EVALUATION OF WATER GOVERNANCE SYSTEMS FOR IMPROVED OPERATION OF SELECTED SMALL-HOLDER IRRIGATION SCHEMES IN NZHELELE AREA, SOUTH AFRICA

By

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DECLARATION

I, **Rudzani Nedombeloni**, hereby declare that this dissertation for Masters in Rural Development (MRDV) submitted to the Institute for Rural Development at the University of Venda has not been submitted previously for any degree at this or another university. It is original in design and in execution, and all reference material contained therein has been duly acknowledged.

Signature……  **……** **Date November 2022**

ABSTRACT

Throughout the world, small-holder irrigation schemes are viewed as a key strategy for increasing agricultural productivity, sustaining rural livelihoods, adapting to climate variability and change, and reducing poverty in rural areas. South Africa prioritises the establishment, rehabilitation and revitalization of small-holder irrigation schemes due to their potential in poverty reduction and enhancing food and nutrition security in rural areas. However, many of these irrigation schemes have failed to achieve their intended objectives for increasing agricultural productivity due to a slew of challenges including irrigation water governance. Therefore, the main objective of this study was to evaluate the existing water governance systems of selected irrigation schemes in Nzhelele area, South Africa. A survey-underpinned by sequential exploratory mixed methods research design was adopted. Twenty-four farmers were purposefully selected to participate in a qualitative study via face-to-face semi-structured interview guide. Correspondently, census sampling method was used to purposefully select 56 famers to collect quantitative data through a 5-point Likert-type scale questionnaire ranging from 1 (strongly disagree) to 5 (Strongly agree). Qualitative data was analysed using ATLAS.ti version 8.0 software to perform thematic content analysis. The IBM Statistical Package for the Social Science version 26.0 software was used to analyse quantitative data. Descriptive statistics was carried out to provide the general features of the data.

The findings of the study showed there were more female farmers than males on the studied schemes. Three quarter of the respondents were married. Moreover, half of the respondents in all the three schemes had acquired secondary education. The study further revealed that there were various water governance institutions within the schemes. These included scheme committee, Water Users Association, Informal water institutions, Department of Water Affairs, Cooperatives, Government Water Schemes, Irrigation Board and the traditional leadership. The results further revealed that farmers in selected irrigation schemes were faced with water governance related challenges which included ineffective irrigation water governance institutions, vandalizing of irrigation water infrastructure, blockage of main canals to disrupt the flow of irrigation water, lack of irrigation water due to unregistered farming, poor agricultural produce and poor adherence to irrigation schedule. In line with this, the study proposed imposing heavy fines, hiring an overseer, registering unregistered farmers, and accountability by those found guilty of vandalising as some of the strategies which can be used to address irrigation water governance challenges in the schemes. In addition, government institutions need to play their roles in irrigation

schemes. Farmers need to be made aware about rules, roles and responsibilities of government institutions. Furthermore, an understanding of the factors which determine the participation of women in farming should be explored.

Keywords: Institutions, irrigation, rural livelihoods, rules and regulations, small-holder irrigation scheme, water governance.

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Special thanks go to my parents, Mr Nedombeloni Thifhelimbilu Richard and Mrs Bila Elisa Tsakani for their endless and continuous familial support. To my siblings, and my daughter, Nghomani Muano Rhema, you remained my constant source of inspiration, strength, and commitment to completing this study.

DEDICATION

This study is dedicated to my daughter, Rhema Muano Nghomani, be inspired my girl.

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ABBREVIATIONS AND ACRONYMS

CMA	Catchment Management Agency
CPR	Common Pool Resource
DAFF	Department of Agriculture, Forestry and Fisheries
DWA	Department of water Affairs
DWAF	Department of Water Affairs and Forestry
ECSCC	Eastern Cape Socio Economic Consultative Council
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
IDP	Integrated Development Plan
IMT	Irrigation Management Transfer
NWA	National Water Act
RAL	Raliphaswa Irrigation Scheme
MAM	Mamuhohi Irrigation Scheme
MAN	Mandiwana Irrigation Scheme
PTO	Permission to Occupy
RESIS	Revitalisation of Small-holder Irrigation Schemes Programme
RSA	Republic of South Africa
SDGs	Sustainable Development Goals
SISs	Small-holder Irrigation Schemes
SPm	Strategic Partnership model

TWDB	Texas Water Development Board
WMIs	Water Management Institutions
WSSCC	Water Supply and Sanitation Collaborative Council
WUAs	Water Users Associations

CHAPTER 1: INTRODUCTION

1.1 Background

Globally, small-holder irrigation schemes are viewed as a key strategy for increasing agricultural production, sustaining rural livelihoods and reducing poverty in rural areas (Apata *et al*., 2020). For instance, it is believed that an increase in the number of small-holder irrigation schemes and the rehabilitation of existing schemes can assist in fighting rural poverty and ensuring food security (Mohammed, 2019). Moreover, optimum functioning of irrigation schemes has the ability to address issues such as hunger, malnutrition and unemployment. Mhembwe *et al.* (2019) assert that the potential for small-holder irrigation schemes to contribute to poverty reduction is hindered by their poor performance due to water unreliability. Moreover, water sufficiency is crucial in increasing agricultural production in irrigation schemes (Attia *et al.*, 2019). Dirwai *et al*. (2019) indicate that small-holder irrigation schemes are crafted and shaped to distribute water efficiently, adequately and equitably. However, Renault *et al*. (2007) indicate that water use in small-holder irrigation schemes in the sub-Saharan Africa has been reported to be below expectations especially in water governance, service to the farmers and cost effectiveness of infrastructure management. Therefore, governance is essential in addressing and transforming water challenges under the increasing pressure of competing water use and climate change (Özerol *et al.,* 2018).

Water governance has risen as an important concern in the international arena and is acknowledged to be associated with adequate and sustained progress towards achieving Sustainable Development Goal (SDG) 1 (End extreme poverty in all forms) and SDG 2 (End hunger, achieve food security and improve nutrition and promote sustainable Agriculture) (United Nations Development Programme (UNDP), 2016; Lindamood, 2018). According to Williams and Grafton (2019), water governance plays an important role in water allocation, water sharing and scheme maintenance. Water governance is defined as the social function that regulates development and management of water resources and provisions of water services at different levels of society and guides the resource towards a desirable state and away from what is undesired (Pahl-Wostl, 2015). Playan *et al*. (2018) argue that irrigation governance is key in strengthening scheme performance and has been emphasized in research and practice since the 1980s. Poussin *et al*. (2015) posit that effective and sustainable performance of irrigation

schemes is based on the effectiveness of governance and institutional arrangements of the schemes. Kajembe *et al.* (2016) affirm that a proper way of governing common pool resources, such as communal irrigation schemes, relies on the specific institutional arrangements that are in place. Akuriba *et al*. (2019) indicate that governance entails the use of rules and regulations to ensure sustainable and effective use of common-pool resources. Akuriba *et al*. (2020) and Apata *et al.* (2020) further assert that these rules and regulations are aimed at fulfilling different dimensions of governance, such as accountability, participation, and transparency and cooperation in the management of resources. Smallholder irrigation schemes are common-pool community resources.

In Africa, particularly in the sub-Saharan African countries, the main objective for the establishment of small-holder irrigation schemes was to increase agricultural productivity thus enhancing food security and eradicating poverty (Mhembwe *et al*. 2019). In particular, smallholder irrigation schemes were meant to reduce dependency on unreliable rainfall patterns, characteristic of many marginal countries in Africa (Mapuranga & Muzerengi, 2017). The Food and Agricultural Organisation (FAO) indicates that irrigation is an essential strategy to alleviate poverty in sub-Saharan Africa, where 80% of people in rural areas depend on agriculture for livelihoods sustenance (FAO, 2010). The population in SSA is expected to increase by 100% in the next 30 years. Thus, smallholder irrigation schemes will be key to feed sub-Saharan Africa in 2050 without large imports (Van Ittersum *et al*., 2016) and extensification. Van Averbeke *et al.* (2011) assert that to optimize agricultural production, institutions governing irrigation water, scheme maintenance and water sharing are crucial. Bakker & Cook (2011) allude that improved water governance promotes responsible actions and measures to protect water resources for improved production. A study conducted by Dlamini (2013) on “The relationship between production performance and governance in small-holder irrigation schemes in Swaziland” revealed that poor irrigation management in the schemes hinders improved agricultural productivity.

Fisher & Paul (2013) reveal that Malawi is rated amongst the poorest and least developed countries in the Sub-Saharan countries and it is not in isolation in the issues of poor water governance for effective performance of irrigation schemes. The Malawian government and NGO/donor supported interventions to improve agricultural productivity in irrigation schemes such as Chitsukwa, Kayerekera and Tchanga, although, agricultural production has been stubbornly

low (Mdee & Harrison, 2019). The former scholars further allude that the issues affecting the efficacy of the irrigation schemes are primarily over grazing land and drinking water for livestock which makes it essential for rules and regulations to be in place over water usage.

South Africa, like other sub-Saharan countries, prioritises the development of irrigation due to its potential in poverty reduction and food nutrition security (Kephe *et al.* 2022). Hence, the South African government has invested a lot of funds to establish, revitalize and rehabilitate irrigation schemes with the intention that these schemes would be productive in achieving poverty reduction (Mujuru *et al*. 2022). However, many of these irrigation schemes have failed to achieve their intended objectives on agricultural production due to technical, institutional and organizational challenges (Fanadzo & Ncube, 2018). Van Averbeke (2012) argues that institutional problems influence the routine maintenance of irrigation infrastructure and water distribution. Maepa *et al*. (2014) claim that lack of maintenance and poor governance in irrigation schemes reduce water delivery, thus, pose a threat to the sustenance of irrigated agriculture in South Africa.

The Department of Agriculture, Forestry and Fisheries (DAFF) (2010) indicates that majority (180) of irrigation schemes in South Africa are in a rural-based province of Limpopo. Van koppen *et al*. (2017) revealed that irrigation schemes in Limpopo province are rife to poor water management, poor infrastructure and conflicts among farmers, hence affecting improved agricultural production. This is evident because 3.1 million people are prone to poverty and food insecurity within the province (Baiyegunhi *et al*., 2013). Similarly, a study of two small-holder irrigation schemes (SISs) in Eastern Cape and KwaZulu-Natal conducted by Mnkeni *et al*. (2010) reveals that farmer organisations and institutions governing water in were largely ineffective and failed to effectively deliver their responsibilities and this has negatively affected productivity and overall performance of the schemes. In 2002, about 126 irrigation schemes in Limpopo province underwent a process known as Limpopo RESIS (Revitalisation of Small-holder Irrigation Schemes) aiming to improve schemes utilisation, manage land conflicts, improve weak institutions and improve degraded infrastructure (Manona & Denison, 2006; Limpopo Department of Agriculture, 2002). Mudau (2010) asserts that eleven schemes in the Nzhelele area, including Mamuhohi, Mandiwana and Raliphaswa irrigation schemes, were identified again for the second phase of irrigation scheme revitalisation known as RESIS Recharge. However, these schemes are still facing constraints such as infrastructural constraints, poor scheme management and inadequate water for irrigation (Denison & Manona, 2007; Letsoalo & Van Averbeke, 2013 & Van koppen *et al*.,2017).

Kesuma *et al.* (2018) suggest that optimal irrigation performance might be the solution to provide additional food to the growing population requiring enough nutritious food but faced with severe resource shortage. This can be achieved by constantly reviewing, evaluating and monitoring the important parameters of a scheme, governance being one of them, and intervening where necessary. It is against this background that the study will be conducted to evaluate water governance systems for improved operation of Raliphaswa, Mamuhohi and Mandiwana irrigation schemes in Nzhelele area, South Africa.

1.2 Statement of the Research Problem

The South African government provides funding towards the establishment and rehabilitation of small-holder irrigation schemes. However, various problems and constraints which hinder the effective operation of such schemes still exist (Fanadzo & Ncube, 2018). Poor water management is a common practice which affects the efficacy of the schemes in terms of water sharing and scheme maintenance (Van Koppen *et al.*, 2017). This is worsened by the fact that rules and regulations governing irrigation water are disputed by farmers themselves. Hence, this raises conflicts and abuse among famers (Boutroue *et al*, 2022 & Muchara *et al*. 2022). Breaking of concrete canals and diverting irrigation water with sandbags and rocks have been a challenge in Nzhelele irrigation schemes (Mudau, 2010). Thus, farmers situated far from the dam are not irrigating their agricultural produce effectively. Van Koppen *et al*. (2017) further indicate that the irrigation schemes are moderately utilised and characterised with poor infrastructure and poor scheme management. The above arguments justify a call by Hassenforder & Barone (2018) to evaluate and modify the institutional framework. This can be achieved through a clear understanding of the dynamics of institutional change including the dynamics between individual choices, institutional design and noting issues that undermined improved access to, and management of water for rural livelihood improvement (Pache & Santos, 2010). Nonetheless, studies on governance of community irrigation schemes as common-pool resources in the developing countries is lacking (Ziem *et al*, 2022). This is also true for South Africa. Thus, this study was undertaken to evaluate the existing water governance systems of Raliphaswa, Mamuhohi and Mandiwana irrigation schemes at Nzhelele area in Limpopo Province of South Africa.

1.3 Justification of the Study

The findings of this study will be helpful to improve the management of water in small-holder irrigation schemes. Furthermore, researchers and academics can use the results to further interrogate the relationship between improved operation of irrigation schemes and water governance. The findings of this study may also contribute to the existing body of knowledge and give a basis for further research in related fields. Lastly, the study outcomes would broaden the general understanding and the significance of water governance among small-holder farmers and institutions governing water towards designing relevant interventions.

1.4 Research Objectives

The main objective of this study was to evaluate existing water governance systems of selected small irrigation schemes at Nzhelele area, Makhado Municipality in Limpopo Province of South Africa.

1.4.1 Specific Objectives

The specific objectives that guided the study were to:

a) Identify the institutions that are involved in water governance and their roles in selected irrigation schemes at Nzhelele area,

b) Determine the effectiveness of irrigation water governance institutions in managing water in the selected irrigation schemes,

c) Determine the challenges faced by small-holder farmers regarding water governance system at selected irrigation schemes at Nzhelele area;

d) Propose the strategies that can be used to address the water governance system challenges faced by small-holder farmers at selected irrigation schemes in Nzhelele area.

1.5 Research Questions

In order to address the above objectives, the following research questions were formulated:

a) Which institutions are involved in irrigation water governance and their roles in the selected irrigation schemes at Nzhelele area?
b) Are irrigation water governance institutions effective in managing water in the selected irrigation schemes? Give reasons for your answer.
c) What are the challenges that small-holder farmers face regarding water governance system at Nzhelele irrigation schemes?
d) Which strategies can be used to address the water governance system challenges faced by small-holder farmers at selected irrigation schemes in Nzhelele area?

1.5 Operational Definitions of Key Terms and Concepts

Governance is defined as a government's ability to make and enforce rules, and to deliver services (Fukuyama, 2013).

Water governance refers to political, social, economic and administrative systems that are in place to develop and manage water resources and the delivery of water services at different levels of society (Hall, 2013).

In this study, Van Averbeke *et al.* (2011)'s definition of irrigation will be adopted. The scholars define irrigation as artificial application of water to land for enhancing plant production.

Institutions refer to social structures in which people cooperate and which influence the behaviour of people and the way they live (Hodgson, 2006). In this study, an institution refers to social structures with a set of rules and regulations which govern water in an irrigation scheme.

Smallholder Irrigation Scheme refers to a group of plot holders who are in a project of irrigation sharing water and irrigation systems (Averbeke, 2012).

Zumdhal (2020) defines water as a substance composed of the chemical elements' hydrogen and oxygen existing in gaseous, liquid and solid state. However, in this study, water refers to irrigation water in a liquid form.

In this study, a definition of *poverty* by Bourguignon (2019) which is not having enough material possessions or income for a person's needs was adopted.

1.6 Outline of the Dissertation

Chapter one introduces and outlines the background of the study and provides the problem statement, research objectives, research questions, and significance of the study. Also, included in this chapter are the key concepts and terms used in the study. Chapter two presents reviewed literature related to previous scholarly work on water governance systems in irrigation schemes. Chapter three outlines the research methodology of the study. The chapter describes the study area, research design, population and sampling procedures, data collection, data analysis and ethical considerations. Chapter four presents research results while chapter five presents discussion of results, conclusions, recommendations, limitations of the study, and areas of further study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviewed literature related to previous scholarly work on water governance systems. The review of literature includes the definitions and discussion of the concepts on water governance and small-holder irrigation. It also covers the impact of irrigation schemes on the livelihoods of people in rural areas. The literature review covered formal and informal water governance institutions which are crucial for improved water governance. It also includes a review of the known water governance related challenges faced by farmers and the intervention strategies used in dealing with such issues.

2.2 Water Governance

Appropriate water governance has emerged as an important focus worldwide and is acknowledged for its potential to contribute in achieving the SDG goal 6 (clean water and sanitation) (Jiménez *et al*., 2020). The international conference on "Freshwater" held in Germany in 2001 identified water governance as the first of three zones for priority action (Water Supply and Sanitation Collaborative Council (WSSCC), 2001). Defining the concept of water governance is complex because there is no universally accepted definition. This is because the concept is viewed and understood differently amongst researchers (Woodhouse & Muller, 2017). Tortajada (2009) alludes that the concept of water governance has been utilized and understood by different schools of thought from different perspectives. Tortajada (2010) states that the concept of water governance is sometimes defined as outcomes or as processes.

It is important to link the concept of water governance to the concept of governance. Governance is defined as a government's ability to make and enforce rules, and to deliver services (Fukuyama, 2013). In accordance with Shah *et al*. (2015), water governance is defined as a set of laws, policies and institutions which have an effect on water economy. Roger and Hall (2015) define water governance as the range of political, social, economic and administrative systems that are in place to develop and manage water resources and the delivery of water services at different levels of society. Lautze *et al.* (2011) relate water governance to the processes and institutions involved in water decision-making. Menard *et al*. (2018) affirm that it is also concerned with the

processes involved in formulating and enforcing rules in the water sector. Dirwai *et al*. (2019) defines water governance systems as those that determine who gets what water, when and how, and who has the right to water and related services and their benefits. Lautze *et al*. (2011) indicate that proper governance of resources involving various groups of people, such as communal irrigation schemes, are based on specific institutional arrangements put in place. Hodgson (2006) defines institutions as the social structures in which people cooperate and which influence the behaviour of people and the way they live. It is the view of Venot & Hirvonen (2013) that water governance is crucial in enforcing rules and regulations in Small-holder Irrigation Scheme to ensure sustainable use of the resource. Thus, some of these rules and regulations are driven towards fairness and equity in an irrigation scheme (Akuriba *et al.,* 2019).

Akuriba *et al*. (2020) allude that those rules and regulations are crucial to achieve different scopes of governance, namely, participation, transparency, accountability and cooperation in the management of resources. Dessie *et al.* (2013) state that hiccups in a common pool resource result not only from lack of supply but also from institutions and organisations in governance. Dlangalala & Mudhara (2020) state that small-holder irrigated agriculture in South Africa encounters inadequate supply of irrigation water emanating from scheme governance problems, with weak institutional arrangements that fail to equitably and effectively govern water resource. Muchara (2014) claims that weak institutional arrangements and management in small-holder irrigation schemes (SISs) in South Africa lead most of them to be dysfunctional. Mudau (2010) alludes that small-holder irrigation is exposed to improper institutions and organisational approaches, as well as a lack of capacity to provide the necessary assistance to farmers. Thus, water governance and institutional arrangements are crucial to control and regulate water use in small-holder farms.

2.3 Small-holder Irrigation Schemes

Defining small-holder irrigation scheme is intricate because there is no universally recognised definition. It is for this reason that small-holder farms are defined in many ways based on the context, country and even ecological zone (Hazell, 2011). Muchemwa-Munasirei (2018) indicates that small-holder is interchangeably used with small-scale, limited resource and sometimes farmworker. Muchemwa-Munasirei (2018) further indicates that the principles which are frequently utilized to categorize farmers as small-holder by different analysts include size of the

land, labour input at the farm and the purpose of farmers in relation to production and income. However, Averbeke (2012) defines small-holder irrigation as a group of plot holders who are in a project of irrigation sharing water and irrigation systems. Fanadzo (2012) alludes that small-holder irrigation schemes initially emerged at the grassroots level to empower rural disadvantaged farmers and ensure food security. Van Averbeke (2008) identified four types of small-holder farmers. These include farmers on irrigation schemes, independent irrigation farmers, community gardeners and home gardeners.

Reinders *et al*. (2010) indicate that irrigation water can be extracted from the source and conveyed to the field by farmers themselves or in a group of small-holder irrigation farmers. Moreover, irrigation water can be diverted using gravity-fed canals, pipes, weirs and water pumps to irrigate agricultural produce through various irrigation methods (FAO, 2001). Denison & Manona (2007) indicate that small-holder irrigation schemes occupy more than 5 hectares of land in size per scheme in South Africa.

In South Africa, irrigation sector contributes approximately 4% to the Gross Domestic Product (GDP) (Calzadilla *et al*., 2014). It is thus not surprising that the government of South Africa has placed high priority to improving the operation of irrigation schemes. The South African government believes that an increase in the number of small-holder irrigation schemes and the rehabilitation, or revitalisation of existing and abandoned schemes, can result in an increase in food production and reduce rural poverty (Van Averbeke *et al*., 2011). Hence, the government has invested up to 2 billion rand to establish, revitalize and rehabilitate SIS in South Africa (Van Averbeke *et al*., 2011). Moreover, in 2022, the outcomes the negotiated to enhance agricultural sector includes the provision of R7 billion in agricultural financing for farmers and SMMEs through the blended finance scheme, agro-processing fund, statutory levies, state grants, industry trust and suppler development programme (Mangolo, 2022). Cousins (2012) asserted that the establishment of new and the restoration of old irrigation schemes could up to 300 000 job opportunities in 2020 in South Africa. In addition, The Bureau for Food and Agricultural Policy (BFAP) (2022) revealed that, In the last quarter of the year 2021, employment within the agricultural sector increased with 7% in comparison to the year 2020. The average level of agricultural employment for 2021 was 838 000, marginally higher than the 829 000 in 2020. Irrigation is also essential for the South African fruit industry, which ranks amongst the most

important export commodities, with fresh fruit accounting for around 35% of SA agricultural exports (MacGregor, 2023)

2.4 Small-holder Irrigation Schemes for Improved Livelihoods for People in Rural Areas

Eliminating poverty and hunger by 2030 worldwide, as proposed by Sustainable Development Goals (SDG) 1 and 2 can be achieved through having well-functioning small-holder irrigation schemes, among other factors (Baumgartner *et al*., 2019). Small-holder irrigation schemes have been prioritised as a rural development model by various developing countries, such as Zambia, Ghana, India and Iran in the past 5 decades, not only because they had higher returns on investment but also because they were found to be adaptable to the local farming systems (Mutambara *et al*., 2017). Poverty reduction and household food security assurance are central policy goals in developing countries, particularly in sub-Saharan Africa (Sinyolo *et al*., 2014). The FAO (2016) affirms that in sub-Saharan Africa, governments have acknowledged the establishment of small-holder irrigation as a crucial strategy to fight drought in communal lands, especially in drier parts of these countries. In line with FAO (2016), Denison *et al*. (2016) also claim that the establishment of small-holder irrigation has been a significant livelihood and income-generating project for majority of rural households in the developing countries. Similarly, Mengistie & Kidane (2016) allude that small-holder irrigation schemes are regarded as a major way to increase agricultural productivity.

Dlangalala & Mudhara (2020) view water as an important resource for improving production of irrigated agricultural produce and its availability and accessibility are vital for alleviating poverty and achieving food security in rural households. Rafael (2023) indicate that Majority of the Africa population resides in rural areas and are dependent on agriculture for food and income. In general, small-holder irrigation farming has been viewed as a livelihood strategy in achieving positive rural livelihood outcomes such as reduced vulnerability and improved food security (Scoones *et al*, 2019; Mutiro & Lautze, 2015). In South Africa, irrigated agriculture contributes about 30 percent of the agricultural production and has a huge potential impact in rural areas (DWA, 2013).

Graefe *et al.* (2019) indicated that irrigated agriculture has gained national public interest and scholarly focus. The importance of irrigated agriculture was stimulated primarily from its location

in the rural areas, where poverty and food insecurity are endemic (Vink & Van Rooyen, 2009). Denison & Manona (2007); Van Averbeke *et al*. (2011) and Serote *et al.*, (2023) indicated that the main objectives for establishing small-holder irrigation schemes in the homelands were to tackle extensive poverty and household food insecurity in rural areas of South Africa.

Mbatha & Masuku (2018) assert that small-holder irrigated agriculture expects to make a significant contribution to improve rural economies by creating employment opportunities to ensure food security and contributing to the Gross Domestic Product (GDP). However, Lehohla (2016) asserts that there is a notable decrease in rural irrigated agriculture since the estimated percentage shows only 13.8% of South African rural households are still engaged in the agricultural sector as compared to 19.9% in 2011. Mutambara *et al.* (2017) claim that the influence of small-holder irrigation schemes for improved livelihoods and wellbeing of irrigators has been inadequate, irrespective of the considerable public investments offered to establish, rehabilitate and revitalize SISs.

Van Averbeke *et al*. (2011) expand that a large number of researchers have identified different limitations that dampen the livelihood outcomes derived by participants from small-scale irrigation farming. Poor management, infrastructural problems, water inadequacies, conflict and theft are some of the hiccups which hinder improved plot holder livelihood and scheme productivity Speelman *et al*., 2008; Yokwe, 2009; Mnkeni *et al*., 2010 and Van Averbeke *et al*., 2011). Mthembu (2013) alludes that due to inadequate formal and informal infrastructure, poor market and low productivity of farming systems, small-holder irrigation schemes are vulnerable in contributing to rural economic development. Chikazunga & Paradza (2012) claim that small-holder irrigation schemes have not much to discharge in rural areas due to the unavailability of financial support system and weak institutions that fail to assist poor rural farmers.

2.5 Irrigation Management Transfer (IMT)

In South Africa, policies, programmes and the strategies in the water sector have been changing since the apartheid government to a democratic government (Mbandlwa, 2023). In 1994, when South Africa became a democratic country, the government eliminated water laws which were established during the colonial era and new laws, rules and policies were established to address the imbalances of the past (Fanadzo & Ncube, 2018). The Irrigation and Water Conservation Act

(Act 8 of 1912) and Water Act (Act 54 of 1956) were obliterated because they favoured the white minority; hence commercial white farmers had unhindered water access (Perret, 2002; Tewari, 2009). The main objective for the establishment of SISs during the colonial era was to alleviate poverty and improve food security through irrigated agriculture (Fanadzo *et al*., 2010). Mutambara *et al*. (2016) stated that since the SISs were established, the government and its agencies had been responsible for managing irrigation water. However, after South Africa become a democratic state, the government decided to transfer the management of small-holder irrigation schemes to the farmer societies who benefitted from them (Dirwai *et al*., 2019). Similarly, to South Africa, the process of transferring the management of irrigation schemes to farmers known as 'Irrigation Management Transfer' (IMT) had been taking place in various countries (Cambaza *et al*., 2020). Vermillion (1997) indicated that the main objectives for the implementation of IMT by the government were to reduce government expenditure on irrigation, improve irrigated agriculture and stabilize deteriorating irrigation systems. Van Averbeke (2008) asserted that the responsibilities to manage and maintain irrigation schemes were transferred to the farmers from the state. Machethe *et al*. (2004) indicated that IMT was initiated as a strategy to improve scheme management performance, increase the profitability of irrigated agriculture, increase accountability of water users, encourage farmers to take responsibility for water resource management with limited government assistance, to improve farmer willingness to pay for the operation and maintenance costs and mainly to reduce recurrent public spending on operation and maintenance of the schemes.

In South Africa, the process of Irrigation Management Transfer started in 1996 in the Eastern Cape and came to an end in 1998 in Limpopo Province (Machethe *et al*., 2004). However, the IMT process had a negative effect in all projects where the government was offering services to small-holders (Fanadzo, 2012). The consequences of IMT were strongly felt on the large, modern small-holder irrigation schemes, because these projects were very complex to manage. Van Averbeke *et al*. (1998) stated that because irrigation schemes were managed by the government from inception, levels of dependency on external management among farmers were exceptionally high, hence, many irrigation schemes collapsed soon after the implementation of IMT (Bembridge, 2000; Laker, 2004). Muchara (2014) asserted that although SISs are managed and operated by farmers, they still portray weak governing and water management institutions, poor rule enforcement mechanisms, lack secured property rights and lack reliable water supply. Thus, many irrigation schemes collapsed and some faced management and sustainability challenge

(Van Averbeke *et al*., 2011). A study conducted by Nkhoma & Mulwafu (2004) on "The experience of irrigation management transfer in two irrigation schemes in Malawi, 1960s–2002" revealed that the IMT process has been fraught with many challenges, not least of which includes lack of adequate funds, delays, lack of public awareness and farmers' conflicting perceptions on the handover of irrigation schemes. These problems inspired after the success of IMT in the Domasi and Likangala irrigation schemes and other schemes within the country. However, existing irrigation schemes were identified as important resources for the economic development in rural areas, hence they needed to be revitalised first so that they may operate productively.

2.6 Government Policies, Strategies and Informal Institutions for improved water use and effective irrigation in South Africa

Currently, water resource in South Africa is controlled by water legislation with government strategies to ensure the achievement of significant water laws and the informal rules (Molobela & Sinha, 2011). Among the newly established water legislation is the National Water Act (No. 36 of 1998). The strategies and programmes include the WaterCare Programme (1998), RESIS (1998), Irrigation Strategy (2015), Catchment Management Agency and Water Users Association along with informal rules and cultural norms at the local level. These legislations and strategies were established to ensure that SA's water resources are protected, used, developed, conserved, managed and controlled (Dlangalala, 2018).

2.6.1 National Water Policy (1997)

Mackay (2003) asserted that following the election of the new government in South Africa in 1994, the philosophy, priorities and approach to management of water resources and allocation of water have been subjected to a significant change. When the Minister of Water Affairs and Forestry become appointed, one of his first actions was to initiate a process of substantial review and reform of national water policy and legislation. The 1997 White Paper on National Water Policy (DWAF 1997) represented a key milestone in the process of reform of the water sector. DWAFF (1997) asserted that the 1997 White Paper mandates that equity in its various forms is fundamental to water management in South Africa, in support of Constitutional requirements. The policy goes on to state that equity implies a concept of fairness which allows for different practices in the management of water in response to different social, economic, and environmental needs

(Backeberg, 2005). Karodia & Weston (2001) indicated the National Water Policy treats water as an economic good, and for the protection, use, development, conservation, management and control of SA's water resources. Moreover, Folifac (2007) stated that the policy redefined the ownership and allocation of water and affirms that all water is public water and that the national government will act as a public trustee.

The National Water Policy was reviewed in 2013 and outlined the objective of managing the quantity, quality and reliability of the nation's water resources to achieve optimum, long-term, environmentally sustainable social and economic benefit for society from their use. It was also redefined in ownership and allocation of water (DWAF, 2013). In the National Water Policy review, it was indicated that water resources have to be managed in each catchment to ensure that the demands of all users are met sustainability, efficiently and equitably, as mandated by the NWA (DWAF, 2013). The National Water Policy requires water users to join water user's associations, to register as water users through licencing, to apply for water rights and pay application and user fees (Sokile *et al*., 2005). Currently, within the Limpopo Province irrigation and irrigation development is under the responsibility of the Department of Water Affairs and Forestry alongside with the Limpopo Department of Agriculture (Mudau *et al.*, 2010). The Department of Water Affairs and Forestry is responsible for the development of national water infrastructure, and for the allocation and control of scarce water resources. On the other hand, the Limpopo Department of Agriculture has the accountability to support and develop irrigation farming in the province (DWAF, 1995). This implies that farmers will have to take full responsibility for the management of irrigation schemes and ensure all the infrastructural maintenance costs, as well as other related management and operating costs.

2.6.2 National Water Act (NWA) (Act 36 of 1998)

The National Water Act 36 of 1988 was established and executed to ensure that water resources in South Africa are protected, used, developed, conserved, managed and controlled (Republic of South Africa (RSA), 1998). Schreiner (2013) outlined three key principles of NWA namely, sustainability, equity and efficiency. The sustainability principle aims to promote social and economic development and to protect the environment for future use. The equity principle ensures that everyone has the right to access, and the water allocation decisions favour all people. While the efficiency principle ensures that water is used efficiently and not wasted. DWAF (1998)

indicated that to achieve the aims and objectives of NWA, two water resource management institutions were established, namely the catchment management agency and water user's association. These institutions allowed users to participate in decision making by decentralization water management to catchment and local levels (Perret, 2002). Backeberg (1997) also indicated that participation of water users in water management can be achieved by establishing organizations representing their interest on a local level.

2.6.3 Water Care Programme (1998)

Water Care programme was launched in 1998 and lasted for five years (Denison & Manona, 2007). The programme was aimed at revitalizing selected small-holder irrigation schemes in Limpopo Province (Dlangalala, 2018). The Water Care programme had the objectives to improve degraded infrastructure, improve leadership, management and productivity of irrigation schemes. This programme allowed the involvement of small-holder farmers in planning and decision making through a participatory approach. Under Water Care, small-holder irrigation farmers were trained to take full responsibility in the management of their schemes (Denison & Manona, 2007).

2.6.4 The Revitalisation of Small-holder Irrigation Schemes (RESIS) (1998)

The RESIS (Revitalisation of Small-holder Irrigation Schemes) programme was developed in 1998 to increase agricultural productivity in small-holder irrigation schemes. Maepa *et al*. (2014) indicated that the objectives of implementing the RESIS programme was to improve the operation of schemes to play a role in local economic development through improved incomes for farmers and to ensure food security. In 2002, the Limpopo Department of Agriculture took a decision to rejuvenate about 126 irrigation schemes (approximately 19 000 ha) in Limpopo Province. This formed part of the Department's strategy to energise agricultural production through revitalising existing and establishing new schemes capable of sustainable economic production. Veldwisch (2013) & Maepa *et al*. (2014) indicate that irrigation schemes with old irrigation technologies and infrastructure were of priority to revitalize. Under Limpopo RESIS, infrastructure was improved and irrigators were given training on how to manage irrigation water (Veldwisch, 2013).

2.6.5 Irrigation Strategy (2015)

DAFF (2015) indicated that in South Africa, irrigation strategy was established as a backup in assisting the agricultural sector to increase its input to agricultural production. The overall aim was to ensure food security, alleviate poverty and create job opportunities (DAFF, 2015). The irrigation strategy seeks to support irrigation initiatives based on the revitalisation of irrigation schemes, establishing of new ones and manage the efficient use of irrigation water. The objectives of irrigation strategy were to increase the contribution of irrigated agriculture to the Gross Domestic Product (GDP), skills development, ensure equal access to irrigated agriculture by historically disadvantaged individuals and to optimize irrigation water use to increase agricultural production (DAFF, 2015).

2.6.6 Water Users Association (WUA)

Water User Associations (WUAs) are government bodies established by the Minister of DWAF under Section 92 of the NWA in South Africa. Pegram & Mazibuko (2003) indicated that WUAs are intended to operate at a local level to facilitate cooperative associations of individual water users who wish to undertake water-related activities for their mutual benefit. WUAs are known as water management institutions (WMIs). The roles of WUA are to enable people within a community to pool their resources to carry out water-related activities more effectively as well as to take over irrigation management functions such as water allocation and distribution, water charging system, irrigation maintenance, financial management, and redressing racial imbalances of the past created by Irrigation Boards and the individual rights principle (Karodia & Weston, 2001; Perret, 2006). However, Dlangalala (2018) claims that WUAs have not achieved their intended objectives. Most associations have not proved effective at cost recovery or become financially self-sustaining, nor have they turned out to be as participatory as hoped (Aarnoudse *et al.,* 2018). Rather, they have tended to reflect gender as well as other socio-economic and political inequalities that already existed in rural communities (Aarnoudse *et al.,* 2018). According to Saruchera (2008), all WUAs were supposed to be established by 2006, meaning that all irrigators had to join WUAs and the membership was compulsory. Contrary, the adoption of WUAs is very poor and their roles have not been fully defined to small-holder irrigators from inception and there is lack of legal water rights among small-holder irrigators which influences irrigators not to participating in WUAs.

2.6.7 Catchment Management Agency (CMA)

Catchment Management Agencies are water management institutions based at the regional level to manage water resources and to execute the key responsibilities of NWA at catchment level. Karodia & Weston (2001) outlined the roles of the CMA to play a coordinating role regarding water-related activities and water management institutions; developing and implementing a Catchment Management Strategy; and encouraging public participation. The CMA is governed by a board that is appointed by the Minister, representing the interests of water users, stakeholders and government (and should include WUA representation where appropriate). However, Bourblanc & Blanchon (2014) asserted that in South Africa, the implementation of CMA has been successful only on two CMAs that been established. The reasons which contributed to the failure of CMAs were poor administration, mismanagement and lack of training of newly appointed public servants or coordination problems.

2.7 Informal institutions

Institutions and organisational structures are of a great importance to enforce laws, policies, rules and regulations in the utilization of common pool resources (Kiparsky *et al.*, 2017). Van Averbeke *et al*. (2011) affirmed that rules to govern collaboration (institutions) and structures to enforce these rules (organisations) are essential for effective and sustainable functioning of collection action. Water governance dimensions (water policy framework, organisations and rules and regulations) established from formal structures assist in the management of water resources (Dlangalala, 2018). In irrigation schemes, irrigators within the scheme interact with the established water institutions to ensure that water resources are equitably distributed across the scheme and used in a sustainable manner (Dlangalala, 2018).

However, Gudaga *et al*. (2018) argued that farmer's acts and behaviour towards land and water resources cannot only be determined by the constitutional rules and procedures in place, but also informal rules. Bandaragoda & Firdousi (1992) indicated that traditional practices and customs play a crucial role in governing common pool resource and social behaviour. In irrigation schemes, farmers tend to develop their own rules, processes and regulations apart from the government laws that suit best their interest of customary laws, religious laws or local norms (Namara *et al.,* 2010). Namara *et al*. (2010) further indicated that local norms play a significant role in ensuring

equitable access to water for both domestic and production use among all people. Falkenmark *et al*. (2004) asserted that though informal rules have the same objectives and purposes in water management like the government laws, they are ignored by official policies and intervention strategies. In most cases, farmers gather together and arrange how irrigation water will be managed so that all irrigators have an equal chance to access irrigation water. This act is most common when there is limited water so that all farmers can effectively irrigate their farms (Meinzen-Dick *et al*., 2002). This practice was recognised as an effective informal water arrangement act (Sokile *et al*., 2005; Deribe, 2008). Although both formal and informal water institutions serve the same goal, informal institutional arrangements (customary institutions) and local institutions are more valuable, influential and powerful compared to formal institutions (Sokile *et al*., 2005; Deribe 2008).

A study conducted by Mudhara & Senzanje (2020) “on the assessment of policies and strategies for the governance of small-holder irrigation farming in Kwazulu-Natal province, South Africa” revealed that informal institutional arrangements were more visible, valuable, influential and powerful at scheme level while formal institutions have low relevance at this level. Bandaragoda and Firdousi (1992) alluded those informal institutions attract greater compliance from individual s and groups because they seem to be more relevant to the needs of the locals. Similarly, a study conducted by Van Asten & Yami (2018) on the “Relevance of informal institutions for achieving sustainable crop intensification in Uganda” revealed that informal institutions play a central role in enhancing farmers’ investment in sustainable crop intensification interventions by facilitating access to land and labour sharing arrangements. The findings further indicate that informal institutions also allow access to financial resources by farmers at lower transaction cost compared to formal on three small-holder irrigation schemes in KwaZulu financial institutions. A study conducted by Dlangalala (2018) in Kwazulu-Natal, South Africa revealed that all the studied irrigation schemes had a constitution which all scheme members, extension officers and traditional authorities drafted. The constitution consisted of rules regarding land and water allocation, operation of the scheme, penalties for noncompliance, and norms for farmer participation and conflict resolution mechanism. Rules and regulations are crucial in managing a common resource for fair allocation of the resource.

2.8 Water governance related challenges faced by farmers

This section covers a discussion of known water governance related challenges faced by farmers namely, poor implementation of regulatory policies, management centralisation, financial and credit constrictions, poor agronomy, poor infrastructure and illegal irrigation practices.

2.8.1 Poor implementation of regulatory policies

Since the 1990s, state building and development strategies have always been dominated by concepts and activities surrounding good governance (Grindle, 2004). Such approaches are constructed using principles and policies that are critical for enhancing institutions that enable states to deliver necessary development (Brinkerhoff & Brinkerhoff, 2015). Most developing countries have several institutions with relevant ideas and institutional constructs in response to problems and needs in these societies (Genus & Stirling, 2018). Water governance in irrigation schemes forms part of these strategies. However, policies therein are not always implemented as they are designated to (Mosse, 2004 & Lange, 2008). According to Mohan & Reddy (2012), these policies are developed by water governing institutions with regards to planning, allocation and protection to be overseen and upheld by farmer-managed irrigation schemes. Water supply adequacy, equity in water distribution and vastness of reliance on water supply are the main expected outcomes of these defaulted policies (Lange, 2008). Garthwaite *et al*. (2017) reported that uneven water distribution is one on the rules-evasion that has led to farmers competing for water, which resulted in several farmers not receiving water when they needed it. Mutambara & Munodawafa (2014) added that a like predicament has caused conflicts and electricity payment disputes between farmers at Tsvovani Irrigation Scheme in Zimbabwe, which affected the scheme's development. In contrast, Chukwuone (2018) stated that a shortfall of this nature cripples' operations in irrigation schemes, leading to dissatisfying farming projects for farmers. Garthwaite *et al*. (2017) argued that there is no point in applying policies and principles for irrigation schemes if such ignorance to adherence continues. Regulatory policies which contain rules and regulations to govern a common pool water resource from both formal and informal institutions should be implemented as planned, this will yield to a better use of a resource.

2.8.2 Management centralisation

Low productivity and limited growth of small-holder irrigation farms in Sub-Saharan Africa is blamed on poor management of SIS in the region (Poku & Mdee, 2011). Fanadzo (2012) reported

that majority of SIS in South Africa are managed, and decisions are strictly enforced by an appointed central management with participation of farmers. Plot farmers only make independent decisions on the type of crop to use and irrigation water management practices (Maepa *et al*., 2014), which have resulted in farmers being depending on government and SIS appointed management for a while, eventuating in poor performance when government allocates the management activities to farmers (Fanadzo, 2012). Fanadzo (2012) added that there is a need for all farmers to fully participate in water distribution and infrastructure maintenance to ensure the achievement of collective goals of farmers. According to Pansera & Owen (2018), this is because decisions made based on the consultation of individual farmers can negatively affect scheme maintenance, water allocation and distribution because farmers rely on a shared distribution system for irrigation water. Van Averbeke *et al*. (2011) argued that individual farmers' and central management's decisions do not represent the needs and goals of a collective farmer community. A' Bear and Louw (1994) reported that the management of the Makhathini Irrigation Scheme in Kwa-Zulu Natal experienced a challenge of reluctant farmers who complained that their wishes are not represented in the overall scheme goals and their needs are ignored. It's crucial for a bottom-up approach to be employed when managing a common pool resource, the farmers are the ones who can ascertain better their challenges and how best such challenges can be addressed, thus they should be consulted in all the decision-making processes by the management.

2.8.3 Financial and credit constrictions

The sustainability and success of SISs in South Africa are mostly affected by the absence of effective credit services (Van der Heijden & Vink, 2013). Birner & Resnick (2010) established that most small-holder irrigation farmers require external funding as they are financially incapable enough to ensure growth in production through financing farming on their own. According to Maepa *et al*. (2014), SISs worldwide struggle to attract sufficient investments, markets and credit from financial service providers. Financial institutions require financial records of the farming business as a prerequisite for financial grating, which most farmers lack as they do not keep records due to lack of proper knowledge (Baloyi, 2010). Machethe *et al*. (2004) specified business collateral as a required form of representation for land rights, which most SISs farmers do not possess. Ortmann & King (2007) argued that financial institutions prefer granting credit to large scale farmers with well-established farms as compared to small-holder farmers due the lack of

assurance of production associated with small farms. Thus, small-holder farmers cannot invest in resources such as seeds, fertilizers and farming technology to increase productivity (Obi & Pote, 2010). On the other hand, the Zimbabwe fast track land reform programme has given farmers opportunity to land ownership and use but banks extracted their credit assistance which has made it difficult for farmers to procure inputs such as assistive machinery (Mutambara & Munodawafa, 2014). Mudau (2010) reported a similar occurrence since the government's land reform policy in South Africa, whereby farmers have access to productive land, yet not provided with farmer support services and failure is becoming normative in many SISs.

2.8.4 Poor agronomic practices

Several agronomic factors are known to inhibit crop productivity in SISs, such as poor weed control practices, fertilizer and plant population management, late planting and poor selection of cultivators' type (Machete *et al*., 2004). The said exist because of limited agro-knowledge and skills among farmers (Van Averbeke *et al*., 2011). Most South African SISs use the cropping model of producing maize in summer and vegetables in winter, which is agronomically and ecologically unsustainable (Fanadzo, 2012), as appropriate crop rotation is not carried out in this model (Van Averbeke, 2012). Notwithstanding the type of cultivar, farmers in Zanyokwe Irrigation Schemes work within a standard population of 40 000 plants (overall maize production) per hectare (Fanadzo *et al*., 2010), which is much less that the expected amount of 80 000 to 90 000 plants per hectare and this only meets the minimum expectancy for medium to long-season cultivars of 40 000 to 60 000 plants per hectare (Fanadzo *et al*., 2010). Monde *et al*. (2005) also reported that farmers in this scheme fertilized their fields only once in two-three years due to lack of finances. According to Fanadzo (2012), small-holder irrigation farmers execute erroneous activities in farming due to lack of insight because of limited training, as the currently offered training is based on scaled down versions of commercial production practices, and as such, incongruent to food insecure farmers in most SISs. A study conducted by Machethe *et al*. (2004) revealed that most small-holder irrigation farmers in Limpopo Province apply a portion of inorganic fertilisers which were unexamined for any soil fertility analysis and recommendations due to farming illiteracy.

2.8.5 Poor Infrastructure

Repair and maintenance of schemes infrastructure are some of the factors that affect the growth and performance of small-holder irrigation schemes (Bembridge, 2000). Poor maintenance of infrastructure is considered a factor accountable for poor performance of SIS in South Africa (Van Averbeke *et al*., 2011). According to Mvelase (2016), big proportions of SIS in Southern Africa are poorly maintained, having leaking canals, with broken pumps and repairs of such are uncommon. Van Averbeke (2013) indicated that lack of regular and proper maintenance of the infrastructure in the Dzindi Irrigation Scheme has resulted in deterioration of the infrastructure. Phispon (2015) also described that infrastructure maintenance and repairs at the Makhathini Irrigation Scheme is neglected. Phispon (2015) stated that internal roads are flooded with water from leaking pipes and are also covered with weeds, irrigation canals have more than a few cracks and are overgrown with weeds and pipelines are leaking and ignored. Mutambara & Munodawafa (2014) reported insufficient technical knowledge in operating and maintaining irrigation infrastructure such as water pumps, canals, and valves to be very common among farmers in most Zimbabwean SISs.

2.8.6 Illegal Irrigation Practices

According to Mdee & Harrison (2017), the Morogoro Municipality of Tanzania refers to illegally water using farmers as those who do not have water use permits from the Wami-Ruvu River Basin Office, as the designated overseer of water resources in the area. Respondents in a study by Douglas *et al*. (2018) reported common illegal activities in irrigation schemes such as illegally blocking water entry to other farmers' fields and opening water through a band from a neighbour's plot. Harrison & Mdee (2019) reported a discovery of a large number of Magororo farmers who defy the water use rule of getting a permit, in order to avoid paying regular fees to the regulatory body. Adekunle *et al.* (2015) argued that illegal irrigation practices interfere with water sharing plans and frames for schemes, as it leads to water shortage for overall coverage of schemes. In addition, Integrated Development Plan (IDP) (2013) stated that illegal irrigation practices do not only affect fellow farmers but as well as residents who rely on the same water sources, leading to unsatisfying water supply for both parties. Fanadzo *et al*. (2010) highlighted over-irrigating as a common case in Zanyokwe Irrigation Scheme, whereby farmers fail to practise correct irrigation scheduling by irrigating more than 24 hours per setting. According to Mudau (2010), problems

related to farming are not uncommon is South Africa. A 'Bear and Louw (1994) revealed that in the Makhathini Irrigation Scheme in Kwa-Zulu Natal, scheme managers find it difficult to recover electricity and water cost from farmers due to illegal abstraction of water by plot holders and community members. In addition, Mudau (2010) indicated that some farmers in Nzhelele, Vhembe district are known to illegally create water outlets to secretly irrigate their own plots on the outskirts of the irrigation scheme through breaking concrete canals and blocking or diverting water using sandbags, rocks or pieces of corrugated iron. Heavy penalties are crucial to be imposed to end this act of drawing irrigation water illegally.

2.9 Solutions to Water Governance Related Challenges Faced by Farmers

Agricultural productivity has to be improved significantly in order to be able to meet the growing demand for food and fibre. Therefore, practical solutions and opportunities have the potential to result in lifetime sustainability for SIS with the participation of farmers in implementation. This section will cover a discussion of suggested solutions to water governance related challenges faced by farmers namely; revitalisation of irrigation water management, agro-training for farmers, credit and marketing strategies and infrastructure maintenance strategies.

2.9.1 Revitalisation of irrigation water management

According to Waskom (1994), problems and limits with regards to irrigation water management can be improved through the implementation of best management practises for irrigation and agricultural water use. As an addition, Texas Water Development Board (TWDB) (2004) noted that best management practises for irrigation are recommended and can be used to enhance effectiveness and consistency of irrigation water. According to Waskom (1994), best management practises are orientated on improving water conservation measures that will be cost effective, which TWDB (2004) highlighted as involving resident farmers in decision making, revising existing policies for objectivity, engaging law enforcement regarding illegal water acquisition by farmers, committing to developing infrastructure for farming efficiency, making agro-focused training available to farmers and offering financial knowledge to farmers. Waskom (1994) suggested making irrigation scheduling, volumetric measurements of irrigation water use, irrigation audits and equipment development as best practices of irrigation water management. Muchara *et al*. (2014) stressed that, for better farming and maintenance of the system, best water management

practices, manageable farmers' conflicts, proper fees collection from farmers and crop productivity to be possible, there is a need for farmers to participate in collective management of the scheme. Shah *et al.* (2002) alluded that the collective management of the scheme will assist in ensuring most relevant and informed decisions that are related to collective resident farmers.

2.9.2 Agro-training for farmers

Kay (2001) suggested that training regarding planning, design, construction, operation, management and maintenance should be made available and if possible, compulsory for farmers, engineers, technicians, management team and extension officers in SISs. According to Cornish (1998), such training must be followed by appropriate technical support in operating and maintaining irrigation systems to ensure realisation of optimal performance. Such training will ensure that farmers are equipped with production skills for productivity and meaningful income (Fanadzo, 2012). Fanadzo (2012) reported that Afghanistan achieved an increase in potato harvest by 205% following training of farmers about potato farming, proper potato management, irrigation scheduling and techniques, fertiliser use and pest control. According to Levidow *et al*. (2014), the general communities will be empowered for community development and prepared for employment opportunities if they are encouraged to seek agricultural knowledge and expertise. Snyder & Cullen (2014) indicated that empowering the society with agro skills will help them see the significance of their reformed land. Fanadzo (2012) recommended that the Department of Agriculture, Forestry and Fisheries in South Africa should train extension officers for water management practices, operation and maintenance of schemes and other agricultural practices to ensure provision of support and knowledge to farmers in SISs. A model of training was implemented in Sekhukhune District, wherein seven irrigation schemes were identified which required assistance and floppy irrigation systems were installed (Van Koppen *et al.*, 2017). The Strategic Partnership (SP) model was in this case employed to train and empower farmers for commercialization of schemes (Eastern Cape Socio Economic Consultative Council (ECSCC), (2013). This model was meant to ensure skills transfer, empowerment, mentorship, full participation from both parties, and expressing the benefit of both parties. The world is now in the Fourth Industrial Era, thus, agricultural farming methods are changing from the indigenous ones, such as furrow irrigation to drip irrigation. Therefore, farmers training is important for sustainable farming.

2.9.3 Credit and marketing strategies

Asia is one of the countries that has established innovative organisational development strategies to improve productivity and diversification in SISs, which include the development of farmer organisations for marketing, contract farming promotion for procuring seeds; fertilizers; and access to credit, developing supply chains to ensure high value exports, facilitating the transfer of marketing knowledge from private sector to SIS farmers and direct economic development in rural areas (Mvelase, 2016; Thapa & Gaiha, 2011). Van Averbeke *et al*. (2011) suggested that farmers need assistance in developing a reliable market network, for the selling, production and purchase of inputs. Sihlobo (2015) also stated that the South African Department of Agriculture, Forestry and Fisheries recommends strategies that encourage farmers to improve their market knowledge, access to subsidise inputs and to partner with commercial farmers. To overcome credit related challenges, Thapa and Gaiha (2011) recommended that farmers establish organisations to integrate in work and co-operate in business management, with the aim to gain sufficient public services, support and access to credit from financial and asserts institutions.

2.9.4 Infrastructure maintenance strategies

In the Garu Tempane District of Ghana and SISs in Ethiopia, the management of irrigation schemes was transferred to WUAs for day-to-day management of these schemes (Lempériere *et al.* 2014; Freeman *et al*. 2008). Van Tilburg (2012) found that the main role of the WUAs is managing the schemes, making decisions for the use of scheme resources and to ascertain the fair availability of land and water for all users. Sinyolo (2013) specified construction, water sharing, operation, management and maintenance of infrastructure as the tasks overseen by the WUAs in Ethiopia. To bring effect to the said duties, Shah *et al*. (2002) suggested that the payment of irrigation charges should be stressed by schemes management and be paid by farmers to be used for covering operational and maintenance costs of the schemes. Alternatively, Kay (2001) suggested that training should not be confined to planning, design, construction, operation, management, but maintenance training should as well be made available for farmers in SISs.

2.10 Theoretical Framework of the Study

This study was guided by Common Pool Resource (CPR) management theory. CPR management theory was developed by Elinor Ostrom and colleagues in response to the work of Olson (1965) and Hardin (1968). The CPR management theory evaluates how rules and regulations set by institutions influence the use of CPRs, such as water, fisheries, and forests (Ostrom, 1990). The rationale to the development of CPR Management theory was to allow a certain amount of the resource to be used during a given period while CPR usage is governed by agreements that specify the physical boundaries of the resource, parties involved, resource allocations, time limitations, authority for dispute resolution and enforcement means (Nhundu, 2013; Ostrom *et al*., 1994). In this theory, Ostrom argues that people should act collectively to overcome the management dilemmas of resource overuse or exploitation by users inherent to common pool resources. Acording to Ostrom (1990), there are sufficient conditions essential for effective management of common pool resources (CPR). Ostrom identified eight design principles that can prevent exploitation and lead to successful governance of the CPR, which are as follows:

1. Clearly defined boundaries (effective exclusion of external unentitled parties of the CPR)
2. There is congruence between the resource environment and its governance structure or rules
3. Decisions are made through collective-choice arrangements that allow most resource appropriators to participate
4. Rules are enforced through effective monitoring by monitors who are part of or accountable to the appropriators
5. Violations are punished with graduated sanctions
6. Conflicts and issues are addressed with low-cost and easy-to-access conflict resolution mechanisms.
7. Higher-level authorities recognize the right of the resource appropriators to self-govern
8. In the case of larger common-pool resources: rules are organized and enforced through multiple layers of nested enterprises.

Therefore, CPR theory is appropriate for this study because it seeks to evaluate how rules and regulations set by institutions influence the use of CPRs, while this study is aimed at evaluating water governance systems for improved operation of the selected irrigation schemes, where

'systems' refer to institutions and rules that govern irrigation water. The evaluative nature of this theory will set a framework of understanding for this study using the design principles by Ostrom in this theory. These design principles have often been used to analyse water governance and institutional arrangements in Small-holder Irrigation Schemes (Dlangalala, 2018; Muchara, 2014; Nhundu, 2013; Ostrom *et al*., 1994; Ostrom & Gardner, 2013). The institutional design principles on irrigation management deal with the appropriation and provision problems and serve as sufficient conditions for fair allocation of the resource (Muchara, 2014). Rules and regulations put in place by both formal and informal institutions govern the use of irrigation water within the scheme. In irrigation schemes, farmers are ought to adhere to the rules in place and act collectively to avoid resource management dilemma and punishment for disputes in the use of irrigation water. Therefore, adopting this framework is central to this study because it provides a comprehensive picture of how to manage and govern irrigation water.

2.11 Summary of Literature Review

The foregoing literature review demonstrated that water governance is crucial in enforcing rules and regulations in Small-holder Irrigation Schemes to ensure sustainable use of the resource. Literature revealed that effective and sustainable performance of irrigation schemes is based on the general governance and institutional arrangements in the schemes in order to maximize agricultural produce. The chapter outlined the concepts of water governance and Small-holder Irrigation Schemes. The reviewed literature indicated that Small-holder Irrigation Schemes have been prioritised as a rural development model by various developing countries and they have the ability to eliminate hunger in 2030 globally.

In South Africa, policies, programmes and strategies have been changing in the water sector since the apartheid government to a democratic government. These changes led to irrigation scheme management being transferred to the irrigators through the IMT process to give full irrigation scheme management power to the farmers and to reduce government expenditure. The literature revealed government policies, programmes, strategies and informal institutions to improve water use and effective irrigation in S.A. Among the newly established water legislation is the National Water Act (No. 36 of 1998) and the National water policy. The strategies and programmes include the Water Care Programme (1998), RESIS (1998), Irrigation Strategy (2015), Catchment Management Agency and Water Users Association along with informal rules

and cultural norms at the local level. Literature review revealed water governance related challenges faced by farmers which include poor implementation of regulatory policies, management centralisation, financial and credit constrictions, poor agronomy, poor infrastructure, illegal irrigation practices. Literature shows several intervention measures and strategies to fight this phenomenon. These are revitalisation of irrigation water management, agro-training for farmers, credit and marketing strategies and infrastructure maintenance strategies.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

The main objective of this study was to evaluate irrigation water governance systems for improved operation of the selected Small-holder irrigations Schemes in Nzhelele area, South Africa. This chapter outlines the methods and techniques that were used to evaluate water governance systems in the selected irrigation schemes. Firstly, the description of the study area is outlined. This is followed by the presentation of the research design, description of the population and sampling procedures, data collection, data analysis and ethical considerations.

3.2. Description of the Study Area

The study was conducted at Mamuhohi, Mandiwana and Raliphaswa irrigation schemes located in Makhado local municipality. The three selected irrigation schemes were deemed appropriate as the study area of interest because the schemes rely on the same dam for irrigation water which is Mutshedzi dam. Moreover, water flows from Mutshedzi dam to Raliphaswa weir and to the selected irrigation schemes for irrigation, thus the three irrigation schemes are interlinked. The Makhado Local Municipality is a category B Municipality situated within the Vhembe District in the Limpopo Province (Figure 3.1). The municipality was established in 1934 as the Louis Trichardt Town Council. With the new Municipal demarcation, several municipalities were established in 1997. Nonetheless, following the Municipal Structures Act of 1998, the municipalities were merged into an NP344 Municipality that is now known as the Makhado Municipality. The municipality is divided into four regions, viz, Makhado, Vuwani, Dzanani and Waterval. It covers a total area of 7 605 km² and lies on the coordinates 23.1138° S, 29.9741° E. The population of Makhado is 516,031 (Statistics South Africa (StatsSA), 2016). The unemployment rate was 15% coupled with 18% of the population with no schooling which resulted in a great dependency on pension and social grants (Makhado Municipality IDP, 2018/19). The municipality's economic growth potential is predominantly in agriculture and ecotourism pursuits sectors because most of the people derive their livelihood from agriculture (Mucina & Rutherford, 2006). The main occupation sector is agriculture for commercial and subsistence purposes (StatsSA, 2011). Makhado Local Municipality is held under communal tenure and is under the control of traditional (tribal) leaders.

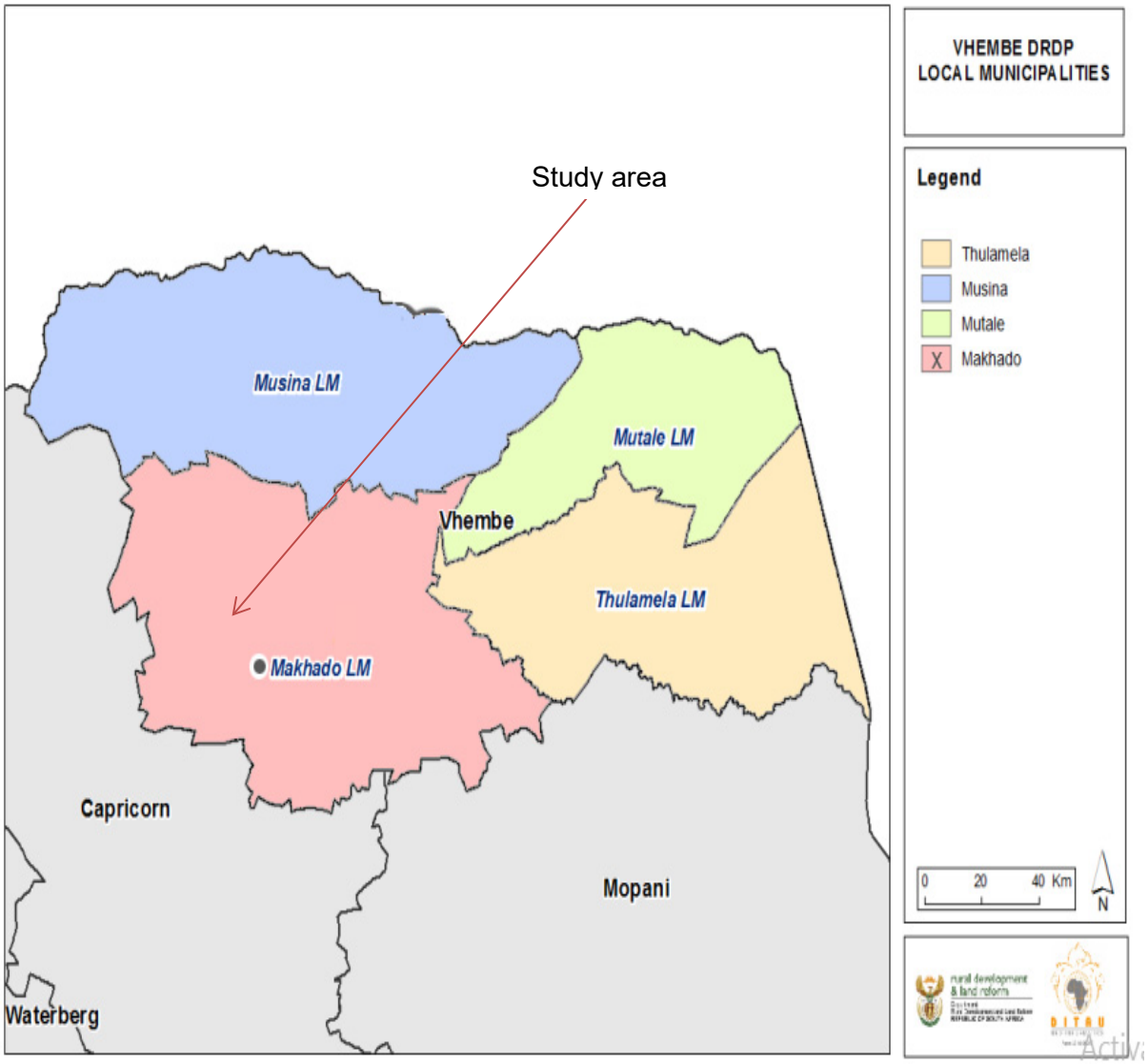

Figure 3. 1: Map showing the location of Makhado Municipality (Htonl, 2016)

3.3. Research Design

In the current study, a sequential exploratory mixed method research design was employed (Figure 3.2). This design was deemed appropriate because of its ability to explore the phenomenon in question (Berman, 2017). In an exploratory sequentially integrated research design, qualitative data is first collected and analysed, and themes are used to drive the construction of a quantitative instrument to further explore the research problem (Creswell & Plano Clark, 2011; De Vos, 2010).

3.4. Training in Data Collection Tools

Data collection tools were constructed to obtain data that relates to the study objective and its research questions. In this study, two data collection tools were designed viz, semi-structured interview guide and close-ended questionnaire. One research assistant was recruited and taken through lessons designed to be familiar with the objectives of the study. Research assistant was recruited based on the knowledge of data collection and the ability to administer data collection tools using local languages. Training of the research assistant was focusing on how to administer data collection tools and the ethical protocols.

3.5. Community Entry

Permission to conduct the study was sought from the Limpopo Department of Agriculture. This was done by writing a permission letter to the Head of the Limpopo Department of Agriculture. Therefore, a meeting was set with the chief of the area where the irrigation schemes are located to seek permission to conduct a study in the community with small-holder farmers. Through liaison with a royal family member, a meeting to introduce the study was held with the chief and a written information on the study was provided. For community entry, the Limpopo Department of Agriculture notified the extension officer to set a meeting with the researcher. Thereafter, communicating with the extension officer provided a gateway and enabled meetings with the farmers and other stakeholders in irrigation schemes. During the meetings, the study was presented to the farmers, scheme committee members and extension officers. Furthermore, the above stakeholders were provided with a written information sheet in support of the verbal explanation of the study.

3.6. Study Population and Sampling Procedures

According to De Vos (2010), population refers to the overall sum of objects or subjects within an area. Landry (2010) also defines population as a group of individuals or elements sharing similar characteristics. In this study, population included famers in the three selected irrigation schemes. These individuals were deemed suitable to participate in the study because they possessed the desired characteristics, viz, practicing irrigation farming at the three selected irrigation schemes, hence they gave relevant and most valid information.

Purposive sampling technique was used to select 24 registered farmers who participated in phase 1 of the study. Purposive sampling was preferred because of its ability to allow the researcher to focus on characteristics of a population that are of interest, which best led to answering relevant research questions (Palys & Atchison, 2008). During phase 2 of the study, census sampling method was used to purposefully select 56 registered farmers to participate in the study. That is, 32 from Mamuhohi, 16 from Mandiwana and 8 from Raliphaswa irrigation schemes. The use of census was seen appropriate because inclusion of the whole available population helped to get deep insight about the phenomenon and it reduced the risk of missing potential insight from members that are not included.

3.7. Data Collection Methods and Techniques

Qualitative and quantitative data was collected through a two-phase sequential integrated study. In the following section, qualitative data collection methods and techniques are presented first.

Phase 1: Qualitative data collection methods and techniques

Qualitative data were collected through face-to-face interviews using semi structured interview questions which were administered to 24 registered farmers. The following uniform set of semi-structured questions were used to guide the face-to-face interviews.

a) Which institutions are involved in irrigation water governance and their roles in irrigation schemes at Nzhelele area?

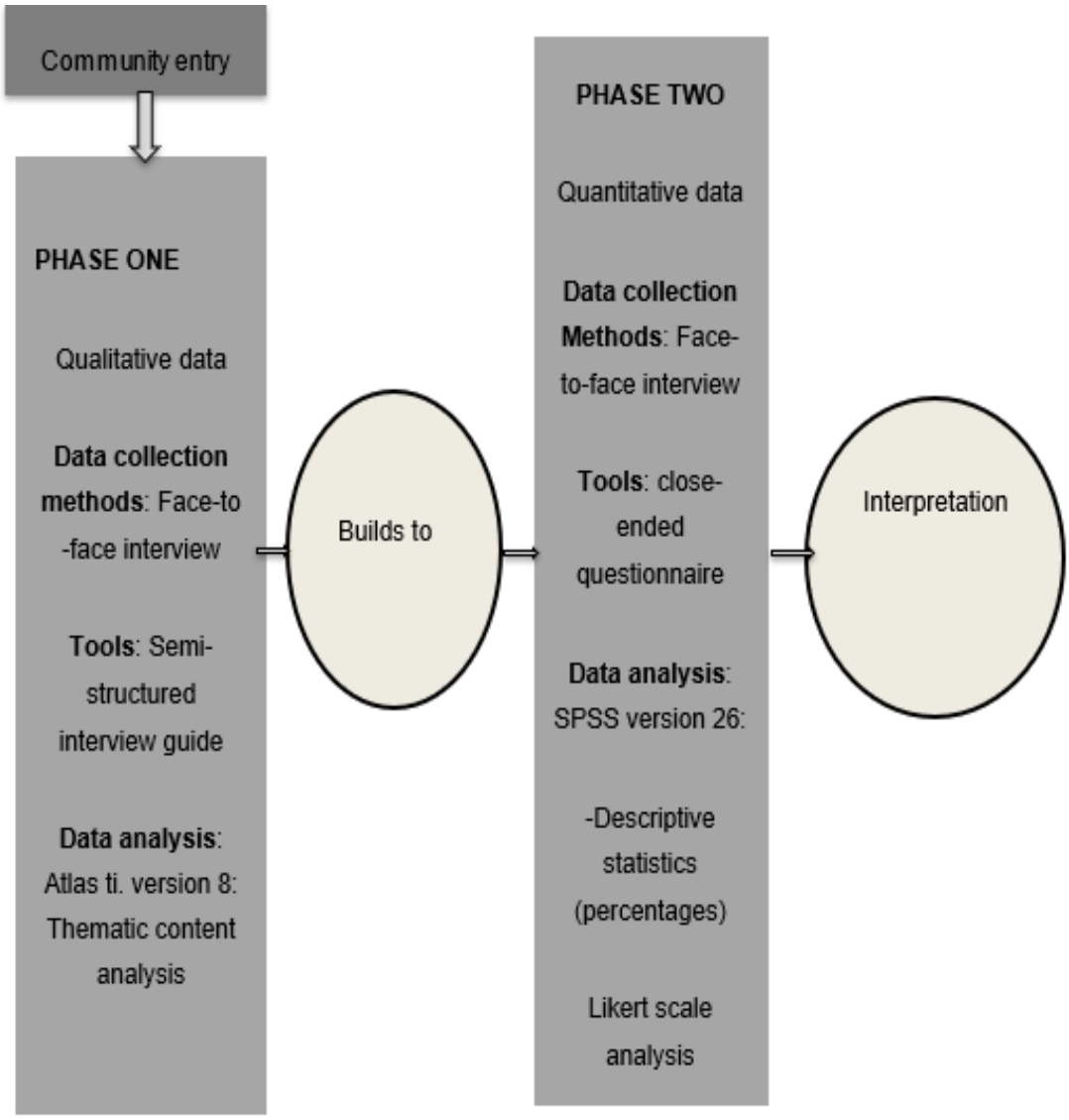

Figure 3.2: Schematic presentation of a sequential exploratory mixed method research design**.**

b) Which institutions are involved in irrigation water governance and their roles in irrigation schemes at Nzhelele area?
c) What are the challenges that small-holder farmers face regarding water governance system at Nzhelele irrigation schemes?
d) Which strategies can be used to address the water governance system challenges faced by small-holder farmers at selected irrigation schemes in Nzhelele area?

Phase 2: Quantitative data collection methods and techniques

During phase two, qualitative data obtained through the face-to-face interview was used to construct a face-to-face close ended questionnaire.

The questionnaire had 14 statements requiring responses on a 5-point Likert-type scale of 1 (strongly disagree) to 5 (strongly agree) (Appendix B). The first section of the questionnaire covered the demographic characteristics of the participants such as gender, age, marital status, sources of income and level of education. The second section covered the respondents' perceptions on the efficacy of the rules and regulations governing water and the challenges faced by small-holder farmers regarding water governance system at selected irrigation schemes at Nzhelele area. The questionnaire was administered to 56 registered farmers. Before its use in data collection, the questionnaire was pre-tested with 10 randomly selected farmers at Vhutuwangadzebu irrigation scheme. This scheme was chosen because it has similar characteristics with the three selected schemes under survey. Piloting the questionnaire entails the inclusion of few individuals who possess the desired characteristics who will not form part of the sample (De Vos, 2014). None of those who participated in the pre-testing were included in the final survey. The results of the pre-test were used to revise a draft questionnaire.

3.8 Ethical Consideration

Prior to the commencement of this study, ethical clearance certificate was sought from the University of Venda Ethics Committee. The study complied with the code of ethics which has been proposed by the University of Venda. In addition, permission to conduct the research was sought from the Limpopo Department of Agriculture (Appendix B). Negotiations for entry into the study area was done with community traditional leaders (i.e., the Chief and the village Headman) and extension officers in each of the three selected irrigation Schemes. In line with

the views of De Vos *et al*. (2012), the following key ethical principles underpinned the execution of the study.

The researcher enlightened the participants of the general nature of the research, which included the expected duration of their participation, the proceeding of the interviews and questionnaire, possible advantages and disadvantages and dangers of the participants that they may be exposed to, so they can make an informed decision on whether to participate in this study (Creswell, 2013). Also, a written consent form entailing brief information of the study was handed to each participant to sign and commit to participate in the study (Appendix C). Furthermore, in line with the informed consent principle, the participants were further informed to withdraw from participating in the study at any level of data collection. The participants were guaranteed that all the information obtained from them will not be made known to anyone other than the researcher, thus it was very confidential and their responses will be made anonymous. It was made known to the participants that there was no foreseen research related injury except any unforeseen issues they may face on their everyday lives. Moreover, participants were informed of the voluntary participation and that there are no research related costs which they will have to cover.

3.9. Data Analysis

Qualitative data which was obtained through face-to-face interviews was cleaned, transcribed and entered into Microsoft excel spreadsheet. Thereafter, data was imported into ATLAS.ti software version 8.0 to perform thematic content analysis. Thematic content analysis involves coding text and developing key themes. Thus, data quotations were selected and assigned codes.

Quantitative data was coded and stored into MS Excel spreadsheet. Preliminary analysis was conducted to check correctness of entries and outliers. Then IBM Statistical Package for the Social Science Version 26.0 software was used to analyse the data. Descriptive statistics was carried out to calculate percentages of a Likert scale type of data on the question of how effective are water governing institutions in executing their roles within the selected irrigation schemes.

CHAPTER 4: RESULTS

4.1 Introduction

In this chapter, the findings are presented. Demographic information and the characteristics of the farmers are presented. Thereafter, the results on the institutions that are involved in water governance and their roles, effectiveness of irrigation water governance institutions in managing water in the selected irrigation schemes, the challenges faced by small-holder farmers regarding water governance system, and the strategies that can be used to address the water governance system challenges faced by small-holder farmers at selected irrigation schemes in Nzhelele area, Vhembe District, are presented.

4.2 Demographic Information

Table 4.1 presents the demographic information of the farmers at selected irrigation schemes in Vhembe District. Mandiwana (62%) and Mamuhohi (75%) irrigation schemes were dominated by females while Raliphaswa irrigation scheme was dominated by male farmers (62.5 %). In general, females constituted most of the farmers in all the schemes. Three quarters (75 %) of the respondents at Raliphaswa irrigation scheme were married. Half (50%) of the respondents in all the three schemes had acquired secondary education. On average, 17.7% of respondents had obtained tertiary qualifications however, Raliphaswa had a score above the average (37.5%) for those with tertiary qualifications. In terms of age groups, all respondents at Raliphaswa were 65 years old and above. The same age group represents the largest group of all farmers at 56.3%.

Table 4.1: Demographic information of the farmers in the selected irrigation schemes in Vhembe District **(N =56)**

Category	IRRIGATION SCHEME (%)			Overall percentage
	Mandiwana	Mamuhohi	Raliphaswa	
Number of Respondents	28.6%	57.1%	14.3%	100%
Gender				
Female	62.5%	75%	37.5%	58.3%
Male	37.5%	25%	62.5%	41.7%
Age				
Below 25 years	6.3%	00.0%	00.0%	2.0%
26-35 years	12.5%	9.4%	00.0%	7.3%
36-45 years	12.5%	9.4%	00.0%	7.3%
46-55 years	12.5%	15.6%	00.0%	9.4%
56-65 years	31.3%	21.9%	00.0%	17.7
Above 65 years	25.0%	43.8%	100.0%	56.3
Marital status				
Single	12.5%	18.8%	12.5%	14.6%
Married	68.8%	53.1%	75.0%	65.6%
Divorced	00.0%	0.00%	12.5%	4.2%
Widowed	12.5%	25.0%	00.0%	12.5%
Separated	6.3%	3.1%	00.0%	3.1%
Education				
No Formal Education	12.5%	34.4%	12.5%	19.8%
Primary	25.0%	12.5%	00.0%	12.5%
Secondary	50.0%	50.0%	50.0%	50%
Tertiary	12.5%	3.1%	37.5%	17.7%

4.3 Primary Reasons for Engaging in Farming

Most (30.4%) farmers joined the scheme to produce food for own household consumption (Table 4.2). A quarter (25%) of the farmers joined with intention to generate household income. A little over a fifth of the respondents were motivated by the passion for farming.

Table 4.2: Primary reasons for engaging into farming

Reasons for farming	Percentage (%)
To support the family	5.4%
Household consumption	30.4%
Income generation	25.0%
Passion	21.4%
Hobby	7.1%
Unemployment	5.4%
Improved livelihoods	5.4%
Total	**100.0%**

4.4 Income generating activities farmers were involved in before farming

Figure 4.1 presents income generating activities done by farmers before joining the irrigation scheme. The results show that farmers came from different backgrounds in terms of their careers. Prior to taking farming as a career, majority (29%) of the farmers were unemployed, some undertook part-time jobs (23%) whereas others were in construction business (18%).

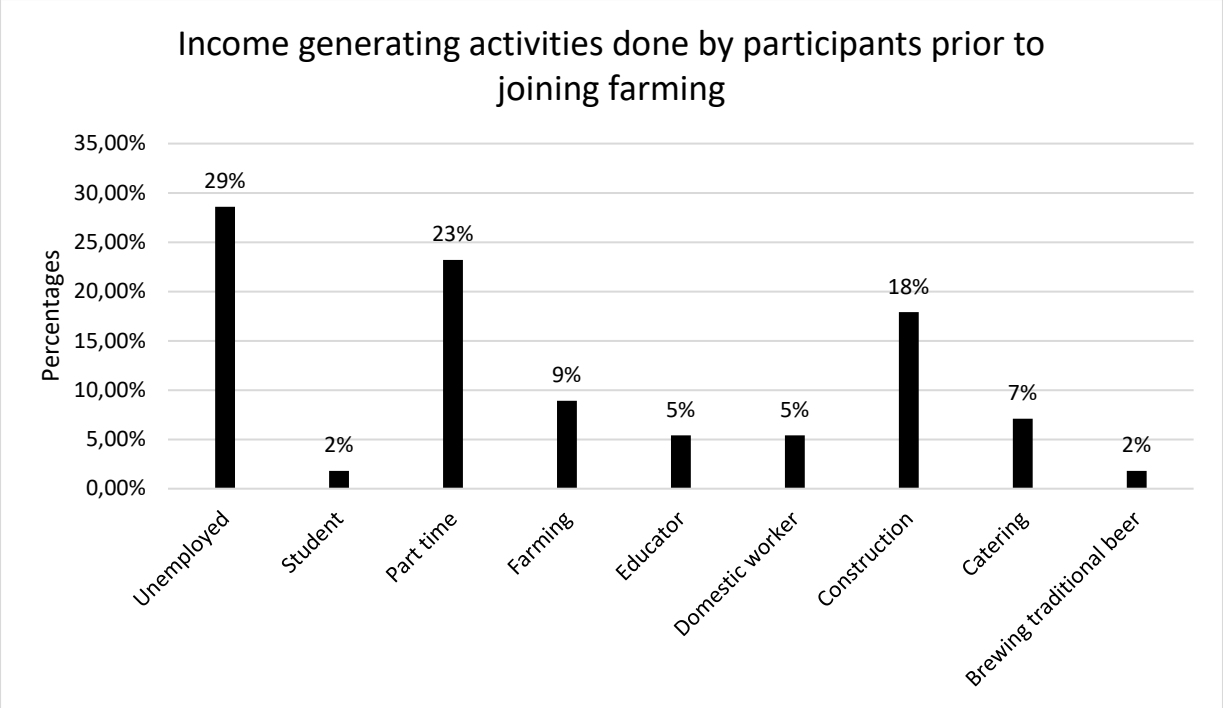

Figure 4.1: Activities which farmers were involved in before farming

4.5 Land tenure systems of the smallholder farmers

Figure 4.2 presents land tenure systems of smallholder farmers in the selected irrigation schemes in Vhembe District. Above half (52%) of the farmers owned the land while only 38% had Permission to Occupy (PTO).

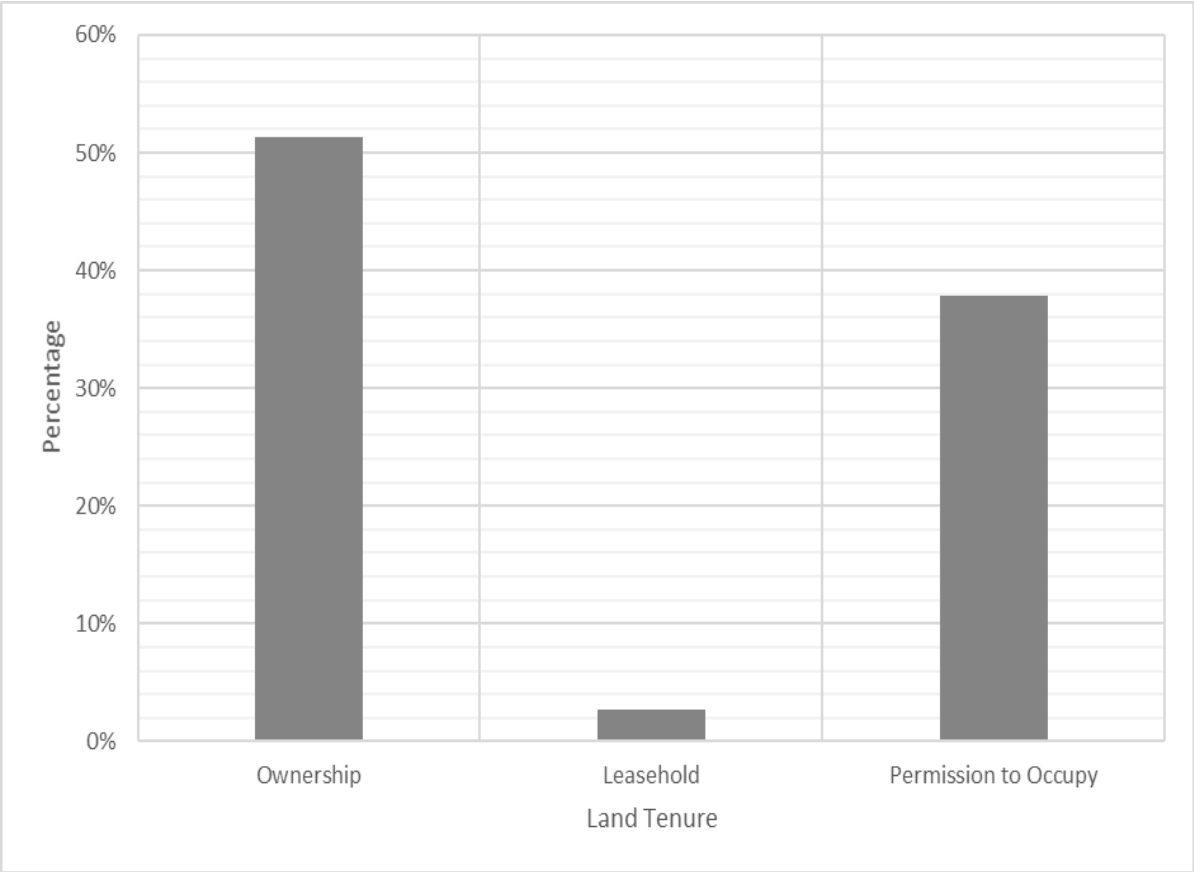

Figure 4.2: Land tenure systems of the smallholder farmers in the selected irrigation schemes in Vhembe

4.6 Sources of Income for smallholder farmers

Table 4.3 presents sources of income for smallholder farmers. The findings revealed that although not necessarily in the majority, a higher proportion (45.7%) of farmers generated their income through agriculture while 37% supplement their income through social grants. Other farmers had sources of income from entrepreneurial (8.6%) activities and pension (8.65).

Table 4.3: Sources of income for farmers in the selected irrigation schemes in Nzhelele area, Vhembe district

Sources of income for farmers	Percentage (%)
Pension	8.6%
Grant	37.0%
Business	8.6%
Agriculture	45.7%
Total	**100.0%**

4.8 Crops grown by farmers in summer

Figure 4.3 presents crops grown in summer. About 89% of the farmers planted maize in summer. Farmers indicated that this type of a crop does not require high volumes of water for irrigation, thus they are suitable to be grown throughout the year. Only 21% of them planted sweet potatoes.

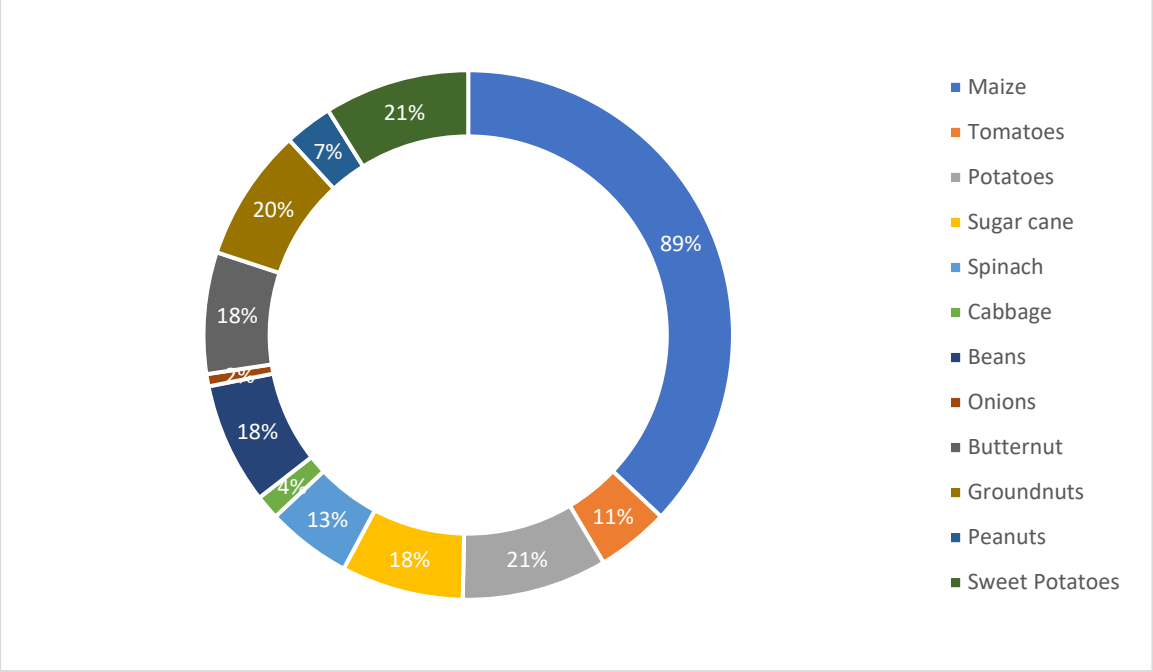

Figure 4.3: Farmers (%) and crops they grow in summer

4.9 Equipment owned by farmers

Table 4.4 presents the results on the equipment owned by smallholder farmers in the selected irrigation schemes of Vhembe District. The majority (91%) of farmers owned hand hoes. About 48% of them owned wheelbarrows while 45% had knapsack sprayers.

Table 4.4: Items/Equipment owned by farmers

Equipment owned by farmers	**Items/equipment owned by farmers in the schemes**	**Proportion of farmers owning the item**
Hand Hoes	166	91.1%
Ox-drawn plough	3	5.4%
Cultivator	3	5.4%
Wheelbarrow	34	48.2%
Trailer	1	1.8%
Tractor	5	8.9%
Tractor-drawn plough	4	7.1%
Knapsack sprayer	28	44.6%
Irrigation pump	8	14.3%
Vehicle	9	16.1%
Water storage facility on your plot for storing irrigation water received	0	0
Rain water harvesting system on your plot	0	0
Borehole or well	0	0
Livestock	61	21.4%
Insurance	1	1.8%
Savings	1	1.8%
Loans	2	3.6%

4.10 Water governance institutions in the irrigation schemes and their roles

Figures 4.4 and 4.5 present the water governance institutions and their roles in irrigation in the selected irrigation schemes. The findings showed that there were various and varied water governance institutions within the schemes. These included Scheme committee, Water Users Association (WUA), Informal water institutions, Department of Water Affairs, Cooperatives, Government Water Schemes (GWS), Irrigation Board (IB) and the traditional leadership. In this section, both qualitative and quantitative results are presented.

4.10.1 Scheme committee

Majority of the farmers (84%) mentioned scheme committee as the main water governance institution in the selected irrigation schemes of Vhembe District. When asked about the roles that the scheme committee plays in relation to water governance, one farmer at Mandiwana irrigation scheme indicated that

"Scheme committee provides us with any kind of support possible in the scheme"

While another farmer at Raliphaswa irrigation scheme revealed that

"The scheme committee is responsible for organising meetings and delivering communiques from other institutions for our attention"

Another farmer at Mamuhohi irrigation scheme stipulated that

"It is the role of the scheme committee to ensure that all the rules and regulations in place are adhered to by the farmers"

4.10.2 Traditional leadership

Another crucial institution revealed by the respondents (16%) was the traditional leadership. When asked about the role that the institution plays, one of the farmers revealed that

"Traditional leadership has the responsibility to resolve conflicts among farmers if the scheme committee has failed to settle that issue"

While another farmer stated

"The traditional leadership deals with those who draw water illegally from the canal"

4.10.3 Other irrigation water governance institutions

Other irrigation water governance institutions that received less percentages though important include the informal water institution (14%) Government water scheme (GWS) (11%); irrigation board (IB) (5%); Department of water affairs (4%) and cooperatives (2%).

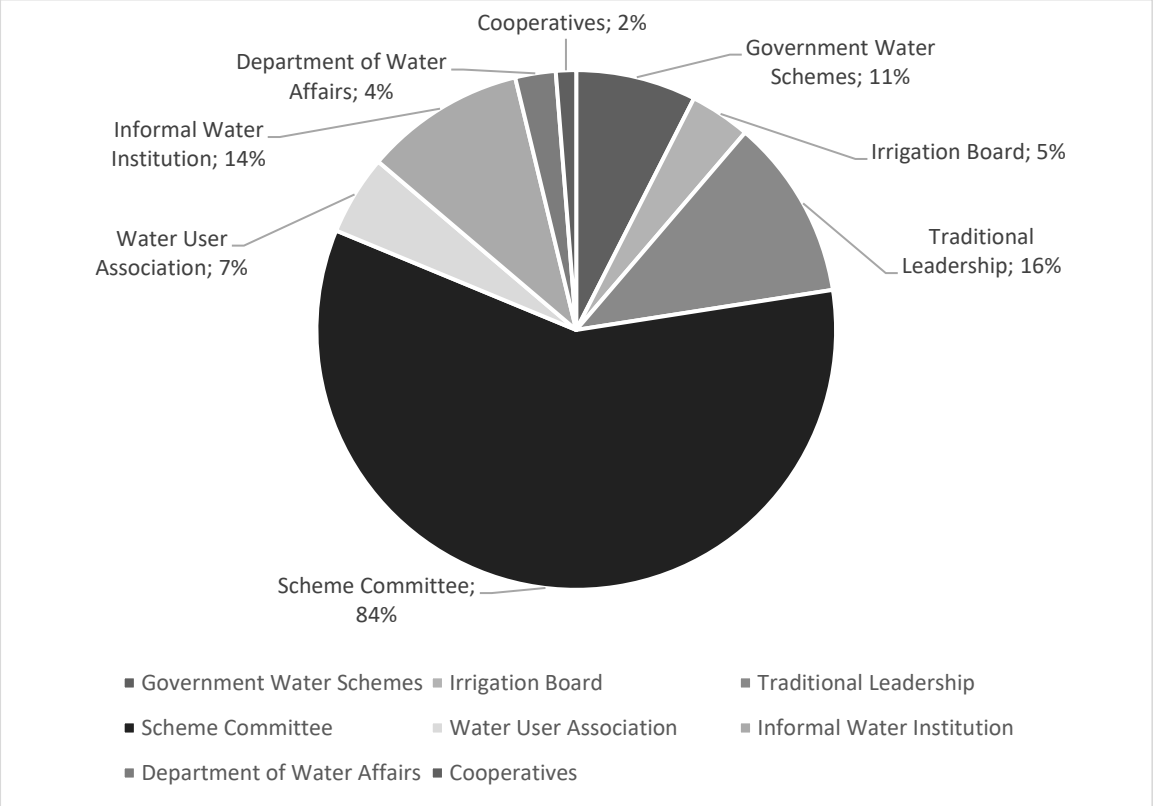

Figure 4.4: Water governance institutions in the selected irrigation schemes in at Nzhelele, Vhembe District.

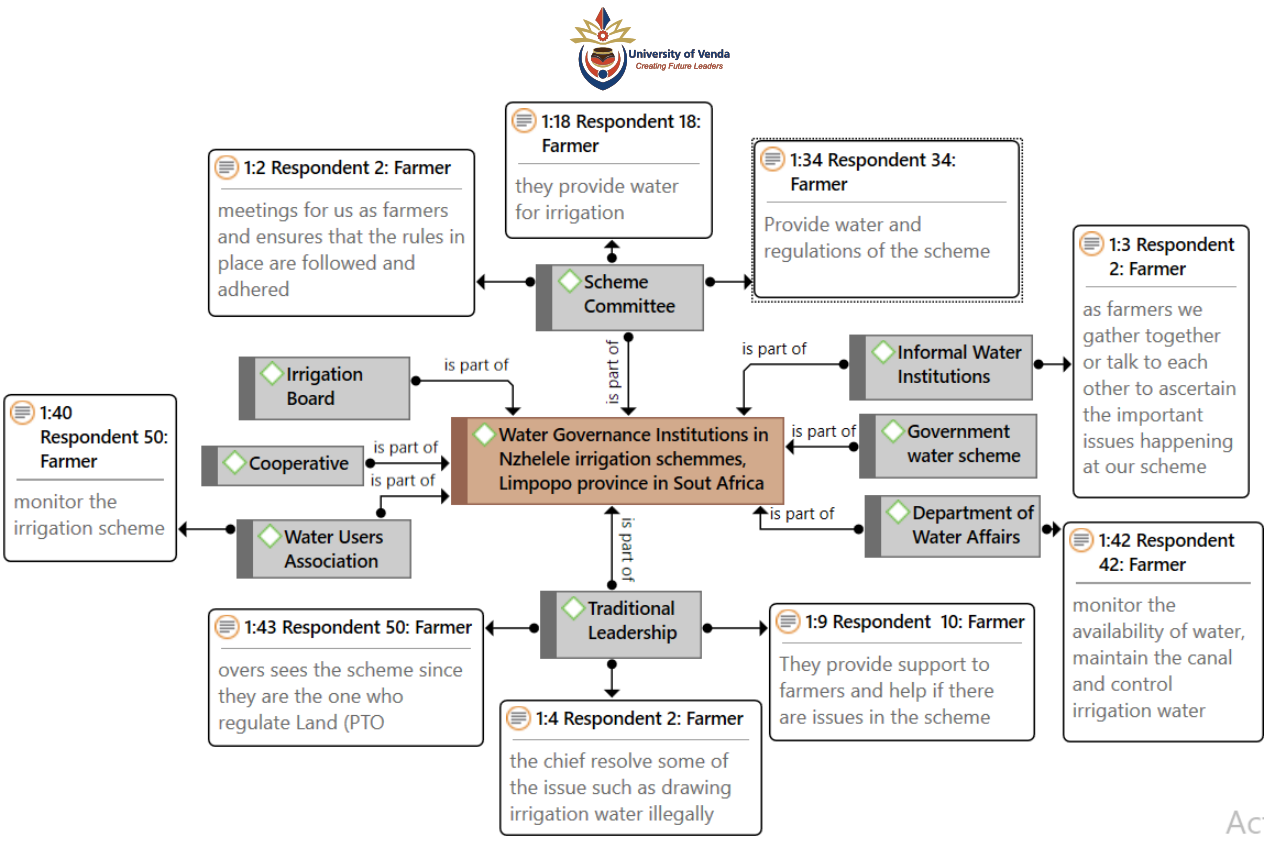

Figure 4.5: Water governance Institutions and their roles in smallholder irrigation schemes in Nzhelele area, Vhembe district

4.11 Farmer perceptions of management and rules effectiveness within the three irrigation schemes

Table 4.5 presents the results on farmer perceptions of management and rules effectiveness within the three irrigation schemes. A high percentage of irrigators (50%) from RAL and MAN (31%) strongly agreed that people use water illegally in the scheme, implying that the majority of irrigators do not adhere to rules and regulations about water use in the scheme. About 43% of the farmers at MAN, 37.5% at RAL and 28.1% at MAM affirmed that farmers are not willing to pay for water use. In all the schemes, majority of the respondents strongly agreed that there is corporation amongst the farmers and scheme management. Farmers from all the selected irrigation schemes strongly affirmed that conflict resolution is handled in a satisfactory way by management. Half (50%) of the respondents at MAN and RAL irrigation scheme indicated that the management is transparent and 75% at MAM affirmed with the perception. Moreover, the results showed that famers adhere to the rules set by scheme management, especially in MAM where above 70% of the farmers comply.

Table 4.5: Farmer perceptions of management and rules effectiveness

Farmer's perspective of rules and management effectiveness	Irrigation scheme	SD	D	N	A	SA
People use water illegally in the scheme (%)	MAN	18.8%	18.8%	12.2%	18.8%	31.3%
	MAM	43.8%	21.9%	3.1%	15.6%	15.6%
	RAL	25.0%	12.5%	0.0%	12.5%	50.0%
Farmers are not willing to pay for water use (%)	MAN	12.5%	12.5%	12.5%	43.8%	18.8%
	MAM	37.5%	15.6%	6.3%	12.5%	28.1%
	RAL	37.5%	12.5%	0.0%	12.5%	37.5%
There is corporation amongst the farmers and scheme management (%)	MAN	12.5%	0.0%	0.0%	37.5%	50.0%
	MAM	6.3%	0.0%	3.1%	25.0%	65.6%
	RAL	12.5%	0.0%	0.0%	12.5%	75.0%
You feel listened to by scheme management (%)	MAN	6.3%	0.0%	0.0%	62.5%	31.3%
	MAM	3.1%	0.0%	0.0%	28.1%	68.8%
	RAL	0.0%	12.5%	0.0%	25.0%	62.5%
You have adequate and meaningful meetings with management (%)	MAN	6.3%	0.0%	6.3%	37.5%	50.0%
	MAM	0.0%	0.0%	6.3%	28.1%	65.6%
	RAL	0.0%	12.5%	12.5%	12.5%	62.5%
All farmers are transparent during meetings with management (%)	MAN	6.3%	0.0%	6.3%	37.5	50.0%
	MAM	0.0%	0.0%	3.1%	31.3	65.6%
	RAL	12.5%	0.0%	0.0%	25.0%	62.5%
Monitoring and control of water at the scheme is good (%)	MAN	12.5%	0.0%	12.5%	37.5%	37.5%
	MAM	0.0%	0.0%	3.1%	31.3%	65.6%
	RAL	0.0%	0.0%	12.5%	37.5%	50.0%
Conflict at the scheme is handled satisfactorily by management (%)	MAN	6.3%	0.0%	0.0%	62.5%	31.3%
	MAM	3.1%	0.0%	0.0%	31.3%	65.6%
	RAL	12.5%	0.0%	0.0%	25.0%	62.5%
There is no corruption at the scheme (%)	MAN	12.5%	18.8%	6.3%	18.8%	43.8%
	MAM	9.4%	12.5%	0.0%	25.0%	53.1%
	RAL	12.5%	0.0%	0.0%	37.5%	50.0%

Scheme management is accountable to the members (%)	MAN	6.3%	0.0%	56.3%	31.3%	6.3%
	MAM	0.0%	3.1%	37.5%	59.4%	0.0%
	RAL	0.0%	0.0%	37.5%	62.5%	0.0%
Scheme management is trustworthy (%)	MAN	12.5%	0.0%	0.0%	37.5%	50.0%
	MAM	3.1%	0.0%	3.1%	25.0%	68.8%
	RAL	0.0%	12.5%	0.0%	37.5%	50.0%
Scheme management is transparent (%)	MAN	12.5%	0.0%	0.0%	37.5%	50.0%
	MAM	0.0%	0.0%	3.1%	21.9%	75.0%
	RAL	0.0%	0.0%	0.0%	50.0%	50.0%
Farmers at the scheme adhere to the rules set by scheme management (%)	MAN	25.0%	0.0%	12.5%	12.5%	50.0%
	MAM	3.1%	0.0%	0.0%	25.0%	71.9%
	RAL	25.0%	0.0%	0.0%	12.5%	62.5%
The penalising of farmers who do not follow the rules is fair (%)	MAN	18.8%	0.0%	6.3%	31.3%	43.8%
	MAM	18.8%	3.1%	12.5%	12.5%	53.1%
	RAL	37.5%	12.5%	25.0%	12.5%	12.5%

Note: **MAN**= Mandiwana irrigation scheme, **MAM**=Mamuhohi irrigation scheme, **RAL**= Raliphaswa irrigation scheme

SD= Strongly Disagree; **D**= Disagree; **N**= Neutral; **A** = Agree; **SA**= Strongly Agree

4.12 Challenges that small-holder farmers face regarding water governance system at Nzhelele irrigation schemes

Figure 4.6 presents the results of challenges that small-holder farmers face regarding water governance system at Nzhelele irrigation schemes. The results revealed the following challenges: ineffective irrigation water governance institutions, vandalizing of irrigation water infrastructure, blockage of main canals to disrupt the flow of irrigation water, lack of irrigation water due to unregistered farming, poor agricultural produce and poor adherence to irrigation schedule.

4.12.1 Poor adherence to irrigation schedule

The results of this study revealed that farmers do not adhere to the irrigation schedule in place. This is evident because some farmers block and divert the flow of water with big stones and sandbags to their plots to enable themselves to irrigate for the whole day. Participant 12 expressed that:

"*Several days where the irrigation schedule points out that it's my day to irrigate, water does not flow into my plot, only to know that those who are situated closer to the Raliphaswa weir have blocked the flow of water with sandbags".*

4.12.2 Irrigation water shortage due to unregistered farming

Unregistered farmers secure small plots (*zwidima*) adjacent to the main fields to which they divert water from the canals. Consequently, registered farmers fail to effectively irrigate their crops because there are no arrangements in place on how irrigation water is to be shared amongst the registered and the unregistered farmers. Participant 10 indicated that:

Irrigation water is just not enough for registered farmers, so it gets worse when those who are not registered also get to irrigate, especially with no irrigation schedule they are adhering to"

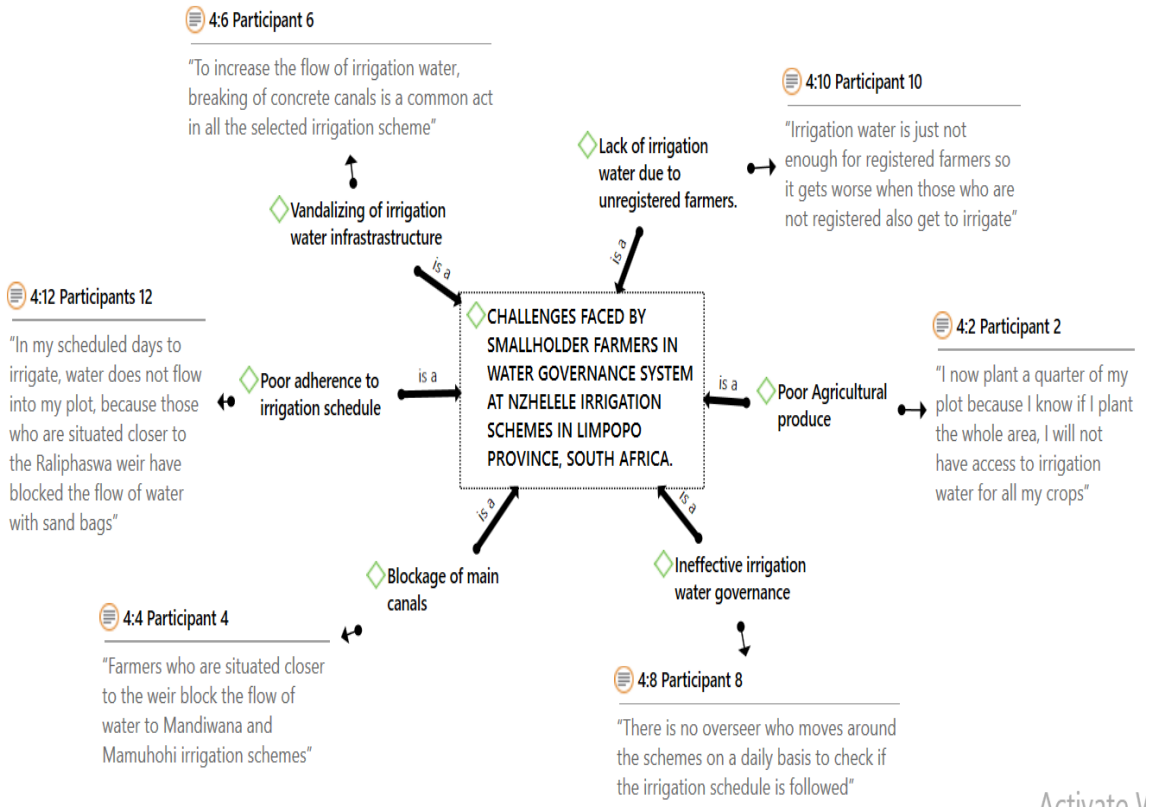

Figure 4.6: Challenges faced by small-holder farmers in water governance systems at the selected irrigation schemes at Nzhelele area, Vhembe District

4.12.3 Ineffective irrigation water governance institutions

The results of this study revealed that some farmers deliberately do not follow the set of rules and regulations in place because they view water governing institutions as ineffective to execute their roles and responsibilities. The leading farmers assigned to oversee the arrangements do not have capacity to enforce them on all the farmers. Participant 8 of the farmers expressed that:

"I divert water using sandbags because there is just not enough water for every farmer to effectively irrigate. Moreover, I know that if I get to be reported for that, the disciplinary measures will only be in talking"

Another farmer alluded that:

"I do irrigate in days which are not allocated to me, because chances are that I might be seen or not be seen by the management because there is no overseer who moves around the schemes on a daily basis to check if the irrigation schedule is followed"

4.12.4 Vandalizing of irrigation water infrastructure

The findings of this study revealed vandalizing of irrigation water infrastructure as one of the challenges faced by farmers within the selected irrigation schemes in Nzhelele area, Vhembe district. The main canal at Mandiwana scheme (Figure 4.7) has been vandalised presumably to enable or to increase the flow of water to Mamuhohi irrigation scheme. Participant 6 indicated that:

"To increase the flow of irrigation water, breaking of concrete canals is a common act in all the selected irrigation scheme"

While another farmer indicated that:

"We are tired of contributing money to patch vandalized infrastructure because of selfish farmers"

Figure 4.7: A vandalised dry main canal at Mandiwana irrigation scheme

4.12.5 Blockage of main canals to disrupt the flow of irrigation water

The findings of this study revealed that, the main canal in Raliphaswa gets blocked preventing the flow of water to Mandiwana and Mamuhohi irrigation schemes (Figure 4.8). Participant 4 from Mamuhohi irrigation scheme indicated that:

"The crops in Raliphaswa irrigation scheme are usually in good condition because they have access and control to irrigation water. This is because farmers who are situated closer to the weir block the flow of water to mandiwana and mamuhohi irrigation schemes"

Figure 4.8: Offtake pipes and rocks for informal water abstraction

4.12.6 Poor agricultural produce

The acts of farmers who divert irrigation water, particularly the Raliphaswa farmers, agricultural production is minimized. The crops in Mandiwana and Mamuhohi irrigation scheme irrigation were wilting or had stunted growth due to water shortage (Figures 4.9 and 4.10). This has reduced the crop yields due to lack of irrigation water. Participant 2 from Mamuhohi irrigation scheme indicated that:

“I planted butternut crop and they died at an early stage because there was no water to irrigate, it was a loss to me”

Another farmer indicated that:

“*I now plant a quarter of my plot because I know if I plant the whole area, I will not have access to irrigation water for all my crops”*

Figure 4.9: Maize drying due to lack of water at Mandiwana irrigation scheme

Figure 4.10: Fallow farms at Mamuhohi irrigation scheme

4.13 Strategies for addressing water governance challenges

Figure 4.11 presents the results on the strategies that can be used to address the irrigation water governance system challenges faced by small-holder farmers at the selected irrigation schemes in Nzhelele area. The results revealed the following major strategies which can be used to address irrigation water governance challenges: doubling of fines, hiring an overseer, register unregistered farmers, accountability by only those found guilty.

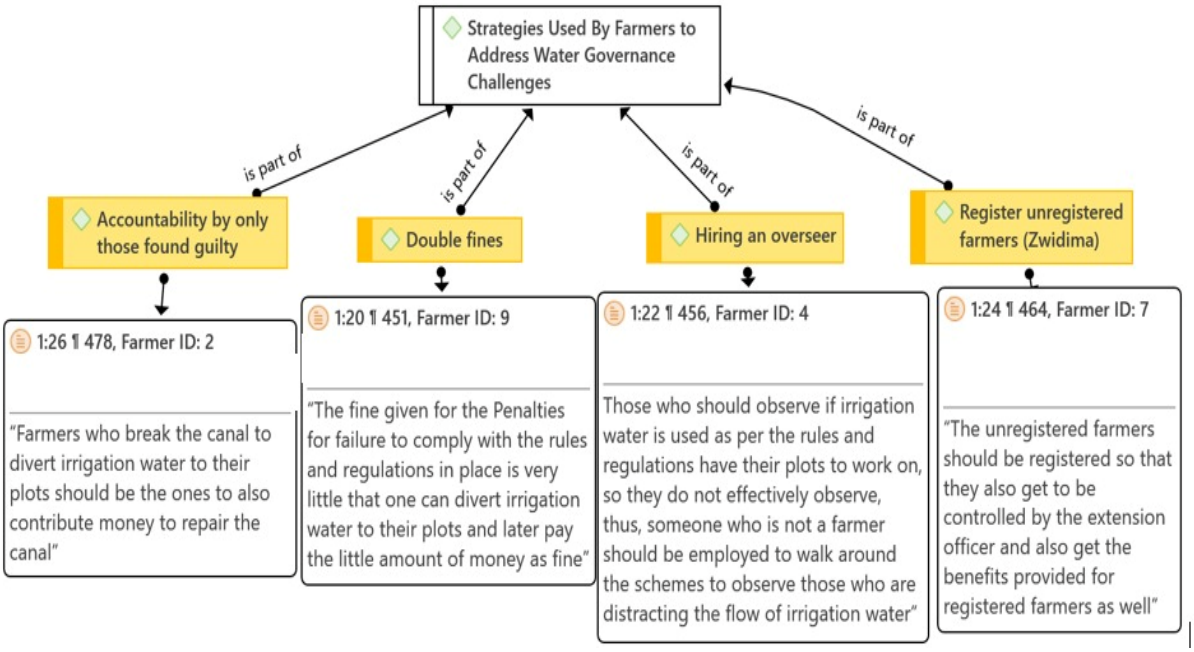

Figure 4.11: Strategies that can be used to address the irrigation water governance system challenges faced by small-holder farmers at selected irrigation schemes in Nzhelele area

4.13.1 Increased monetary fines

Farmers in this study revealed the raising of fines as one of the strategies which can fight the challenges faced by famers regarding irrigation water. The farmers are usually fined five hundred rands, thus, the farmers indicated that the fine should be doubled to R1000.00. One of the farmers at Raliphaswa irrigation scheme expressed that:

"The fine given for the penalties for failure to comply with the rules and regulations in place is very little that one can divert irrigation water to their plots and later pay the little amount of money as fine"

Another farmer at Mamuhohi irrigation scheme alluded that:

"The amount of money for fines should be increased so that we don't find it simple to break the rules and regulations set"

4.13.2 Hiring an overseer

The results in this study showed that farmers believed that employing someone who will observe all the activities done in the scheme on a daily basis could effectively address the challenges faced by farmers regarding irrigation water governance within the selected schemes. This was suggested by one of the farmers at Mandiwana irrigation scheme who indicated that:

"Those who should observe if irrigation water is used as per the rules and regulations have their plots to work on, so they do not effectively observe, thus, someone who is not a farmer should be employed to walk around the schemes to observe those who are distracting the flow of irrigation water"

4.13.3 Register the unregistered farmers (Zwidima)

The findings of this study revealed that unregistered farmers should be registered because they are using the same irrigation infrastructure and irrigation water with the registered farmers. Thus, they must be part of the irrigation schedules and meetings. One of the farmers stated that:

"Farmers who are practicing farming in Zwidima should be registered and be part of us because they are using the same irrigation water and infrastructure like us who are registered"

While another farmer indicated that:

"The unregistered farmers should be registered so that they also get to be controlled by the extension officer and also get the benefits provided for registered farmers as well"

4.13.4 Accountability to those found guilty

The study revealed that farmers who break the concrete canals should be held accountable for the repair of the canals. They further indicated that some farmers break the canal to divert water with no worries of how the canal will be fixed because they know that after all everyone will contribute money to repair parts of the canal which are broken. One of the farmers indicated that:

"Farmers who break the canal to divert irrigation water to their plots should be the ones to contribute money to repair the canal"

CHAPTER 5: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The chapter presents the discussion of the findings based on the study objectives. The demographic profile of respondents is discussed. The conclusions drawn from the study findings are outlined to synthesise the results. Recommendations, areas of future research, and limitations of the study occupied the last sections of this chapter.

5.2 Discussion

In general, most farmers who participated in the study were predominately females. The findings of this study imply that farming activities are undertaken by female compared to male counterparts in the selected irrigation schemes. This could be because women are considered as chauffeurs of the local economy amounting to 80% of farmers involved in smallholder farming in sub-Saharan Africa (FAO, 2012). Machete (2020) & Chifamba *et al*. (2013) allude that agricultural farming has been the help to many women for securing food and income in their households. In all the irrigation schemes, the majority of the farmers were married with an overall percentage of over 65%. El-Zoghby *et al*. (2020) indicate that married individuals are more productive in what they execute because they have support from their spouses. Based on the above claim, the dominance of married farmers in the study could mean that they receive support from their spouses in their agricultural activities. The majority (62.5%) of the farmers had attained primary and secondary education. Machete (2020) claims that educational background is crucial even though it is not related to a specific field because such education can still be deployed to improve farming activities. The findings of this study revealed that the majority of the farmers were above 65 years, thus it implies that registered farmers were mostly old people in the selected irrigation schemes. However, a study conducted by Njeru & Gichimu (2014) on “Influence of access to land and finances on Kenyan youth participation in agriculture” revealed that young people do not engage in agricultural activities because they view it as a low-status income-generating activity with a belief that agriculture requires a lot of physical strength. Simango (2015) found that young people mostly engage in off-farm activities like fixing cars, washing cars and welding.

A large proportion of farmers revealed that the main reason for engaging into farming was to produce food for household consumption. In support of this, Mbatha *et al*. (2021) indicate that subsistence farming is important to address the challenges of household food insecurity. Haung *et al*. (2021) maintain that producing own food for household consumption is cheaper compared to buying it in shops. Furthermore, the findings of this study revealed that some farmers got involved in farming as an idea to generate income. Income generated through farming has helped in poverty reduction and improving standards of living (Liu *et al*., 2020). The results of this study showed that about 21% of the farmers got involved into framing because of passion. These results imply that farming with passion helps in working hard for great production despite any other circumstances like water shortage.

Prior to farming, farmers in three selected irrigation schemes were involved in various income generating activities. However, the majority of them were unemployed. This implies that agriculture has been a great source of employment and income generating activity to many farmers within the villages where the three selected irrigation schemes are located (Note, 2018; Christiansen *et al*., 2021). Note (2018) & Christiansen *et al*. (2021) allude that agriculture has been playing a vital role in job creation especially in developing countries. The findings further revealed that some farmers undertook part-time jobs while others were in construction. The fact that farmers in this study were engaged in construction and other piece jobs would mean that, they could deploy some of the skills in maintenance of the schemes for example, repairing the broken canals. Resultantly, this will reduce the amount of money to be contributed for labour purposes.

Farmers within the three selected irrigation schemes fall under different land tenure systems. Above half of them had land ownership right compared to those who had permission to occupy (PTO). Those with land ownership indicated that they worked hard and greatly invested in their lands for high production. This was because there had no threats of land tenure insecurity. In support of this, Fanadzo & Ncube (2018) claim that land tenure insecurity has been a major cause of poor agricultural production in irrigation schemes in South Africa.

Agriculture has become an attractive way to generate income and improve the standards of living especially in rural areas (Osabohien *et al.*, 2020). In line with this, the respondents in the current

study revealed that they generated income through agricultural practices. These results were also confirmed by Woyesa & Kumar (2012) who found that in the African continent, people are diverting to agriculture in order to generate income. Apart from agricultural activities, farmers supplemented their income through social grants, entrepreneurial activities and pensions. The respondents claimed that these extra sources of income assisted them to acquire more agricultural inputs for great production (Oladipo *et al*., 2019).

The farmers in the selected three irrigation schemes produced crops in both summer and winter seasons. The majority of them indicated that they produce maize crops in both summer and winter. This could be because maize is consumed as a staple in the African region including South Africa, where intake ranges from 52 to 450 g/person/day (Ekpa *et al*., 2019; Ranum *et al*., 2014). However, Maize intake in the African regions differs from the consumption in the Latin American region where the intake varies from 50 to 267 g/person/day (Ranum *et al*., 2014). Ekpa *et al*. (2019) reveal that maize accounts for 40% of cereal production in sub-Saharan Africa, where more than 80% is used as food. ŽIlić (2012) & Serna-Saldivar (2016) stated that maize is also considered an important source of nutraceuticals known to enhance health and prevent diseases, this includes yellow maize, blue maize and red maize. The respondents claimed that maize crops were commonly grown in three selected irrigation schemes because they did not require high volumes of water for irrigation and therefore, suitable to be grown throughout the year.

Respondents in three irrigation schemes owned various and varied equipment for agricultural activities. However, the majority of them owned hand hoes and wheel barrows. This could be because farmers do not have the financial resources to purchase vital modern farming equipment such as tractors, irrigation pump and vehicle or trailer (Akimowicz *et al*., 2016). The above claim is also supported by Lajoie-O'Malley (2020) who stated that smallholder irrigation schemes often do not have the capital to buy big machinery or advanced farming equipment. Mechanisation is regarded as a motor for agricultural transformation, however many farmers in the Sub-Saharan countries are still using hand hoes and ox drawn plough (Van Loon *et al*., 2020).

The results of this study revealed that there were various water governance institutions within the irrigation schemes. These included scheme committees, traditional leadership, government

waster schemes, irrigation board, Department of Water Affairs and cooperatives. Each institution played a different role for the smooth operation of the schemes.

The study revealed that the scheme committee was the main institution that played a vital role in the governance of irrigation water within the selected schemes. Importantly, each irrigation scheme had its own committee. It was further revealed that the main role that the committee members played was to address water-related challenges encountered by farmers. For example, the committee was responsible for organising meetings and water irrigation schedules. This is in line with the findings of Mudhara & Senzanje (2020) who confirm that irrigation scheme committees are water governance institutions which deal with the provision and sharing of irrigation water. In line with this, Mwadzingeni *et al.* (2021) further reveal that irrigations scheme committees are the engines of the success of irrigation schemes.

Traditional leadership was another functional institution that governed the irrigation schemes in the study area because traditional leaders are custodians of land and they play a crucial role in land allocation including the irrigation schemes. Added to this was their role in resolving any other issues arising from the community. Muchara (2014) supports the findings of this study by indicating that traditional leadership play a crucial role of punishing farmers who drew water illegally from the canal and ensure water security within the irrigation schemes.

Informal water institutions were also found to be crucial in water governance issues within the schemes. These were formed by farmers themselves to address challenges encountered in the schemes. Namara *et al*. (2010) is in agreement with the findings whereby they confirmed that farmers formulate their own rules and regulations to solve their own issues. Mudhara & Senzanje (2020) claim that farmers tend to be compliant with rules and regulation they formulated because they seem to align and to be relevant to their challenges. Other water governance institutions revealed in this study were Government water scheme (GWS); irrigation board (IB); Department of water affairs and cooperatives. Although these are important, they received fewer percentages because the respondents claimed that they received inadequate support from such institutions. Mudau (2010) claims that since the implementation of land reform programmes in South Africa, there has been limited support by government institutions to farmers, hence failure is normative in many Small-holder Irrigation Schemes (SISs) in South Africa. Chikazunga & Paradza (2012)

assert that small-holder irrigation schemes are unproductive because they lack financial support from public institutions to assist poor rural farmers.

Farmers perceived that the scheme management is unable to manage the activity of water theft within the selected schemes. Water theft was a common practice in the three selected irrigation schemes. The respondents complained about some farmers who use water illegally. This was the evidence that some irrigators did not adhere to set rules and regulations. These results are in agreement with those of Abdelhaleem *et al*. (2021) in a study conducted in Fayoum, Egypt. The scholars claim that farmers did not adhere to water allocation schedule and management rules. Resultantly, other farmers were unable to irrigate effectively. Furthermore, the results revealed that the majority of farmers were not willing to pay for the water that they used. This implies that the majority of farmers benefited from using irrigation water at the expense of the few who paid. The fact that farmers refused to pay for the water could be because there were no strong penalties imposed for such an act. A similar observation was made in a study conducted by Dlangalala (2018) whereby the majority (85.6%) of farmers did not want to pay for water they used because they believed that water is a natural resource. Moreover, Fanadzo & Ncube (2018) are of the view that farmers are only willing to pay for reliable water access.

In all the schemes, the majority of the respondents strongly agreed that there was cooperation and transparency amongst the farmers and scheme management. This could be because they frequently hold meaningful meetings to deliberate on matters affecting them as indicated earlier. In addition, the respondents strongly affirmed that conflict resolution is handled in a satisfactory manner by the scheme committee. This could be because the scheme committee resolved conflicts with farmers in dispute before the matter was taken to the traditional authorities or high courts. Similarly, in studies conducted by Deribe (2008) & Dlangalala (2018), farmers in dispute resolved their conflicts before they were taken to institutions which deal with conflict resolutions like the traditional authorities or the scheme committee.

Despite the roles that the water governance institutions played in the three irrigations schemes; farmers were faced with various water related challenges. The findings revealed that some farmers failed to adhere to the irrigation schedules set by scheme committee. Those whose farms were located close to the weir, blocked water canals with sandbags and big rocks to divert water

to their plots. This illegal irrigation practices disrupted water sharing schedules as it led to water shortage for overall coverage of schemes (Adekunle *et al.,* 2015). These findings confirmed those of Mudau (2010) that smallholder farmers in the study area are known for illegally diverting water using sandbags, rocks or pieces of corrugated iron.

Drawing water illegally by unregistered farmers was also rife in the study area because the unregistered farmers resorted to stealing water as they were excluded in water irrigation schedules provided by scheme committee. The uneven distribution of water has led farmers to compete for water. As a result, several farmers do not receive water when they needed it (Garthwaite, *et al*., 2017). Similar predicament has caused conflicts and disputes between farmers at Tsvovani Irrigation Scheme in Zimbabwe which led to the underdevelopment of the schemes (Mutambara & Munodawafa, 2014). Chukwuone (2018) claims that a shortfall of this nature cripples the operation in irrigation schemes, leading to dissatisfying farming projects for farmers.

Farmers in the selected irrigation schemes deliberately did not follow the set of rules and regulations because they viewed water governing institutions as ineffective to execute their roles and responsibilities. Moreover, the committee did not have the capacity to enforce rules to all the farmers. In support of this, Dlangalala & Mudhara (2020) revealed that small-holder irrigated agriculture in South Africa encounters inadequate supply of irrigation water emanating from poor scheme governance, with weak institutional arrangements that lack the capacity to govern water resource equitably and effectively.

Vandalizing of irrigation water infrastructure was a common practice within the selected irrigation schemes. This is worsened by the fact that this act was practiced by farmers themselves in order to increase the flow of water to their plots. Van Koppen *et al.* (2017) indicate that breaking of irrigation infrastructure to increase the flow of water has been affecting the efficacy of the schemes in terms of water sharing and scheme maintenance. Mudau (2010) also confirmed that breaking of concrete canals to divert irrigation water has been a challenge in Nzhelele irrigation schemes. Thus, hindering farmers situated closer to the dam to effectively irrigate.

The findings of this study revealed that irrigation water get blocked in the main canal at Raliphaswa irrigation scheme. This prevented the flow of water to Mandiwana and Mamuhohi

irrigation schemes. Some farmers used huge stones and sand bags to divert water to their plots. Similar illegal irrigation activities were reported in studies conducted in Malawi by Douglas *et al*. (2018) and in South Africa by Mudau (2010).

Due to the acts of farmers who diverted irrigation water, particularly at Raliphaswa irrigation scheme, there has been a great shortage of water to the schemes situated at the tail end, i.e., Mandiwana and Mamuhohi, hence, their agricultural production was minimized. The crops in Mandiwana and Mamuhohi irrigation scheme were dry and had stunted growth due to water shortage. Attia *et al.* (2019) state that water sufficiency is crucial in increasing agricultural production in irrigation schemes. A study conducted by Dlamini (2013) on "The relationship between production performance and governance in small-holder irrigation schemes in Swaziland" reveals that poor irrigation management in the schemes hinders the improvement of agricultural productivity.

This study proposed various and varied strategies that could be used to address the challenges related to water governance. For example, increasing monetary fines was viewed as the possible solution that could be used to deal with the challenges related to noncompliance to rules and regulation. The findings further revealed that farmers were fined five hundred rands for noncompliance. Thus, the study suggested that the fine should be increased to R1000 so that those who do not comply with the rules find it hard to break them because of high monetary fines. Similarly, the findings from a study conducted by Dlangalala (2018) on "Effects of interactions between governance, intergenerational and gender dimensions on smallholder irrigation scheme in KwaZulu-Natal, South Africa" reveals that noncompliance and unlawful behaviour are dealt with by imposing a heavy monetary fine.

Farmers believed that employing someone who would oversee all the activities in the scheme on a daily basis could effectively address the water irrigation challenges faced by farmers within the study area. A study conducted by Chai & Zeng (2021) reveals that unauthorized water withdrawals by farmers and community members has been a great casual factor of decrease in water supply, hence, affecting farmers to irrigate effectively. Hiring an individual to monitor the activities undertaken in the scheme on a daily basis might help to reduce farmers who are not

compliant to the irrigation schedule, unregistered farmers and non-farmers who draw irrigation water illegally.

Another strategy suggested by the respondents was to register all unregistered farmers so that they may abide or governed by the rules and regulations in place. This would prevent the illegal drawing of water in three selected irrigation schemes. The findings further indicated that when unregistered farmers get registered, they will be part of the irrigation schedules and meeting, resultantly, it will reduce conflicts amongst those who are registered and those who are not registered. Accountability was another strategy which was suggested by the respondents in this study. Majority of the farmers proposed that fellow farmers who break the concrete canals should be accountable for the repair. This may reduce the breakage of water canals in the schemes.

5.3 Conclusions

This study showed that there are various and varied institutions governing irrigation water in the three selected schemes namely, Mamuhohi, Mandiwana and Raliphaswa irrigation schemes. These institutions include the Scheme committee, Water Users Association (WUA), Informal water institutions, Department of Water Affairs, Cooperatives, Government Water Schemes, Irrigation Board and the traditional leadership. The study revealed that scheme committees were the main institutions that govern irrigation water in three selected schemes because scheme committees were responsible for organising meetings to address water related matters. Moreover, the scheme committee is also responsible for scheduling times for irrigation and overall management of the schemes. Traditional council was also identified as an important institution responsible for the allocation of land for farming and resolving conflicts among farmers.

Water theft is common among the farmers in three selected irrigation schemes. Water is drawn illegally especially by unregistered farmers. Sand bag sand rocks are used to block canals and water is diverted to illegal farms. Thus, the majority of farmers fail to comply with rules and regulations for water use and offenders are reluctant to pay fines for using water wrongly. Vandalizing of irrigation water infrastructure is rife in all the irrigation schemes. Lastly, the study proposed various strategies that can be used to address irrigation water governance system

challenges within the schemes which include doubling of fines, hiring an overseer, register unregistered farmers and accountability.

5.4 Recommendations of the Study

Based on the results of the study, the following recommendations are made:

a) A further study of similar nature to other smallholder irrigation schemes in Vhembe district is recommended to facilitate a further understanding of irrigation water governance for improved operation of smallholder irrigation schemes in other parts of Vhembe district or Limpopo province as a whole.

b) There is a need for government institutions to play their roles in irrigation schemes to be recognised by the farmers. Moreover, awareness of farmers about rules, roles and responsibilities of government institutions should be crucial to improve the adherence with government formal institutions.

c) Majority of the farmers do not adhere to the irrigation schedule; thus, it disrupts the flow of water to other deserving plots. Therefore, this study recommends that any farmer who will be found to be obstructing water illegally to their plots should be denied water when it is their time to irrigate, in that way farmers will respect the irrigation schedule.

d) Females were dominated in the current study; thus, a study should be conducted on the factors which determine the participation of women in farming. Moreover, a research study to determine the extent of involvement of formal institutions in irrigation water governance in SISs should be conducted

5.5 Limitations of the Study

In this study, the aim was to interview 124 famers, instead only 56 of them participated because of Covid-19 pandemic and measures which were put in place by the South African government. This was further worsened by the fact that some members lost their lives due to Covid-19. In addition, some famers were no longer involved in farming activities because of old age.

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APPENDICES

Appendix A: Semi-structured interview guide

Section A: Demographic Details of Respondents

1. Background Information

NB. Please circle (O) or tick (✓) the correct box.

1.1 Gender

Female	1
Male	2

1.2 What is your age group?

< 20 years	1
20-30 years	2
31-40 years	3
41-50 years	4
51-60 Years	5
More than 61 years	6

1.3 What is your marital status?

Single	1
Married	2

Living together with spouse though not married	3
Divorced	4
Widowed	5

1.4 What is the highest level of education?

None	1
Primary	2
Secondary	3
Tertiary	4

1.5 How many are in the household?

>5

<5

1.6 Are you employed?

Yes

No

If your answer to question 1.6 is no please proceed to question 1.7

1.7 What is your source of income?

Section B

Farmers' questions aimed to evaluate water governance for improved operation of the selected irrigation scheme in Nzhelele area.

a) Which institutions are involved in water governance in irrigation schemes at Nzhelele area?
b) What are the rules and regulations governing water allocation and access?
c) What are the rules and regulations governing irrigation schedule?
d) What are the rules and regulations governing conflict management and Penalties for non-compliance?
e) Are water governing rules and regulations effective in managing water in the selected irrigation schemes? Give reasons for your answer.
f) What are the challenges that small-holder farmers face regarding water governance system at Nzhelele irrigation schemes?
g) Which strategies can be used to address the water governance system challenges faced by small-holder farmers at selected irrigation schemes in Nzhelele area?

Appendix B: Questionnaire

Section A: Demographic Details of Respondents

1. Background Information

NB. Please circle (O) or tick (✓) the correct box.

What is the name of your irrigation scheme?

Mandiwana	Mamuhohi	Raliphaswa

1.1 Gender

Female	1
Male	2

1.2 What is your age group?

< 20 years	1
20-30 years	2
31-40 years	3
41-50 years	4
51-61 Years	5
More than 61 years	6

1.3 What is your marital status?

Single	1
Married	2
Living together with spouse though not married	3
Divorced	4
Widowed	5

1.4 What is the highest level of education?

None	1
Primary	2
Secondary	3
Tertiary	4

1.5 How many are in the household?

>5
<5

1.6 Are you employed?

Yes
No

If your answer to question 1.6 is no please proceed to question 1.7

1.7 What is your source of income?

Pension	Social grant	Agriculture	Remittances	Other

Section B

How far do you agree with the following statements in relation to irrigation water governance? Tick the applicable.

No	Statement	Strongly disagree (1)	Disagree	Not sure	Agree	Strongly agree
1	I am aware of the National Water Act of 1998					
2	I am aware of the National Water Policy					
3	I am aware of the Water Users Associations					
4	I know that I have to have a water licence to use irrigation water					
5	I am satisfied with the involvement of Limpopo Department of Agriculture in the irrigation scheme					
6	I am aware of the irrigation scheme committee					
7	I am satisfied with the executive scheme committee					
9	I am satisfied with the contribution of the traditional council in irrigation management					
10	I am satisfied with the level of contribution of the traditional council in the rule enforcement					
11	I partake in decision making of the rules and regulations in relation to irrigation water					
12	The election process of the executive committee is fair					
13	The rules regarding water access are fair					
14	The rules regarding water allocation in the scheme are fair					
15	Water allocation is fair to all users					
16	The irrigation water schedule is fair					
17	I am aware of my rights to access water to irrigate					
18	Monitoring and control of irrigation water by the management is fair					

19	I say all the problems I have relating to irrigation water					
20	Penalties for failure to comply with the rules are fair					
21	I am satisfied with how water conflicts are managed in the scheme					
22	Fines given to law breakers is fair					
23	I attend meetings relating to irrigation water					
24	I participate in canal maintenance and repair costs					
25	I have been involved and witnessed irrigation water conflicts					
27	There is corruption in irrigation water distribution					
28	Current water distribution practices negatively affect crop production					
30	People use water illegally in the schemes					
31	The tenure security of the land influence my land use decision					
32	Farmers do not have access to agriculture extension services					
33	The scheme management does not listen to my concerns					
34	I break the rules set by the scheme management					
35	I do not receive market support services					
36	I do not have access to credit					
39	I receive training for operating and maintaining the scheme infrastructure					
40	Farmers do not meet the monetary contributions agreed upon in the scheme					
41	Farmers do not contribute to canal cleaning and other communal activities					
42	Farmers irrigating at the wrong time					

43	People without a water allocation taking water from the canal					

Appendix C: Informed Consent Form

RESEARCH ETHICS COMMITTEE

UNIVEN Informed Consent

LETTER OF INFORMATION

Title of the Research Study	: Evaluation of water governance systems for improved operation of the selected small-holder irrigation schemes in Nzhelele area, South Africa
Principal Investigator/s/ researcher	: Nedombeloni Rudzani, *BA. Degree in Development Studies; BA Honours in Rural development.*
Co-Investigator/s/supervisor/s	: Dr M.A Mathaulula and Dr E.J Mwendera

Brief Introduction and Purpose of the Study

I am Nedombeloni Rudzani, a student at the University of Venda registered for Masters in Rural Development (MRDV). I invite you to participate in a research study which seeks to evaluate water governance systems for improved operation of the irrigation scheme you are located in. You were carefully chosen to participate in the study because of your unique characteristics, viz; you are a stakeholder or a farmer at the selected irrigation schemes. Before you take a decision on whether to participate in the study or not, kindly read the information below.

Outline of the Procedures

The research data will be collected in the offices of the extension officers in each scheme. You were chosen to be part of this study because you are either a farmer or a stakeholder in Mamuhohi, Mandiwana and Raliphaswa irrigation scheme. This study will be in two phases, in-depth data will be collected through One-on-One interviews and it will be analysed. The second phase of collecting descriptive data through the use of self-administering questionnaire which will follow after a month. Participants will be required for two days, for one hour per day. When you decide to participate in this research study, you will be given a consent form to sign.

Risks or Discomforts to the Participants

This study knows none or predictable risks above the risks you might face in everyday life. If you feel that you are not comfortable to answer some or all question you are allowed to do so.

Benefits

This study will not have any directed benefit to you for your participation. Nevertheless, the information obtained from this study will help to improve water governance systems for effective operation of irrigation scheme. Furthermore, the study findings will also contribute to the existing body of knowledge relating to water governance and improved operation of irrigation schemes.

Reason/s why the Participant May be Withdrawn from the Study

You may decline to answer any or all questions and you may terminate your involvement at any time if you feel uncomfortable. You will not be forced to give reasons on why you no longer want to be part of the study and there are no consequences to follow up your decisions.

Anonymity

Your responses to this study will not reveal your personal information, thus your responses will be anonymous. Please do not write any identifying information on your responses. Every effort will be made by the researcher to make you anonymous by assigning code names or numbers in all your responses.

No harm to participants

This will be ensured through refraining from conducting the study in a perilous environment and through avoiding activities that pose harm to the body and mind of the participants during the study. However, there are no foreseen research related injury.

Confidentiality

The study participants will be assured of the confidentiality on all the information they shared with the research team. To ensure confidentiality, responses will be made anonymous through requesting participants not write any identifying information on their response sheets and the researcher will place your information in a safe locked cupboard where it can only be accessed by the researcher. The researcher will not disclose any person-defining information to a third party without the participant's approbation.

Voluntary participation

The participants will be informed of voluntary participation principle which dictates that people should be involved in research willingly.

Remuneration

No money or materialistic things will be paid for participating in this study. However, the participants will be provided with lunch and refreshments on the days that you participate.

Costs of the Study

Participants in this study will not be expected to cover any costs towards the study. The researcher will be responsible for every cost of the study.

Persons to Contact in the Event of Any Problems or Queries:

Please contact the researcher on 0793919742. You can contact my supervisor DR M.A Mathaulula on 0765352313 and Co-supervisor Dr E.J Mwendera on 0644168926 or the University Research Ethics Committee Secretariat on 015 962 9058. Complaints can be reported to the Director: Research and Innovation, Prof GE Ekosse on 015 962 8313 or Georges Ivo.Ekosse@univen.ac.za

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be requested to sign a consent form. After you signed the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher (Nedombeloni Rudzani), about the nature, conduct, benefits and risks of this study.

- I have also received, read and understood the above written information regarding the study.

- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.

- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.

- I may, at any stage, without prejudice, withdraw my consent and participation in the study.

- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Full Name of Participant Date Time Signature

I, …….. …… …… ……..

(*Name of researcher*) herewith confirm that the above participant has been fully

Informed about the nature, conduct and risks of the above study.

Full Name of Researcher

..... Date..... Signature.....

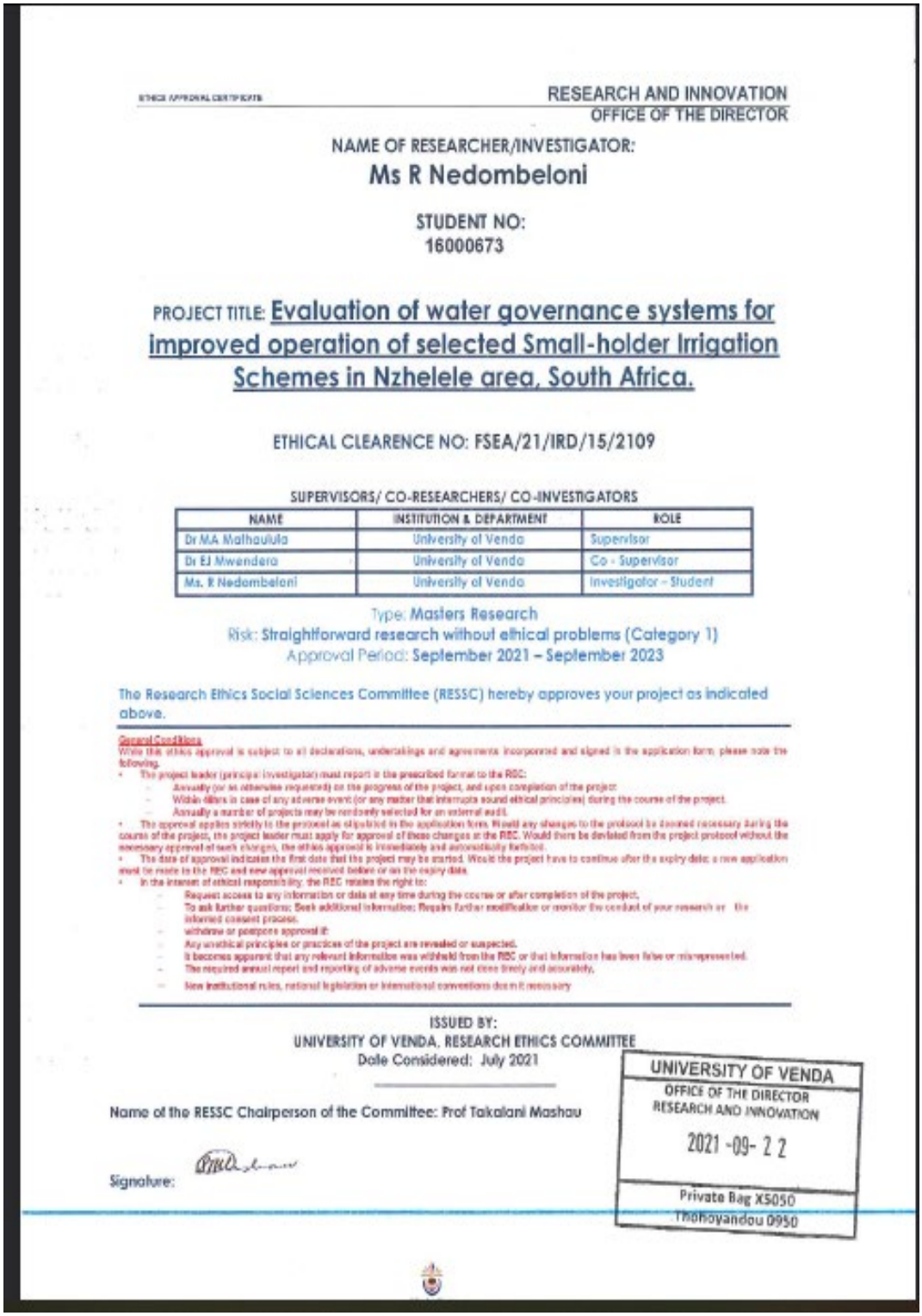
Full Name of Witness (If applicable)

..... Date ..... Signature.....

Full Name of Legal Guardian (If applicable)

..... Date..... Signature.....

Appendix D: Ethical clearance certificate



ETHICS APPROVAL CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Ms R Nedombeloni

STUDENT NO:
16000673

PROJECT TITLE: **Evaluation of water governance systems for improved operation of selected Small-holder Irrigation Schemes in Nzhelele area, South Africa.**

ETHICAL CLEARENCE NO: FSEA/21/IRD/15/2109

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr MA Mathaulula	University of Venda	Supervisor
Dr EJ Mwendera	University of Venda	Co - Supervisor
Ms. R Nedombeloni	University of Venda	Investigator - Student

Type: Masters Research
Risk: Straightforward research without ethical problems (Category 1)
Approval Period: September 2021 – September 2023

The Research Ethics Social Sciences Committee (RESSC) hereby approves your project as indicated above.

General Conditions
While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following.

- The project leader (principal investigator) must report in the prescribed format to the REC:
  - Annually (or as otherwise requested) on the progress of the project, and upon completion of the project
  - Within 48hrs in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
  - Annually a number of projects may be randomly selected for an external audit.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the REC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the REC and new approval received before or on the expiry date.
- In the interest of ethical responsibility, the REC retains the right to:
  - Request access to any information or data at any time during the course or after completion of the project,
  - To ask further questions; Seek additional information; Require further modification or monitor the conduct of your research or the informed consent process,
  - withdraw or postpone approval if:
  - Any unethical principles or practices of the project are revealed or suspected,
  - It becomes apparent that any relevant information was withheld from the REC or that information has been false or misrepresented,
  - The required annual report and reporting of adverse events was not done timely and accurately,
  - New institutional rules, national legislation or international conventions deem it necessary

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE
Date Considered: July 2021

Name of the RESSC Chairperson of the Committee: Prof Takalani Mashau

Signature:

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