternatives of rainwater harvesting to supplement irrigation. FTQ2</li> <li>● Fort Cox must include the concerns of sustaining water in the induction of new employees and students. FTQ3</li> <li>● Wastewater has value and it should not be wasted. The conservation of clean water depends on minimizing wastage from leaks and reducing unnecessary consumption. FTQ3</li> </ul>
<p><b>Analysis of the sayings findings</b>  <i>A key finding regarding the sayings stemming from this survey tool was that, climate change is a major threat to water resources across the world and this has a very deepening impact on</i></p>	<p><b>Analysis of cultural-discursive arrangements findings</b>  <i>A finding regarding the cultural-discursive arrangements stemming from this survey tool was that, knowledge sharing and</i></p>

<p><i>the livelihood of people and the economy: FTQ3 and FTQ3. In addition, another finding echoed by FTQ3 was that infrastructure breakdowns such as leaking water pipes contribute significantly to the collapse of the water system which is much needed for water management and curriculum practices.</i></p>	<p><i>information dissemination is key amongst Fort Cox community members to be equivalent with current sustainable water management practices: FTQ1</i></p>
<p><b>Doings:</b></p> <ul style="list-style-type: none"> <li>● Monitoring and maintenance of water infrastructure FTQ2</li> <li>● Collects water for supplementary use in agriculture and other water necessities. FTQ2</li> <li>● Teaching students on innovative ways of harvesting and saving water at an early stage will reduce the water wastage and they will go back to their hometowns and spread the knowledge, FTQ2</li> <li>● Conserves water and avoids erosion. FTQ2</li> <li>● Turn off your tap when you brush your teeth. FTQ3</li> <li>● Building water ponds, Harvesting water using tanks and Building dams FTQ3</li> <li>● Before using grey water, primary treatment, secondary treatment (Biological Oxidation or disinfection) and tertiary treatment (Chemical coagulation, filtration, or disinfection) must be followed before using grey water. FTQ3</li> <li>● Then implement the techniques of using grey water. FTQ3</li> <li>● Install the tanks to harvest water from the rain. FTQ3</li> <li>● This practice will conserve the water demand in the institution because we can use grey water for Agriculture, Landscape, toilet flushing, sport grounds, construction activities, concrete mixing</li> </ul>	<p><b>Material-economic arrangements</b></p> <ul style="list-style-type: none"> <li>● Allocated residential areas with monthly or weekly quotas for use. FTQ1</li> <li>● Put up water tanks, the gutterings are already there, it's only a matter of directing them to the water tanks and there's a steady water supply. FTQ1</li> <li>● Saves water and costs attached to water tariffs. FTQ2</li> <li>● Groundwater resources could provide a valuable contribution to overcoming climate variability and meeting demands during extended dry periods. A surplus of surface water runoff during wet periods can be used to replenish the acquirer system. Capturing rain at the source through rainwater harvesting. FTQ3</li> <li>● Build the storage dam for grey water. There must be some septic tanks for grey water harvesting. FTQ3</li> <li>● Installation of individual water use meters in all properties is an important strategy to encourage consumers to repair leaks promptly and to avoid excessive use of water. FTQ3</li> <li>● Developing the maintenance section, budgeting for infrastructure maintenance, and the institution must assist the maintenance section with financial resources. FTQ3</li> <li>● Conduct regular water audits. FTQ3</li> </ul>
<p><b><i>Analysis of the doings findings</i></b>  <i>According to FTQ1 and FTQ3, recycling of wastewater and greywater will help save water for other agricultural practices such as irrigation, construction, and flushing. Fort Cox</i></p>	<p><b><i>Analysis of material-economic arrangements findings</i></b>  <i>FTQ1 suggests allocation of monthly quotas to all residents to reduce water wastage will be important to save cost attached. This was</i></p>

<p><i>must invest in fixing damaged infrastructure and develop an early detection system for possible leakages and damages, FTQ1 and FTQ2. Rainwater harvesting will also help supplement needy agriculture necessities during the dry season through mulching and building water storage ponds and investing in storage tanks, FTQ2 and FTQ3. Through teaching and awareness of innovative means of sustainable water management, this will help save and protect little water available for maximum benefits. FTQ3 suggests turning off the tap principle when brushing teeth.</i></p>	<p><i>supported by FTQ2, who suggest that the system will help reduce water tariffs. This can be done by allocating storage tanks per house and for rainwater collection purposes. FTQ3 argues that regular water audits are very important to track the usage amount of water per time allocated of which water meters can be used to manage water usage, FTQ2 and FTQ3. Building capacity in the maintenance and allocating adequate resources will help address water infrastructure challenges speedily and increase efficiency, FTQ3.</i></p>
<p><b>Relatings</b></p> <ul style="list-style-type: none"> <li>● Fort Cox is situated in a drought prone area. FTQ1</li> <li>● With global warming and the change in climate there's a need for innovative ways of saving water. FTQ2</li> <li>● Draw long term and short term plans for maintenance. FTQ1</li> <li>● Start introducing awareness campaigns to improve the sustainable use and management of water. FTQ1</li> <li>● Reduce the negative impacts on the environment. FTQ1</li> <li>● Relevant training. FTQ2</li> <li>● Reporting and monitoring of infrastructure. FTQ2</li> <li>● Awareness and responsibility. FTQ2</li> <li>● Conserves water and avoids erosion and water pollution. FTQ2</li> <li>● Sharing of required information. FTQ2</li> <li>● The maintenance department will therefore maintain a continuous programme of inspection and preventive maintenance to discover and stop leakage for both financial and health reasons. FTQ3</li> <li>● Development of awareness posters and flyers around the institution And development of water harvesting policy. FTQ3</li> </ul>	<p><b>Social-political arrangements</b></p> <ul style="list-style-type: none"> <li>● Allow for the ease of accessing water within the institution. FTQ1</li> <li>● A workshop on how to recycle, reserve and manage water will be a great deal of help. FTQ2</li> <li>● Infrastructure maintenance, community outreach and awareness campaigns FTQ2</li> <li>● Organising awareness campaigns in the institution and surrounding areas. FTQ3</li> <li>● Educating more people especial from the supporting staff in other departments: FTQ3</li> </ul>

<ul style="list-style-type: none"> <li>● Building water conservation awareness and education among employees and students cannot only save water can also save money on operational and production costs. FTQ3</li> </ul>	
<p><b><i>Analysis of the relatings findings</i></b>  <i>A key finding from the relatings stemming from this survey tool was that Fort Cox is situated in a drought prone region of the Eastern Cape where water for agriculture and basic needs can be very challenging: <b>FTQ1</b>. This survey also finds that there is a lack of capacity building programmes, awareness and information sharing on relevant much needed water management curriculum practices: <b>FTQ1, FTQ2 and FTQ3</b>.</i></p>	<p><b><i>Analysis of social-political arrangements findings</i></b>  <i>A key finding from this survey tool regarding the social-political arrangements was that, investing on educational training and awareness is important to capacitate the community: <b>FTQ2 and FTQ3</b></i></p>

*Appendix E: Analytical memo 5: Student's USAT questionnaires*

<b>The students' knowledge of the sustainable focus on water management of Fort Cox Agriculture and Forestry Training Institute and in the curriculum practices as informed by Kemmis (2009) Practice Architectures Theory model.</b>	
<i><b>LEVEL 1 ANALYSIS:</b> What are the sayings, doings and relatings of students at Fort Cox on sustainable water management on the campus and in the curriculum?</i>	<i><b>LEVEL 2 ANALYSIS:</b> What are the associated arrangements and conditions that enable or constrain sustainable water management and associated curriculum practices?</i>
<p><b>Sayings</b></p> <ul style="list-style-type: none"> <li>● Animal's production should also be involved because water is an essential resource for animals. SQ1</li> <li>● Forestry students have a module which focuses on soil and water conservation. SQ2, SQ6, SQ13, SQ14, SQ15</li> <li>● Students are learning about how to conserve water, what are good strategies to use water. SQ5. SQ12</li> <li>● Agroforestry helps to conserve and protect the natural resources. SQ7</li> </ul>	<p><b>Cultural-discursive arrangements</b></p> <ul style="list-style-type: none"> <li>● Students have ideas but they do not put them into practice due to lack of courage or motivation. SQ1</li> <li>● There is a lack of knowledge and rules to control water at student residence. SQ3</li> <li>● Students have plenty of ideas but do not put them into practice because of lack of funds and resources and motivation from the top management. SQ3</li> <li>● Some students are willing to participate but some are not willing and there is some great interest and responsibility. SQ16</li> </ul>
<p><i><b>Summary of the sayings</b></i></p> <p><i>SQ1 feels that Animal production students should also be taught water management subjects because water is the fundamental resource for any animal wellbeing. SQ2 et al, confirms that forestry curriculums have a course which covers soil and water conservation topics. According to SQ5 and SQ12, there are some lessons on water conservation techniques in the current stated curriculum. In addition, SQ7 argues that subjects like agroforestry caters for water conservation techniques and helps protect other natural resources.</i></p>	<p><i><b>Summary of CDAs</b></i></p> <p><i>SQ1 and SQ3 argue that students have ideas on sustainable water management practices but there is no financial support and inspiration. Poor knowledge on sustainable water management techniques, lack of rules, and control measures in the residence, SQ3. There is a willingness to participate in sustainable water management activity practice by the majority of students, SQ16.</i></p>
<p><b>Doings:</b></p> <ul style="list-style-type: none"> <li>● Washing laundry and showering. There is a high water wastage due to unrestricted water usage. SQ1, SQ5, SQ6, SQ11</li> </ul>	<p><b>Material-economic arrangements</b></p> <ul style="list-style-type: none"> <li>● Students have plenty of ideas but do not put them into practice because of lack of funds and resources and motivation from the top management. SQ3</li> </ul>

<ul style="list-style-type: none"> <li>● The only career counselling is through the module soil and water conservation that only benefit the Crop production and Forestry students. SQ1, SQ7</li> <li>● Water is mostly used in the residences because of the laundry, showers are being used, and water is also used for cleaning the dust bins. There are no practices put in place for the conservation of water. SQ2, SQ4</li> <li>● There is little effort being made towards environmental education. There are one or two programmes that are done a year and they are not enough. SQ2</li> <li>● Crop production students have a society group where they engage in activities around the campus. SQ3</li> <li>● Misuse of water doing laundry and showering is common and no punishment. SQ3, SQ15</li> <li>● Students are learning about how to conserve water, what are good strategies to use water. SQ5</li> <li>● In the forestry department we have practical sessions which are based on the planting of trees and educating people about the value of the trees in our environment. SQ8</li> <li>● In the forestry department, students do learn about soil and Water conservation. SQ8</li> <li>● Decaying waste material utilised at Fort Cox nursery site, and non-decaying materials collected and disposed in specified areas. SQ9</li> <li>● Bush clearing of unwanted tree species invading areas used to be walking trails and dams. SQ9</li> <li>● Creation of farrows so water has defined routes to the water catchments. SQ9</li> <li>● Seminar presentations organised for students concerning sustainable water and environment management. SQ9, SQ13</li> </ul>	<ul style="list-style-type: none"> <li>● There are farrows, gutters and drainage systems which direct rain and water from showers etc. to the rightful areas. SQ8, SQ9</li> <li>● There are water pipes on the roof that catch water and drive the water to underground pipes. SQ12</li> <li>● There is a new water source area around the school that is underway that will be able to supply water. SQ13</li> <li>● There is a computer centre and library to use if one seeks for information. SQ15, SQ16</li> </ul>
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<ul style="list-style-type: none"> <li>● Students were involved in building water ponds to save water for irrigating and also advocate water saving irrigation systems. SQ10</li> <li>● Students do leave taps leaking and they seem not caring about it. SQ10, SQ11</li> <li>● Water is used for cleaning the dust bins in the residents and also used for laundry, showers. SQ10</li> <li>● Students do farm structures that will help in saving water e.g.; farm ponds, farrows. SQ11</li> <li>● During practicals students do practices such as grey water collection for watering of veggies. SQ15</li> <li>● During practicals, there are activities and tasks that are given by lectures for water management. SQ16</li> </ul>	
<p><b>Summary of the Doings</b></p> <p><i>SQ1 et al describe the usage of water at residence by students as uncontrolled or unchecked practice which results in high wastage. This is through laundry and other domestic houses such as showering and cleaning. SQ10 and SQ11 argue that students leave the taps running in the residence and no one seems to care about water wastage. According to SQ1 and SQ7, students do receive career counselling on sustainable water management practices through a stated curriculum course called Soil and Water Conservation offered to Crop production and Forestry curriculum only. Environmental education content is poor and that compromises student knowledge in that context, SQ2. However, students' initiated clubs try to cover the gap on action learning and environmental education associated with good water management practices left by the taught curriculum, SQ3 and SQ5. Fortunately, forestry students are exposed to the practicals which covers environmental education and management of forest</i></p>	<p><b>Summary of the MEAs</b></p> <p><i>SQ3, argues that lack of financial support to some of their action learning activity practices demotivate them. According to SQ8 and SQ9, Fort Cox has existing furrows, gutters and storm water drainage systems which may be used to capture rainwater and grey water. Fort Cox has a newly built purification plant that will be servicing the Fort community with water from the Keiskamma River, SQ13. With the availability of library and computer centre, literature on sustainable water management practices can be sourced for Fort Cox water management and curriculum activity practices, SQ15 and SQ16.</i></p>

<p><i>resources including water, SQ8. Construction of water conservation during practicals is mostly practiced around the campus, that include, diversion of farrows, greywater harvesting, bush clearing of water consuming plants and building of rainwater catching ponds, SQ9, SQ10, SQ15. Lecturers are involved in giving advice and guidance to students during this curriculum activity practices through action learning, SQ16.</i></p>	
<p><b>Relatings</b></p> <ul style="list-style-type: none"> <li>● There are no awareness programmes based on water management. SQ1</li> <li>● There is no student group involvement. Mostly they are discouraged by the endless procedure of getting approvals. SQ1</li> <li>● There is no collaboration between students and management. SQ1</li> <li>● Students do not see themselves as self-responsible in environmental education rather they depend on the lecture’s task to show their willingness. SQ1</li> <li>● There are no orientation programmes on sustainable water management for students. There are no orientation programmes on sustainable water management for students. SQ2</li> <li>● There are no awareness programmes that are done within the college. SQ2</li> <li>● There are no management activities conducted independently by students in order to manage the sustainable use of water. SQ2</li> <li>● No support centre to deal with environmental issues at campus but we learn some of this knowledge in class through certain courses. SQ3.</li> <li>● There are no orientation programmes based on water management and only during certain courses we learn about water management. SQ3</li> </ul>	<p><b>Social political arrangements</b></p> <ul style="list-style-type: none"> <li>● There voluntary community servicers goes as far as soil and water conservation goes, after the module has been achieved no student shows interest at volunteering. SQ1</li> <li>●</li> <li>● Some they try to raise in meetings but other students ignore. SQ7</li> <li>● Students find it their responsibility to monitor the period of irrigations on their sports fields and also the removal of spreading of thorn plants in and around the environment. SQ9</li> <li>● Crop and forestry students do gather in groups for water management practices. SQ11</li> <li>● Students just waste water and are not aware of how to save water. SQ15</li> <li>● There are clubs at school according to each faculty and also political organizations that help with environmental education. SQ16</li> <li>● There are activities that political organizations engage one but not as efficiently as they could be. SQ16</li> </ul>

<ul style="list-style-type: none"> <li>● Students are discouraged by long approvals and lack of information and passion for agriculture has a role to value in an environment and water management practices which are sustainable. SQ3</li> <li>● There are no other collaborations between students and management except during teaching and learning activities. SQ3</li> <li>● No water management is in place to guide them as to how the water should be used efficiently. SQ4</li> <li>● Without signs or notes that maintain water usage, it results in water wastage because there are no rules. SQ7</li> <li>● Educational trips emphasise on the importance of trees in our environments, and also on how water is managed sustainably. SQ9</li> <li>● They are done once a year and that doesn't make them effective because they are not efficient. SQ10</li> <li>● Students doing soil and water conservation might further learn more on water management. SQ12</li> <li>● Programs like Umvotho Bubomi are one of the programs that assist with water management. SQ16</li> <li>● Lectures and students don't only interact on these programs but as in academics whereby there are courses that we do as part of water management. SQ16</li> </ul>	
<p><b>Summary of the Relatings</b></p> <p><i>Fort Cox does not have documented awareness programmes of sustainable water management practices, SQ1. Sometimes students have initiatives but lack funding and support to demotivate them, mainly because of poor collaboration and long approval procedures within Fort Cox water management and curriculum activity practices, SQ1 and SQ3. In addition, SQ1 argues that students do not want to take self-responsibilities on sustainable water</i></p>	<p><b>Summary of the SPAs</b></p> <p><i>According to SQ1, students do volunteer community service support by the Soil and Water Management course to Fort Cox communities for awareness and advice on sustainable water management practices. There is no collaboration between management and students to support some of their action learning practices, SQ1. SQ2 argues poor awareness programmes on water management practices contributes to high water wastage at Fort Cox. Fort Cox</i></p>

*management practices but they rely on the lecturers for initiatives. SQ2 and SQ3 argue that students don't receive any sustainable water management and environmental education awareness and orientation in the campus. SQ2 argues that students don't have self-control measures of their own on water management practices at the residence and in the field of study. Lack of signage on sustainable water management and use is evident in the campus, SQ7. According to SQ16, students and lecturers participate in community outreach programmes and learning networks collaborated with Fort Cox such as Imvoto Bubomi Learning Network which assist them by sharing best available and innovative water management practice methods.*

*doesn't have an environmental education support centre to cater for sustainability topics, SQ3. There is an attempt to address some of the water management challenges through student meetings but not all students are interested, yet others make it their responsibility to push for good environmental knowledge practices, SQ7 and SQ9. Students' initiated clubs are supported by SRC and they play a vital role to inspire others on best agriculture practices, SQ16.*

**Appendix F: Field technicians' responses to the USAT**

Unit-based Sustainability  
 Assessment Tool for Fort Cox Institution water management and curriculum practices  
 Field technicians

<b>Assessment Criteria</b>			
<b>X</b>	<b>=</b>	<b>Don't know</b>	no information concerning the practice
<b>0</b>	<b>=</b>	<b>None</b>	there is total lack of evidence on the indicator
<b>1</b>	<b>=</b>	<b>A little</b>	evidence show poor performance
<b>2</b>	<b>=</b>	<b>Adequate</b>	evidence show regular performance
<b>3</b>	<b>=</b>	<b>Substantial</b>	evidence show good performance
<b>4</b>	<b>=</b>	<b>A great deal</b>	excellent performance
(Add a tick (√) for key project areas and where more information is needed)			

<b>FTQ</b>	<b>FTQ1</b>	<b>FTQ2</b>	<b>FTQ3</b>	<b>FTQ1</b>	<b>FTQ2</b>	<b>FTQ3</b>	<b>FTQ1</b>	<b>FTQ1</b>	<b>FTQ3</b>
<b>SWM</b>	X	0	0	√	√	X	√	√	X
<b>WRP</b>	X	1	0	√	√	X	√	√	X
<b>RDI</b>	X	3	2	√	√	X	√	√	X
<b>WWR</b>	X	1	1	√	√	X	√	√	X
<b>WST</b>	2	2	1	√	√	X	0	√	X
<b>WIM</b>	X	2	1	√	√	X	0	√	X
<b>RHA</b>	1	2	3	√	√	X	√	√	X
<b>WPR</b>	X	0	3	√	√	X	√	√	X
<b>ACP</b>	X	X	1	√	√	X	√	√	X
<b>LM</b>	X	0	2	√	√	X	√	√	X
<b>IESA</b>	X	2	1	√	√	X	√	√	X

<b>Fort Cox Water management activity practices (FCWMP)</b>
Field technician Questionnaire ( <b>FTQ: 1 – 3</b> )
Sustainable water management practices ( <b>SWM</b> )
Water recycling practices – grey water and waste water recycling ( <b>WRP</b> )
Repairing of damage and/or leaking infrastructure associated with water wastage <b>RDI</b>
Water wastage reduction practices <b>WWR</b>
Indoor water use standards and practices/water saving techniques <b>WST</b>
Water infrastructure maintenance ( <b>WIM</b> )
Rainwater harvesting activities/methods ( <b>RHA</b> )
Water pollution reduction practices ( <b>WPR</b> )
Awareness campaigns and outreach programs on sustainable water management ( <b>ACP</b> )
Landscaping maintenance (emphasizing native plants and reduce the use of chlorinated water for lawn maintenance) ( <b>LM</b> )
Integration of other operations into the educational and scholarly activities concerning sustainable water management practices of the Institution ( <b>IESA</b> )

**Appendix G: Frequency ratings of student's questionnaire using USAT**

Unit-based Sustainability  
Assessment Tool for Fort Cox Institution water management and curriculum practices involving students

<b>Assessment Criteria</b>			
Rate activities and opportunities in the water management, environment and sustainability area.			
X	=	Don't know	no information concerning the practice
0	=	None	there is total lack of evidence on the indicator
1	=	A little	evidence show poor performance
2	=	Adequate	evidence show regular performance
3	=	Substantial	evidence show good performance
4	=	A great deal	excellent performance
(Add a tick (√) for key areas and where more information is needed; briefly outline key activities in the area of sustainability)			

<b>WMO</b>	<b>Student ratings from 1 - 16</b>	<b>Student ratings from 1 - 16</b>	<b>Student ratings from 1 - 16</b>
<b>SAS</b>	3 3 2 3 3 3 3 3 3 3 2 3 3 3 2 3	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √
<b>SEK</b>	1 0 1 2 1 0 2 1 1 1 1 X 1 X 1 1	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √
<b>WMP</b>	1 0 1 1 1 0 0 3 2 2 1 2 3 0 1 0	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √
<b>OPS</b>	1 0 1 0 0 0 2 1 2 1 1 0 1 0 1 1	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √
<b>WMA</b>	1 1 1 1 2 1 1 1 0 0 0 0 1 0 2 1	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √
<b>CCO</b>	1 1 1 0 0 0 2 0 0 1 1 3 0 0 1 0	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √	X √ √ √ √ √ √ √ √ √ √ √ √ √ √ √

<b>VCS</b>	1 0 1 0 0 2 2 0 2 0 0 0 0 0 1 0	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
<b>SWM</b>	1 0 1 1 0 1 1 0 0 3 3 X 0 0 1 1	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
<b>ESM</b>	1 0 1 0 1 0 3 0 0 0 3 0 0 0 1 0	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
<b>SCM</b>	1 X 1 0 1 1 1 0 3 1 1 0 0 0 1 1	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
<b>ESS</b>	1 0 1 0 1 X 1 0 0 0 0 0 0 0 0 1	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	X ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓
<b>SEE</b>	1 X 1 - 1 X 3 1 1 0 1 X 1 1 1 1	X ✓ ✓ ✓ - ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	X ✓ ✓ ✓ - ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓

<b>Water management opportunities</b>	<b>WMO</b>
Student's academic societies or other Student Group(s) with an environmental education or sustainability emphasis	<b>SAS</b>
Student Environmental knowledge support centre	<b>SEK</b>
Water management practices in residences or dormitories by students (e.g. recycling)	<b>WMP</b>
Orientation program(s) on sustainable water management for students	<b>OPS</b>
Student environmental and sustainable water management awareness programmes	<b>WMA</b>
Career counselling focused on work opportunities related to Environmental Education and Sustainable water management topics	<b>CCO</b>
Voluntary community service by students related to sustainability issues and concerns	<b>VCS</b>
Involvement of student groups in the campus in sustainable water management initiatives	<b>SWM</b>
SRC involvement in environmental and sustainable water management initiatives	<b>ESM</b>
Student collaboration with management in the area of environmental and sustainable water management	<b>SCM</b>
Environmental and sustainable water management activities initiated by students themselves (independent of departments, lecturers, management etc.)	<b>ESS</b>
Students' willingness to take responsibility in the environmental education and sustainability space	<b>SEE</b>