ASSESSMENT OF POLICIES AND STRATEGIES FOR THE GOVERNANCE OF SMALLHOLDER IRRIGATION FARMING IN KWAZULU-NATAL PROVINCE, SOUTH AFRICA

Report to the
Water Research Commission

by

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Executive Summary

The South African government has considerably invested financially and in terms of policies and programmes towards improving the performance of smallholder irrigation schemes (SISs). However, the performance of SISs remains low, dampening the prospects of lifting wellbeing in communal areas. Policies favourable to smallholder farmers include the Integrated Food Security and Nutrition Programme and the National Development Plan.

At the same time water is becoming scarce and solutions that go beyond technical efficiency are needed. Institutional aspects of land and water management are possible opportunities for enhancing irrigation performance. Institutional capacities can be improved through the participation of various decision-makers, whether formal or informal. Customs and traditional practices interact with national Acts to affect land and water rights in SISs. Gender and land tenure underpinned by traditional systems determine incentives for irrigation farmers.

The failure of SISs to fully perform was studied through a research whose aim was to assess the effectiveness of policies and strategies, rules and regulations and governance of programmes that provide support to smallholder irrigation farmers on irrigation schemes. The research was conducted at four irrigation schemes in KwaZulu-Natal Province, namely Tugela Ferry, Mooi River, Makhathini Flats and Ndumo. The schemes were selected on the basis of their unique and contrasting characteristics, which allow for a comparative study on the effects of the policies, strategies, rules and regulations.

A mixed-methods approach was used where both formal and informal data collection was conducted. Extensive literature review and formal sample-based survey with structured questionnaires were used. Data were subjected to statistical analyses for drawing inferences. Periodic consultations with irrigation farmers and key stakeholders were also done.

The study revealed the coexistence of formal and informal rules and regulations in the respective irrigation schemes. The formal acts, policies, rules, and regulations include the Irrigation Strategy (2015), National Water Resources Strategy (2013), Water Allocation Reform (2006), and the National Water Act (1998). The latter has provision for the establishment of a Catchment Management Agency (CMA) and a Water Users Association (WUA). Informal rules and regulations are area specific and emanate from the traditional authorities.

Irrigation farmers lack awareness of formal policies, making them, for the most part, inconsequential in SISs. Only 4% of the irrigation farmers had knowledge about WUAs, and only 0.3% claimed to be WUA members. The irrigation farmers across the irrigation schemes, do not know government policies. Instead, locally developed rules and regulations not linked to the objectives of national policies prevail. Government policies are only implemented through direct intervention.

Informal institutional arrangements tend to be more visible, valuable, influential and powerful at scheme level while formal institutions have low relevance at this level. Irrigation farmers' perceptions of the effectiveness of traditional rules differ according to the scheme's commercial or food security orientation. More food security-oriented irrigation schemes see informal rules as more effective compared to those in commercially-oriented schemes. Irrigation farmers in food security-focussed schemes were satisfied with land allocation of traditional authorities while irrigation farmers in more commercially-oriented schemes were not satisfied with their security of land tenure.

In South Africa, the definition of smallholder producers is highly contested. Whereas, globally smallholder farmers are family-based farmers who face a variety of constraints, the government of South Africa defined smallholder producers as those who produce food for home consumption and also consciously aim to earn an income through selling surpluses to the market. The definition differentiates smallholder producers from subsistence/resource-poor producers, where the latter produce mainly or entirely for own consumption. Accordingly, the former group of producers should be called 'commercially-oriented' smallholder producers, to differentiate them from 'subsistence or food security-oriented' producers.

Dissatisfaction with scheme rules exists in specific localities in irrigation schemes where water is not readily available. In Mooi River Irrigation Scheme water shortages in some blocks led some irrigation farmers to abandon their plots. This was largely attributed to non-compliance to schedules by the irrigation farmers in the upper blocks. Regarding land allocations, gender inequity was evident and was unfavourable to women. Women are highly dependent on men as the latter have control over more resources. Traditional norms often prevent women from participating in public organisations and in decision-making processes.

The co-existence of formal and informal institutions partly causes dysfunction in the implementation of strategies, rules, and regulations. This dysfunction can be attributed to the

contrasting nature of the two systems. Government-instituted systems are changed from time-to-time. Such dynamic policies and rules interact with traditional institutions and rules that are largely static across generations. In view of rural dynamics, the transmission of the government rules or programmes takes time and at times are not fully implemented during the set life-span and locally concocted rules, regulations, and institutions prevail.

The fact that different government departments use varying approaches to interact with irrigation schemes leads to formal policies, rules, and regulations being ineffective. For example, the departments of agriculture work through cooperatives. In contrast, the department of water has adopted the WUAs as the vehicle for conducting its work. As a result, policies, rules, regulations, training coming from different government departments/institutions are not the same, resulting in different levels of understanding of rules among irrigation farmers.

Different approaches to provision of support exists across SISs. The government only provides extension support to the food security-oriented schemes, while the private sector and the non-governmental organisations are mostly involved in the commercial-oriented ones.

The dysfunction of irrigation schemes management has serious consequences for the irrigation farmers. It leads to badly dilapidated infrastructure, especially canals. Stakeholders (extension workers and irrigation designers) had no operation and maintenance programmes to address the damages. Government officials failed to articulate policy. As a result, schemes had no WUAs.

Most irrigation farmers across the four irrigation schemes had no formal training on irrigation and water management and lacked understanding of the need for Irrigation Management Transfer (IMT). Irrigation farmers' expectation of traditional type of support, including bailiffs, is hindering the effectiveness of local institutions.

Gender, land ownership and level of education were found to be key determinants of the performance of SISs. Nevertheless, the performance of smallholder irrigation depends on a variety of factors. No single intervention whether policy, strategy or rules can singularly determine irrigation performance. A holistic approach is required in order to determine how such interventions can be employed to improve irrigation schemes. Other factors determining scheme performance are irrigation farmers' participation in irrigation management, awareness of the national water policies, membership to cooperatives, training received, extension

support, and membership to irrigation committees. Besides, policy, other related interventions are required to change performance of irrigation schemes. The various factors operate in combinations and synergistically to each other. The relationship between rules and regulations in governance and the factors determining their effectiveness is not linear but is a cyclical and complex system.

Recommendations for policy changes

Based on the research findings, the following recommendations were made:

- Traditional and formal rules and regulations need to be harmonized.
- Effort to achieve gender equity needs to be prioritized.
- A participatory way of developing policies, rules and regulations is needed. The use of a participatory approach for developing policies, rules and regulations could be a medium- to long-term goal.
- Training needs to be conducted urgently on irrigation and water management. Training in water management will allow irrigation farmers to understand water availability at the catchment level and how that translates to water availability in the scheme.
- SIS stakeholders need to be sensitized about government initiatives and existing policies, rules and regulations, and the need for coordinated execution of interventions.
- Customary laws need to be adjusted to give men and women, youth and elderly, equality, for instance, with regards to land.
- The IMT needs to be re-configured to make it functional across all smallholder irrigation schemes.
- Informal institutions on water resource management need to be recognized so that they can be appropriately incorporated into irrigation water governance.
- Irrigation farmers institutions need to be granted greater autonomy so that they can deal with scheme matters without government support.
- The configuration or appropriateness of WUAs needs to be reconsidered.
- A holistic approach is required in the implementation of irrigation policies rules and regulations and/or the rolling out of programmes.
- Government departments need to synchronize their messages and approaches before taking them to the SIS level.

Areas for future research

The following are the identified areas of further research:

- A more thorough study on what elements of the IMT to retain and how to roll them out is required.
- There is need to study whether an appropriate level of co-existence of formal and informal institutions, rules, and regulations can be established without compromising on improving performance of SISs.
- There is need to establish the relationship between the level of commercialisation among smallholder irrigation farmers and informal institutions, rules, and regulations.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADA	Agribusiness Development Agency
APAP	Agricultural Policy Action Plan
ARC	Agricultural Research Council
BBBEE	Broad-Based Black Economic Empowerment
BCR	Benefit-Cost Ratio
BEE	Black Economic Empowerment
CMS	Catchment Management Strategies
CPR	Common-pool Resource
CR	Condition rating
DAE	Departments of Environmental Affairs
DAFF	Department of Agriculture, Forestry and Fisheries
DARD	Department of Agriculture and Rural Development
DPME	Department of Planning Monitoring and Evaluation
DRDLR	Department of Rural Development and Land Reform
DWA	Department of Water Affairs and Forestry
DWAS	Department of Water and Sanitation
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GEAR	Growth, Employment and Redistribution
GIZ	Gesellschaft für Internationale Zusammenarbeit (German Development Agency)
GWP	Global Water Partnership
IAD	Institutional Analysis and Development
ICA	Infrastructure Condition Assessment
IDA	Institutional Development Analysis
IE	Institutional environment
IFSNP	Integrated Food Security and Nutrition Programme
IGDP	Integrated Growth and Development Policy
IMC	Irrigation Management Committees
IMT	Irrigation Management Transfer

IRR	Internal Rate of Return
IWRM	Integrated Water Resource Management
KZN	KwaZulu-Natal
MC	Management Committee
MFIS	Makhathini Flats Irrigation Scheme
MRIS	Mooi River Irrigation Scheme
MTSF	Medium Term Strategic Framework
NDP	National Development Plan
NGOs	Non-governmental organisations
NGP	New Growth Path
NIS	Ndumo Irrigation Scheme
NPV	Net Present Value
NWA	National Water Act
NWRS	National Water Resource Strategy
O&M	Operation and maintenance
PC	Principal Component
PCA	Principal Component Analysis
PE	Physical externalities
PGDS	Provincial Growth Development Strategy
PIM	Participatory Irrigation Management
PTO	Permission to Occupy
RCI	Relative Causal Index
RDP	Reconstruction and Development Programme
RESIS	Revitalisation of Smallholder Irrigation Schemes
SA	South Africa
SAAFWUA	South African Association of Water Users Associations
SABI	South African Irrigation Institute
SAHRC	South Africa Human Rights Commissions
SAII	South African Irrigation Institute
SIS	Smallholder irrigation scheme
SLA	Sustainable Livelihood Approach
TFIS	Tugela Ferry Irrigation Scheme

TRALAC	Trade and Law Centre
UKZN	University of KwaZulu-Natal
WMA	Water Management Areas
WRC	Water Research Commission
WUA	Water Users Association

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CHAPTER 1: INTRODUCTION

1. Background

According to Herrero *et al*. (2009), the human population is expected to increase to 8.2 billion by 2050 and a billion of this increase is expected to be in Africa. This increase in population will mean higher demand for food. Strategies that increase Africa's food production potential need to be perused. SIS could be one of those strategies used to prepare smallholder irrigation farmers not only to supply sufficient food, but also to exploit the commercialisation potential created by this potential development.

The agricultural sector in South Africa contributes less than 2.5% to the Gross Domestic Product (GDP) and employs about 10% of the population (Calzadilla *et al*., 2014) yet uses more than 80% of available land and around 60% of available water (Grain SA, 2015). The sector has a dualistic production structure comprising commercial and small-scale agriculture (Mudhara, 2010; Thamaga-Chitja and Morojele, 2014). Small-scale agriculture is less developed and less resourced, with most smallholder and subsistence farmers being prone to food insecurity (Baiphethi and Jacobs, 2009; Thamaga-Chitja and Morojele, 2014). This points to the significant potential of enhancing the productivity of smallholder agriculture and exploiting the vast potential for increasing their contribution to national GDP and alleviating poverty.

Enhancing agricultural productivity through irrigation is a vital strategy for rural poverty alleviation in most developing countries where the majority of rural people depend on agriculture for their welfare (Muchara, 2014). Water plays an important role in social and economic development (Pahl-Wostl *et al*., 2008; Muchara, 2014), and proper management of the resource is deemed important for sustainable development (Teutsch and Kruger, 2010; Kalbus *et al*., 2012). In recognition of the role that smallholder irrigation farming can play in attaining better rural livelihoods, the South African government has made a significant investment in rehabilitating infrastructure on existing irrigation schemes (Perret and Geyser, 2007, Ntsonto, 2005). In 2012 the government budgeted R15 million for the rehabilitation of smallholder irrigation schemes (Department of Agriculture, Forestry and Fisheries (DAFF), 2012a). Although the South African government considerably invested in the rehabilitation and revitalisation of smallholder irrigation schemes (SIS), the performance of the SISs remains

below expectation (Sinyolo *et al.,* 2014). The under-performance of SISs has been attributed to various factors. Muchara *et al*. (2014) noted that communally managed irrigation schemes in South Africa have problems of water supply emanating from poor adherence to rules and regulations, challenges in water allocation, land allocation, appropriate management, local conflicts and poor farmer participation and collective action in managing resources. It has also been evident that policies, strategies, including rules and regulations, in SISs play a prominent role in their governance and performance. Muchara (2014) also attributed the poor performance of SISs to a lack of human capital, operational rules, dysfunctional property rights systems, accountability issues and informal and formal arrangements.

The hope placed on SISs as being the vehicle for uplifting the agricultural productivity in rural areas, in general, and the communal areas in particular, is reflected in government policies. Policies such as the Integrated Food Security and Nutrition Programme (IFSNP) and the National Development Plan (NDP) Vision 2030 placed high priority to the expansion of the smallholder farming. The government refurbishment of irrigation schemes in the hope of improving the livelihoods of the users and to having a trickle-down effect on the local and national economies has not yielded the expected results. It is now clear that the performance of SISs depends on a variety of factors. While the availability of land and water are critical, the challenges related to policies, strategies, rules and regulations, and overall governance programmes that provide support to smallholder irrigation farmers on SISs also play critical roles.

Effective policies and rules are crucial for the successful performance of irrigation (Straton and Ward, 2006). Appropriate institutional structures for water allocation are critical to the proper functioning of irrigation systems. Improved irrigation performance also depends on governance. Strengthening of institutional capacities requires wide participation of a cross section of all levels of decision-makers at all stages in policy formulation and project design (Norton, 2004). The irrigation sector of South Africa, though similar in many respects to those of other developing countries, has some special institutional characteristics.

Institutions could be either rules or organisations (Bandaragoda and Firdousi, 1992). South African institutions in irrigation are of various types, namely, legal, social, and political. Legally there are Acts, such as National Water Act (NWA) (Act 36 of 1998) (Kemerink *et al*., 2011; Perret, 2001). The Act determines the manner in which water rights are allocated and

managed by legislating the establishment of Catchment Management Agencies and Water Users Associations (WUAs). The benefits of WUAs are yet to be realised (Backeberg, 2006). On the other hand, social customs and traditional practices also exist and they affect land and water rights, among others. Social institutions also affect how people associate and their access to markets, etc. Informal rules and traditional practices play pivotal roles in irrigation performance (Bandaragoda and Firdousi, 1992). Therefore, both formal and informal institutional settings affect irrigation performance.

Institutional inefficiencies lead to shortages and inequitable distribution of water (Letsoalo and Van Averbeke, 2006). Maintenance of infrastructure was an important institutional weakness which negatively impacted productivity (Letsoalo and Van Averbeke, 2006). Collective ownership and development of infrastructure is fraught with challenges, and irrigation canal maintenance suffers the most under such circumstances (Letsoalo and Van Averbeke, 2006). Mnkeni *et al*. (2010) also observed that most problems at SISs were due to weak organisational and institutional arrangements, which require the strengthening of farmer organisations. However, Makombe *et al*. (2001) found that in Zimbabwe, the community managed schemes outperformed the government managed schemes. This indicates that there is an appropriate balance between formal and informal management of SISs that may improve performance.

Tlou *et al*. (2006) identified land tenure as having the greatest impact on other systems found in SISs. In this vein, insecure tenure limits farmer incentives to make long-term development investments on their land. Several studies indicated that a gender dimension existed with regards to land ownership, where males were the holders of irrigation plots, whilst females did most of the farming (Machethe *et al*., 2004; Tlou *et al*., 2006). Besides, the tenure system prevailing on nearly all smallholder schemes precluded plot holders from using their holding as collateral to access loans from registered financial service providers (Machethe *et al*., 2004; Tlou *et al*., 2006).

The need for more effective support services are a recurrent theme in most smallholder irrigation scheme assessments (Mnkeni *et al*., 2010; Tlou *et al*., 2006; Machethe *et al*., 2004). There is general agreement that human and social capacity development among smallholder irrigation farmers is a pre-condition for increasing the performance of the schemes (Shah *et al*., 2002). In this regard, University of KwaZulu-Natal implemented a research project commissioned and managed by the Water Research Commission entitled “Assessment of

policies and strategies for governance of smallholder irrigation farming in KwaZulu-Natal Province, South Africa (Project No. 2556)". This report is based on the work conducted during this project. The research builds on three research projects on women empowerment conducted across four provinces, namely; Eastern Cape, KwaZulu-Natal, Limpopo, and North West (Chitja *et al*., 2015, Denison *et al*., 2015, Oladele and Mudhara, 2016) which investigated the constraints, opportunities, and challenges undermining women empowerment and their achievement of sustainable rural livelihoods. The studies pointed to the need to be cognisant of the women's circumstances, such as literacy levels, appropriate training techniques, and the need for multi-stakeholder dialogue inclusive of rural women, appropriately designed government programmes and extension approaches that meet the needs of rural women, policy awareness, and training on market access, institutional development and appropriate people-centered-approaches during empowerment.

1.2 Project objectives

The research aim was to assess the effectiveness of policies and strategies, rules and regulations and governance of programmes that provide support to smallholder irrigation farmers on irrigation schemes.

The specific research objectives were as follows:

- To review the existing policies and strategies, rules and regulations of programmes and their influence on the governance and performance of irrigation schemes in South Africa.
- To review the literature on the assessment of the effectiveness of policies, strategies, rules and regulations, governance on irrigation performance
- To describe and explain how policies, strategies, rules and regulations and governance programmes affect irrigation schemes with respect to:
    i. Land and water allocation and land tenure,
    ii. Inter-generational relationships,
    iii. Gender,
    iv. Tradition and culture.
- To describe the factors that influence the effectiveness of policies, strategies, rules and regulations – old or new, focusing on factors that include:
    i. How information is communicated to irrigation farmers,
    ii. Gender,

iii. Generational differences,
iv. Level of education,
v. Household-level factors.

- To specify appropriate changes to existing policies, strategies, rules, regulations and governance programmes that can enhance the performance of smallholder irrigation schemes in South Africa. This can include recommendations on new policies, strategies, rules, regulations and governance programmes that can enhance the performance of smallholder irrigation schemes in South Africa.

Outline of the Report

This report comprises seven chapters. Chapter 1 presents an introduction, including the project objectives. Chapter 2 has the literature review on policies, strategies, rules and regulations and governance of programmes in smallholder irrigation schemes. This is followed by Chapter 3 where the study methodology is narrated. Chapter 4 explores the existing policies, strategies, rules and regulations and governance of programmes, while Chapter 5 presents the factors that influence the effectiveness of policies, strategies, rules and regulations. Chapter six looks at the effects of policies, strategies, rules and regulations and governance programmes on irrigation schemes. Chapter 7 present summary, conclusions and recommendations in terms of proposals of appropriate changes to existing policies, strategies, rules, regulations and governance programmes to enhance the performance of smallholder irrigation schemes in South Africa. The chapter also suggests areas for future research.

CHAPTER TWO: LITERATURE REVIEW ON POLICIES, STRATEGIES, RULES AND REGULATIONS AND GOVERNANCE OF PROGRAMMES IN SMALLHOLDER IRRIGATION SCHEMES

This chapter first looks at the salient characteristics of smallholder irrigation farmers, which are critical in the understanding of how the circumstances in their irrigation schemes are later unpacked. Together with an understanding of the complexity of the communal management of resources, which includes the complication of collective resource management, the report then unpacks the theoretical constructs for understanding how the smallholder irrigation schemes work. The report then unpacks the policies, strategies, rules and regulations affecting the governance of smallholder irrigation schemes.

2.1 Background

The agricultural sector in South Africa contributes less than 2.5% to the Gross Domestic Product (GDP) and employs about 10% of the population (Calzadilla *et al.,* 2014) yet uses more than 80% of available land and around 60% of available water (Grain SA, 2015). The sector consists of a dualistic production structure comprising a commercial and a small-scale agricultural sector (Mudhara, 2010; Thamaga-Chitja and Morojele, 2014). Small-scale agriculture is less developed and poorly resourced, with most smallholder and subsistence farmers being prone to food insecurity (Baiphethi and Jacobs, 2009; Thamaga-Chitja and Morojele, 2014). This indicates the potentially significant role smallholder agriculture can play in contributing to national GDP and poverty alleviation through enhanced productivity.

In recognition of the role that smallholder irrigation farming can play in attaining better rural livelihoods, the South African government has made significant investments in rehabilitating infrastructure in existing irrigation schemes (Perret and Geyser, 2007). In 2012 the government budgeted R15 million for the rehabilitation of smallholder irrigation schemes (DAFF, 2012a). Despite these efforts, communally managed irrigation schemes in South Africa experience problems of water supply, largely emanating from poor adherence to rules and regulations, challenges in water and land allocation, lack of appropriate management, local conflicts and poor farmer participation and collective action in managing resources (Muchara *et al*., 2014).

Indeed, much hope rests on the smallholder irrigation being a channel for uplifting the

productivity of rural areas, in general, and the communal areas in particular. Policies such as the Integrated Food Security and Nutrition Programme (IFSNP) (DOA, 2007) and the NDP Vision 2030 attached a high priority to the expansion of the smallholder farming sector. The South African Government has been refurbishing many irrigation schemes in the hope of improving the users' livelihoods and to have a trickle-down effect on the rest of the economy. However, it is now clear that the performance of the smallholder irrigation schemes depends on a variety of factors. While the availability of land and water are critical, it is now increasingly clear that there are challenges emanating from soft issues such as policies, strategies, rules and regulations, and overall governance programmes that provide support to smallholder farmers on irrigation schemes. Therefore, a holistic approach is required in order to determine how interventions can be employed to improve irrigation schemes

2.2 Characteristics of smallholder Irrigation Farmers

The majority of the world's poor people reside in rural areas (Markelova *et al.*, 2009). About 72% of poverty-stricken South Africans are based in rural areas (Neves and Toit, 2013), where smallholder agriculture is the primary livelihood activity. Therefore, efforts to reduce poverty should focus on smallholder agriculture (Markelova *et al.*, 2009).

The definition of smallholder producers in South Africa is highly contested in both political and academic circles (Greenberg, 2013). Smallholder farmers have numerous definitions subject to the area and context. However, in South Africa, smallholder farmers generally refer to farmers owning small plots of land on which they mostly grow subsistence crops, relying on family labour (DAFF, 2012b). Factors such as farm size, distribution of resources amongst different crops, resource distribution between food and cash crops, livestock and off-farm activities, use of external inputs and the fraction of food crops sold characterize smallholder farmers (DAFF, 2012b). DAFF (2012b) defined smallholder producers as those who not only produce food for home consumption but also have a conscious objective of earning income by selling surpluses to the market. This definition implies that smallholder producers are distinct from subsistence/resource-poor producers, where the latter produce mainly or entirely for own-consumption. In other words, the former group of producers is what Cousins *et al.* (2007) argued should be called 'commercially-oriented' smallholder producers, to differentiate them from 'subsistence-oriented' producers. According to Machethe *et al.* (2004), smallholder irrigation sector refers to a range of farm typologies, i.e. small-scale farmers, resource-poor

farmers, peasant farmers, food-deficit farmers, household food security farmers, land reform beneficiaries and emerging farmers. The common factor among these farmer types is the shortage of production resources, especially capital, support services and reliance on family labour.

Smallholder farmers often face with challenges such as old-fashioned technologies, low returns to resources of production, high seasonal labour fluctuations, limited market access, poor infrastructure and poor organisational support (DAFF, 2012c; Jari and Fraser, 2009; Lahiff and Cousins, 2009). Production usually takes places in communal gardens, individual gardens or on open rangelands. Women are the dominant players and mainly farm for household consumption (Lahiff and Cousins, 2009). Smallholder farmers produce crops under different moisture regimes, dry-land (rain-fed) or irrigated farming or both.

2.3 Irrigation Farming in South Africa

Climate change has exacerbated annual rainfall fluctuations in South Africa, making droughts more frequent and crop production risky in most parts of the country. Over 60% of the country receives an annual rainfall average of less than 500 mm (Cousins, 2013). Another consequence of climate change has been increasing temperatures over the years, which has resulted in the land getting drier, with only 10% of the country receiving over 750 mm or more of rainfall per annum (Bernstein, 2013). These circumstances make irrigated farming imperative. To this end, about 1.3 million ha of land in South Africa is irrigated and smallholder irrigation farmers utilize 0.1 million hectares, or less than 10% of the irrigated area (Van Averbeke *et al.*, 2011). These smallholder irrigation farmers span a range of characteristics, such as irrigation scheme farmers, individual irrigation farmers, communal gardeners and home gardeners (Van Averbeke, 2008). The irrigation scheme farmers are the focus of this study.

Irrigated farming is a costly practice and the largest user of run-off water in South Africa (Reinders, 2011). However, through irrigated farming, irrigation farmers achieve increased crop productivity and agricultural performance, resulting in increased opportunities for crop diversification (Namara *et al.*, 2010; Sinyolo *et al.*, 2014a). Increased production could subsequently lead to higher incomes, thus reducing the likelihood of suffering from food insecurity in rural communities (Tibesigwa and Visser, 2015). Therefore, irrigation farming for smallholders has the potential to significantly reduce poverty in rural communities

(Adam *et al.*, 2016; Sinyolo *et al.*, 2014a).

2.3.1 Development of smallholder irrigation schemes in South Africa

Smallholder irrigation schemes (SIS) are agricultural projects involving land users who usually draw water from a shared distribution system. In some cases, the irrigation farmers also share a water storage or diversion facility (Van Averbeke *et al*., 2011). The development of irrigation schemes in South Africa began in the 19th Century, and DAFF (2012c) identified three development phases since then. The first phase which occurred before 1875, and termed the Agricultural Phase, had no water resource assistance from the government. In 1877, the Cape Colony initiated a policy to promote flood irrigation. The third phase, the Agricultural-Mining-Industrial phase, introduced public water storage systems. Introduction of storage systems was due to variable rainfall. This stage saw more settlers forming co-operatives. During this phase, loan writing off, partial subsidisation of private and cooperative schemes occurred. Besides, the phase saw the government introducing subsidized public schemes (DAFF, 2012c).

In the South African context, a SIS is a multi-farmer irrigation project whose area is larger than five hectares, established by agencies or black people for their development in rural or resource-poor areas (Perret and Geyser, 2007). Key characteristics of SIS's include the gravity-based supply system, having beneficiaries with relatively small farm sizes (1 to 2 ha) and largely subsistence orientation in production. Another characteristic of SISs is that irrigation farmers often leave a vast share of their land uncropped due to limited resources and cash constraints for input procurement (Perret and Geyser, 2007). Significant SIS development took place between 1975 and 1985 (Van Averbeke *et al.*, 1998). However, according to Laker (2004) and Sinyolo *et al.* (2014a), SIS's have been under-performing due to factors resulting from common-pool resource (CPR) management challenges.

2.3.2 Challenges of smallholder irrigation schemes

Most SISs in South Africa are CPR since they serve groups of irrigation farmers that depend on a shared distribution system to access irrigation water. Various studies to understand the factors affecting the performance of smallholder irrigation schemes and contrasting views are in the literature regarding the effects of shared resources. Hardin (1968) identified the problem of "tragedy of the commons", whereby individuals overuse and exhaust a common pool resource even though it may not be in their best interest to do so. This could result from a lack

of individual ownership of a resource and the inability to restrict the resource usage by the individuals accessing it. While economic theory suggests that individuals are utility-maximizing, such behaviour seems violated when property ownership is in state hands (Hardin, 1968). Van Vugt (2009) and Ostrom (1990) subsequently questioned this argument of the "tragedy of the commons", despite its initial wide acceptance.

Van Vugt (2009) argued that utility maximisation or self-interest is not the only driver of users, but they also take account of the wider implications of their actions for other users and the environment. On the other hand, Ostrom (1990) suggests that there is a way of managing CPR that can prevent over-exploitation. She provides a framework for self-governance of CPR, which seeks to reveal that if individuals work together, they can reverse over-exploitation. Ostrom (1990) identified eight principles or conditions that can lead to successful self-government of CPRs. The following sections discuss the principles.

- ***Clearly defined boundaries:*** The CPR has clearly defined boundaries in the community. Such clear boundaries ensure internalisation of positive and negative externalities. In that way, the users bear the negative externalities and enjoy the benefits of positive externalities (Ostrom, 1999; Cox *et al.* 2010).

- ***Congruence between appropriation and provision rules and local conditions:*** Local rules are often set according to the time, place, resource units available, and national rules and regulations hardly consider the different specific characteristics in each user community, which could hinder the goal of preventing over-exploitation. The rules set at the national level should align, to some extent, to local norms, practices and strategies (Ostrom, 1999).

- ***Collective choice arrangements:*** This involves users who benefit from the CPR participating in modifying the rules affecting it. Ostrom (1999) noted that CPR adhering to this principle, together with the first two, are at a better position of tailoring rules according to their circumstances and environments, which could ultimately lead to better management of the resource.

- ***Monitoring:*** Successful rule enforcement happens provided there is effective monitoring that takes place within the system. For this principle, monitors are accountable to the users or maybe the users themselves (Ostrom, 1999).

- ***Graduated sanctions:*** Ostrom (1999) suggests that users who disobey operational rules should face graduated sanctions. She also notes that if the first five principles are adhered to then that will constitute a successful case. If beneficiaries of CPR participate in setting operational rules (Design Principle 3), to be enforced and monitored (Design Principle 4), "using graduated sanctions (Design Principle 5) that define who has rights to withdraw from the CPR (Design Principle 1) and that effectively restrict appropriation activities given local conditions (Design Principle 2), the commitment and monitoring problems are solved" (Ostrom, 1999: 3).

- ***Conflict-resolution mechanisms:*** CPR users, as well as officials, should have access to low-cost mechanisms of resolving conflicts. When people share a resource over time, low-cost conflict resolution mechanism is important for rule enforcements (Ostrom, 1999).

- ***Minimal recognition of rights to organize:*** Governmental authorities should recognize rules and regulations formed at the local level. If authorities do not acknowledge the locally formed rules, it may be challenging to sustain a rule-led CPR in the long-run (Ostrom, 1999).

- ***Nested Enterprises:*** Organisation and enforced rules are through multiple nested enterprises, whereby organisations exist within an even larger organisation. Thus, there can be different rules in various layers of the organisation (Ostrom, 1999).

Given the eight Design Principles, Ostrom (1999) also indicates that CPRs could still fail despite adopting the principles. Such failure could be due to corruption and opportunistic behaviour, dependency on external stakeholders, international aid that does not take account of indigenous knowledge and institutions.

Lack of human capital contributes to the underperformance or failure of SISs. As such, Fanadzo (2012) recommended that irrigation farmers receive training to ensure better management of water resources. Fanadzo (2012) identified poor irrigation scheduling methods as a cause of

low irrigation efficiencies in the Zanyokwe Irrigation Scheme, in Eastern Cape Province. The success of SISs can also be assessed according to farmer's productivity, mainly expressed as crop yields, since SISs were mainly developed to enhance agricultural production (Van Averbeke *et al.,* 2011). Machethe *et al*. (2004) found that higher crop yields occur due to better irrigation scheme practices. Weed management, general technical skills, extension support, and in-field water-use also influence crop yields in SISs (Muchara, 2014).

However, other issues including operational rules, property rights, accountability issues, and informal and formal arrangements affect poor management (Muchara, 2014). Poor infrastructure, such as poor canal lining, leads to water losses (Agide *et al.*, 2016), which could also result in water-logged field conditions (Muchara, 2014). Lack of accountability results in fewer incentives for irrigation farmers to participate in the scheme or take up responsibilities, consequently leading to the poor performance of the scheme. Clarity of system boundaries also affects the performance of SISs through the limited capacity for irrigation farmers to manage water efficiently.

Muchara (2014) reported that there were no proper systems to record actual land under irrigation and the quantity of water available in the Mooi River Irrigation Scheme, KwaZulu-Natal Province. Sinyolo *et al.* (2014b) found that in the Tugela Ferry Irrigation Scheme, irrigation farmers compete for water and some could not access water at times. The uncertainty of water access consequently affects household crop production and general scheme performance. Additionally, there is also the challenge of access to proper institutions and organisations that can provide irrigation farmers with requisite assistance (Muchara, 2014). These challenges that SIS's face have led the government to establish policies and strategies to improve the performance of South African irrigation schemes.

2.4 Sustainable Livelihoods Framework and Governance of Smallholder Irrigation Schemes

The concept of "livelihoods" has become increasingly popular in development and thinking for conceptualizing the economic activities of poor people in their pursuit of livelihoods (Adato and Meinzen-Dick, 2002). The Sustainable Livelihood Approach (SLA) allows the analysis of the relationship between people's access to resources, their diverse livelihoods activities and factors at all levels of societies, i.e. micro, intermediate and macro levels (Farrington *et al.*,

1999). The framework is useful for looking at how rules and regulations affect people, and therefore, communities' activities and how they fare. The SLA draws attention to the activities that take place within the broader policy and institutional context at different times and how they influence livelihood strategies. In the SLA perspective, the 'context' traces the evolution and state of rules and regulations, among other phenomena, while on the other transforming structures and processes, which pertain to the rules, policies, culture and institutions that influence how irrigation farmers/households use their assets to realise their livelihoods. The SLA provides the framework for analysing the rules, regulations, etc. facing smallholder irrigation farmers. The rules and regulations fall under the transforming structures and processes of the framework, while the historical perspective is in the context.

2.5 Acts and Policies in Smallholder Irrigation

This section discusses the interaction between policies and acts in government and their effects. The Integrated Growth and Development Policy (IGDP) for Agriculture, Forestry and Fisheries, has a detailed analysis of the challenges facing smallholder irrigation farmers. Based on this analysis, the IGDP outlines possible appropriate responses (Trade and Law Centre (TRALAC), 2015). The Agricultural Policy Action Plan (APAP) seeks to translate the high-level responses offered in the IGDP into tangible, concrete steps (DAFF, 2015). However, this first iteration of APAP is not a fully comprehensive plan; rather, identifies several focused actions, in anticipation of future iterations of APAP that will take the process further. The government planned APAP to occur over five years, with annual updates. APAP states that it is aligned with the New Growth Path (NGP), the NDP and Industrial Policy Action Plan (IPAP), and seeks to assist in the achievement of government-set Outcome 4 of 'Decent Employment through Inclusive Growth', and that of Outcome 7, i.e. 'Comprehensive Rural Development and Food Security'.

The APAP 2014-2019 shows the linkages with other government policy pronouncements. It articulates that its alignment with the NGP, the NDP, and the Medium-Term Strategic Framework in respect of stated outcomes. The NGP is the country's vision to place jobs and decent work at the centre of economic policy. It sets to create five million additional jobs by 2020. The NGP identified infrastructural development and agriculture as foundations for the creation of more jobs and addressing rural underdevelopment. The NGP set targets of increasing the smallholder sector by 300 000 households.

On the other hand, the National Development Plan (NDP) calls for an inclusive rural economy wherein rural areas are spatially, socially and economically well-integrated and coordinated, and where residents are economically active and food secure (Department of Planning Monitoring and Evaluation (DPME), 2015). The NDP also envisages the creation of a million new jobs by 2030. The first cycle (i.e. 2014-2019) of this Medium-Term Strategic Framework (MTSF) for the rural sector will focus primarily on seven imperatives that are at the core for the formation of an inclusive and integrated rural economy. Broadly, the framework proposes the provision of comprehensive support to smallholders to ensure increased productivity. APAP itself, among other things, proposed the revitalisation of irrigation schemes, and in the process to put an additional 1250 hectares under irrigation by 2019.

2.5.1 Irrigation water acts in South Africa

Irrigation water plays an important role in sustainable social and economic development (Pahl-Wostl *et al.*, 2008; Muchara, 2014). As such, the South African government has made a substantial investment in smallholder farming and irrigation to benefit the population in rural areas (Machethe *et al.*, 2004). It is vital that irrigation water is properly managed, given its importance for sustainable development (Teutsch and Kruger, 2010; Kalbus *et al.*, 2012). To ensure the equitable allocation and sustainable use of water, from time-to-time, the government passes legislation such as acts and policies. Strategies and programmes operationalize the Acts and policies and ensure effective management of water, among other resources.

Of necessity, legislation on water resource management has changed over the years due to changes in contexts, such as political regimes. Water Acts are laws made to guide how water use, allocation and distribution can happen in the country. Pre-colonisation, customary law governed water rights in South Africa. People generally knew their water rights, and disputes over water use or intervention by authorities would only occur when a community believed that another tribe or group was encroaching their water sources (Tewari, 2009). South African Irrigation Institute (SAII) (2014) offers a historical analysis of the evolution of legal systems governing water allocation in South Africa. According to this narrative, the water management principles emerged in the 17th and 18th centuries, based on the Roman-Dutch law. In the 19th century, the British also emphasized law on the water during their occupation of the country. After 1910, water legislation was a combination of English common law, Roman-Dutch civil law and some features of customary law (SAII, 2014).

In 1912, the South African Government promulgated its first Irrigation and Water Conservation Act (Mudau, 2010). This Act aimed to promote the development of irrigation. The Act particularly focussed on irrigation water and made a distinction between "private" and "public water". Mudau (2010) traces the effects of the Act and points out that the era was characterised by large-scale, uncoordinated private irrigation development. As a result, the Act led to the construction of schemes such as Great Fish, Clan William, Graaff-Reinet, Lower Sundays River, and Hartebeespoort. During that period, the government constructed dams as Irrigation Board schemes. Almost half a century later, the government enacted the Water Act (Act 54 of 1956), which embedded riparian rights. The act also re-introduced *dominus fluminis*, which was the basis in Roman-Dutch civil law. This meant that the government had the power to control areas surrounding rivers and the right to control the use of river water, through the relevant minister (Tewari, 2009).

The Global Water Partnership (GWP) defines the Integrated Water Resource Management (IWRM) as a process that promotes the coordinated development and management of water, land and related resources, to maximize economic and social welfare equitably and sustainably (GWP, 2000). The IWRM is enshrined in the National Water Act (Act 36 of 1998), deemed as one of the best water legislations ever passed (Schreiner, 2013). The Act was to ensure the protection, use, development, conservation, management and control of South Africa's water resources. The key factors underlying the National Water Act are the need to meet basic human water needs, encourage fair access to water, to redress the consequences of past racial and gender segregation, and to establish suitable institutions to allow this process (Department of Water Affairs and Forestry (DWA), 2000). The National Water Act (36 of 1998) also endeavours to "provide for fundamental reform of the law relating to water resources; to repeal certain laws; and to provide for matters connected therewith" (DWA, 2000:1). The Water Act of 1956 differed from the 1998 Water Act in that it the latter does not grant anyone a permanent right to use water, in other words, the Act abolished the concept of private water. The ACT makes it mandatory that a person uses water when he/she has a lawful water-use license. Also, the Act stipulates that water used in terms of a general authorisation and water-use for domestic purposes (DWA, 2000).

2.5.2 Water Acts, policies in South Africa

This section seeks to demonstrate relationships between Acts and policies. A "hand and glove" relationship exists between an act and a policy. Acts give legal basis to a policy. Similarly, laws and Acts give legal effects to policies. A policy is a goal or an objective set by the government, which is aligned with the set laws or Acts (Kim, 2014). In this regard, South Africa's main water policy is the National Water Policy, which seeks to protect, use, develop, conserve, manage and control South Africa's water resources (Karodia and Weston, 2001). Given the existing Acts and policies, the relevant minister then develops a strategy. Figure 2.1 depicts the relationship between acts, policies, strategies and programmes in water resource management.

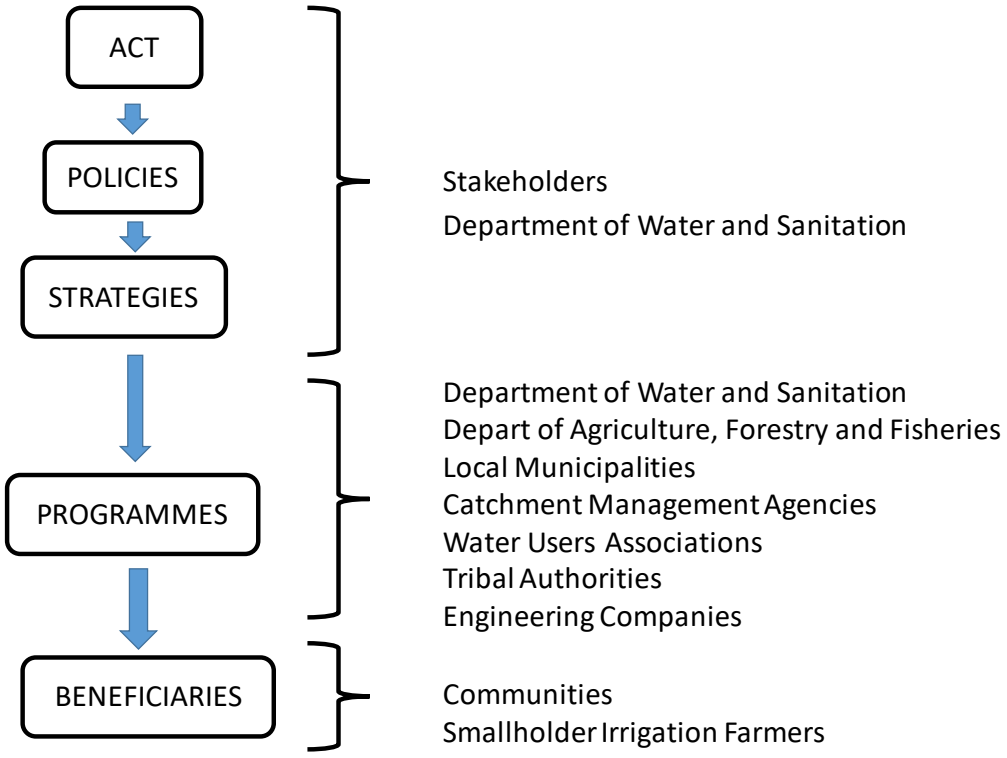


Figure 2.1: Linkages between the acts, policies, strategies and programmes in water resource management

2.5.3 Strategies

The strategy outlines the objectives, plans, guidelines, procedures and the institutional arrangements required for achieving the desired goal. The current water strategy, the National Water Resource Strategy (NWRS), which is periodically reviewed, binds all stakeholders and institutions to use it under the National Water Act of 1998 (DWA, 2004). The first edition of

the strategy, promulgated in 2004, describes how water resources are being used and protected in conformity with the existing policies and laws (DWA, 2004). In 2006, the government released the second edition, NWRS2. The strategy seeks to achieve equity, job creation, growth and development. However, the main objective was to ensure that water-use supported the fair and sustainable, social and economic transformation and development (DWA, 2006). The Water Allocative Reform (WAR) programme, was developed as a vehicle for meeting the objectives of the NWRS and the following eight major principles underpin it:

- Redress past race and gender imbalances in water use.
- Ensure that capacity development programmes support water allocation processes that promote productive and responsible water use.
- Facilitate water access by black- and women-owned enterprises so that the water allocation process contributes to Broad-Based Black Economic Empowerment (BBBEE) and gender equity.
- The water allocation process responds to local, provincial and national planning initiatives, as well as to South Africa's international and regional (SADC) obligations and initiatives.
- The water allocation process must be a fair, reasonable and consistent way that does not undermine existing legal uses.
- Protection of water resources through the attainment of developmental and environmental objectives.
- Potential changes in waste discharge or non-point source impacts should be re-allocated under water regimes.
- The administrative role of authorising water use needs reduction (DWS, 2008).

The strategy sought to have black people use 30% of available water, with half of them being women. Such targets would allow for the meeting of objectives of the strategy.

2.5.4 Irrigation Management Transfer

Following the democratisation of South Africa in 1994, the provincial government dismantled the homeland agricultural parastatals and transferred the management of smallholder irrigation schemes to the farmer communities who benefitted from them. Generally, a similar process, referred to as 'Irrigation Management Transfer' (IMT) had been occurring. Vermillion (1997)

identified three main reasons for governments to implement IMT. These were to reduce public expenditure on irrigation, improve the productivity of irrigation schemes and stabilising the deterioration of irrigation systems. The transfer of ownership and management responsibility to irrigation farmers in the late 1990s was not a deliberate effort but was due to the Government's budgetary reprioritisation and it coincided with the withdrawal of financial support for management and maintenance of irrigation schemes (Gomo *et al.,* 2014). Consequently, the smallholder farmers faced high production costs of water pumping costs without government support and this accompanied the ceasing of infrastructural development and upgrades. IMT affected all projects where parastatals previously offered services to smallholders. The larger, more modern smallholder irrigation schemes strongly felt the effects since they were complex, with high dependency levels among irrigation farmers because of centralized management (Van Averbeke *et al.*, 1998). However, farming collapsed following the implementation of IMT (Laker, 2004). Small irrigation schemes, particularly the schemes based on canals, were more resilient and continued to operate, albeit at reduced levels (Machethe *et al.*, 2004).

Besides IMT, the 1990s also saw the establishment of several new smallholder irrigation schemes. The new schemes aligned with the Reconstruction and Development Programme (RDP). Irrigation development converged with a need for an improvement in food security at the community or group level and supported the establishment of small schemes. Denison and Manona (2007) identified 62 smallholder irrigation schemes instituted during this era, but they only covered a combined 2 383 hectares, indicating their limited size (38.4 ha on average). Typically, these projects used mechanical pump-and-sprinkler technology to extract and apply irrigation water, respectively.

Growth, Employment and Redistribution (GEAR) superseded the RDP as the overall development policy of South Africa. GEAR shifted the strategy to eradicate poverty from funding community-based projects to pursuing economic growth through private sector development. The government identified irrigation schemes as important resources for achieving economic development in the rural areas, and that they required revitalized. This was the birth of the Revitalisation of Smallholder Irrigation Schemes (RESIS) (Denison and Manona, 2007).

In February 2000, cyclone Conny ravaged the Limpopo Province (Khandlhela and May, 2006). Heavy rains caused widespread floods and damage to roads, bridges and to weirs that provided water to many smallholder canal-based schemes (Van Averbeke, 2012). The declaration of Limpopo Province as a disaster area allowed allocation of funds to repair the damaged infrastructure, providing impetus to the WaterCare programme. WaterCare programme aimed to revive selected smallholder irrigation schemes, in terms of not only infrastructure but also leadership, management and productivity. WaterCare used a participatory approach and involved smallholder communities in planning and decision-making and provided training to enable these communities to take full management of their schemes (Denison and Manona, 2007).

In 2002, the Limpopo Province broadened its irrigation scheme rehabilitation intervention by launching a comprehensive revitalisation programme, called RESIS (Revitalisation of Smallholder Irrigation Schemes). RESIS adopted the participatory approach of the WaterCare programme and had a plan for the revitalisation of all smallholder schemes in the province (Denison and Manona, 2007). As with the WaterCare programme, RESIS combined the reconstruction of smallholder irrigation infrastructure with the provision of support to enable effective IMT. In support of IMT, the programme dedicated a third of the revitalisation budget to capacity building among irrigation farmers. RESIS also sought to enhance the commercialisation of the smallholder farming systems on the schemes as a way towards the improvement of the livelihood of plot holder households (Van Averbeke, 2008).

WaterCare programme and the first phase of RESIS (1998-2005) primarily emphasised the rehabilitation of scheme infrastructure and on sustainable IMT, and less on commercialisation. Canal schemes revitalized during this phase retained their water conveyance methods. However, starting in 2005, commercialisation became the primary growth objective of RESIS. The introduction of the Black Economic Empowerment (BEE) strategy in South Africa probably influenced the change in approach (van Averbeke, 2008). Nationally, the BEE strategy aimed to increase the share of black people in the economy and it emphasized entrepreneurship.

2.6 Milestones Strategies for Water Governance

The KwaZulu-Natal Department of Agriculture and Rural Development (KZN DARD) (2015)

presented its five-year plan for the period 2015-2020). The strategic plan reflects a plan for formulating policy and strategies that interact with the smallholder irrigation farmers for improved rural economies. The strategic goals and objectives of this plan aligned with both the provincial and national priority areas for the agricultural sector (KZN DARD, 2015). The strategic plan recognizes both the provincial and national acts, policies and strategies, which they should align with. Similarly, as pointed out earlier, the APAP of the national DAFF also synchronizes with other government policies and strategies.

The South African government has embarked on a NGP, which is the country's main economic policy that aims to drive decent job creation to address high unemployment and economic stagnation, with a target of five million jobs by 2020 from all key sectors. Agriculture, which contributes significantly to the GDP, is viewed as one the of main employment creation drivers in this regard given its character as labour intensive and ability to absorb the less skilled amongst the jobseekers. To this end, NGP proposes that the government agricultural policy focus on:

- Restructuring of land reform to support smallholder schemes with comprehensive support around infrastructure upgrade and revitalisation.
- Acceleration of land claims processes and better support to new farmers following restitution settlements.

2.6.1 Medium Term Strategic Framework 2015-2020

In pursuit of strategic configuration and policy consistency, the government proposed the Medium Term Strategic Framework (MTSF) 2015-2020 as the first five-year implementation phase of the NDP. Policy priorities of both the NDP and the NGP (DAFF, 2012c) inform the MTSF document.

2.6.2 Integrated Growth and Development Plan

The IGDP is the national DAFF sector plan that replaced the 2001 Strategic Plan for South African Agriculture (DAFF, 2012c). It sets out a vision for agriculture and related sectors and provides strategic direction regarding all the critical issues that affect the sector performance and governance and its contribution to the national economy. It serves as an important strategic reference document for provincial departments responsible for agriculture. IGDP is consistent

with the NDP and other policy frameworks, and therefore advocates for food security, economic growth and development of SIS schemes, which in turn, should fuel rural economic development.

2.6.3 Agrarian Transformation Strategy

The Agrarian Transformation programme proposes several interventions ranging from the provision of basic services and social amenities for rural communities, food security support, interventions in crop production (DAFF, 2012c). This strategy seeks to increase crop production through irrigated agriculture. The strategy aims at revitalising irrigation schemes and ensuring high performance.

National policies and strategies give guidance in the formulation of provincial strategies and programmes. For examples, in 2011 the provincial government of KZN launched a Provincial Growth Development Strategy (PGDS), which aimed at accelerating poverty reduction, especially among the black population. The PGDS had priority targets, with agriculture identified as the key driver for a quick economic boost to the rural folk. The resuscitation of irrigation schemes and upgrading of the old infrastructure was at the focal point of the strategic framework. Table 2.1 presents the acts, policies and strategies.

2.7 Institutional Arrangements on Smallholder Irrigation Schemes

Muchara *et al.* (2014) reported that irrigation farmers in community-managed schemes vary in their levels of water access. However, the greatest challenge in these schemes is the lack of understanding of the level of water-use security or the influence of local management systems. A sundry of factors influence the performance of irrigation schemes. The involvement of water users in water appropriation plays a critical role in the equitable distribution.

Table 2.1: Timeline of acts, policies and strategies

Policy, Act or Strategy	Year	Objectives	Reference
Irrigation and Water Conservation Act (Act 8 of 1912)	1912	Promotion of irrigation development.	Mudau, 2010
Water Act (Act 54 of 1956)	June 1956	Consolidation and amendment of laws relating to the control, conservation and use of water for domestic, agricultural, urban and industrial purposes.	FAO, 2015
National Water Act (Act 36 of 1998)	August 1998	To ensure that South Africa's water resources were protected, used, developed, conserved, managed and controlled.	DWA, 2000
National Water Policy	April 1997	Treat water as an economic good, and for the protection, use, development, conservation, management and control of South Africa's water resources.	Karodia and Weston, 2001
		National Water Resource Strategy (NWRS1/2)	
New Growth Path (NGP)	November 2010	Drive decent job creation to address economic stagnation.	TRALAC, 2015
		The Agricultural Policy Action Plan (APAP) *Medium Term Strategic Framework (MTSF)*	
NDP	February 2013.	Eliminate poverty and reduce inequality by 2030.	DAFF, 2012c
		Medium Term Strategic Framework (MTSF) *Integrated Growth and Development Policy for Agriculture, Forestry and Fisheries (IGDP)* *Agrarian Transformation Strategy*	
National Water Resource Strategy 2	July 2013	Ensure that water-use supported the fair and sustainable, social and economic transformation and development.	DWA, 2006
		Water Allocative Reform (WAR) *Water Care* *Revitalisation of Smallholder Irrigation Schemes (RESIS)*	

Groups of farm lots further sub-divided into smaller units, where each subdivision comes with an overlooking authority that manages and operates the infrastructure. The smallest indivisible sub-group of water users has very little or no say on the implementation of water use and appropriation strategies as the authority hierarchically above represents them.

Muchara *et al.* (2014) also reported that the hierarchal arrangement ensures that the overseeing authority at the main canal operates within the rules and regulations of allocated water from DWAS. However, this setting has proved ineffective as political challenges constantly rocked them, which make the water allocation difficult.

Mbatha and Antrobus (2008) applied the physical externalities (PE) model to evaluate challenges of irrigation water apportionment among irrigation farmers along the Kat River Valley in South Africa. According to the model, the geographical location of farmers along a given watercourse, from which individuals divert water leads to structural inefficiencies that adversely affect the whole farming community, with harsher effects being felt downstream (Mbatha and Antrobus, 2008). Poor coordination and non-compliance with institutional and regulatory instruments lead to such water allocation inefficiencies.

Dorward and Omamo (2009) point out that the implementation of the IMT in Sub-Saharan Africa makes a continuous assessment of irrigation governance institutions critical. The Institutional Development Analysis (IDA) is an appropriate approach under such circumstances (Ostrom, 1990).

2.7.1 Water management institutions in South Africa

Table 1 shows the progression with which rules were enacted. The NWRS provides a framework for driving water resource management in Water Management Areas (WMA). In October 1999, nineteen WMAs were established (Karodia and Weston, 2001). Since then, viability assessments on the management of the WMAs have considered various factors. These include water resources management, available funding, capacity, skills and expertise. After the assessment, it was proposed that the 19 WMAs be merged into nine. The nine WMAs are Limpopo; Olifants; Inkomati-Usuthu; Pongola-Mzimkulu; Vaal; Orange; Mzimvubu-Tsitsikamma; Breede-Gouritz and Berg-Olifants (DWA, 2006). The advantages of consolidating the WMAs into fewer ones are that it would lead to the improved management

of integrated systems. It would be easier to distribute technical skills over fewer institutions. Other advantages of fewer WMAs are the faster facilitation of Catchment Management Areas (CMA). As a result, the larger, fewer CMAs improve "cooperation and coordination on regional, provincial, and international levels" (ibid; 1).

The Natural Water Resource Strategy outlined the establishment of CMAs, within WMAs, throughout the country. The agencies are to co-ordinate water-related activities such as water charge collection, registration and water authorisation. CMAs choose representatives from local and provincial governments, current and potential water users. The agencies are also to develop and implement Catchment Management Strategies (CMS) and encourage local community participation (Karodia and Weston, 2001). The CMAs in the different WMAs collaborate with national, provincial and local governments, and other water management institutions and associations.

Key players in the management of water resources are the WUAs (Kemerink *et al.*, 2013). WUAs are cooperative associations that embark on water-related activities for the benefit of individual irrigation farmers and water users and generate income through water use charges (Backeberg, 2006). As stipulated by the NWA, former Irrigation Boards were transformed into WUAs to incorporate irrigation farmers who did not previously qualify to access water resources due to lack of formal water entitlement (Faysse and Gumbo, 2004). WUAs enabled previously disadvantaged irrigation farmers to partake in the management of water resources and to be responsible for the management of irrigation schemes (Perret and Geyser, 2007). However, other studies have reported that irrigation farmers have limited knowledge of WUAs. Others do not participate in WUAs for various reasons.

The DAFF together with the Department of Water and Sanitation (DWAS) are the key role players in smallholder irrigation responsible for the creation and maintenance of irrigation infrastructure. The Provincial Departments of Agriculture are responsible for providing agricultural extension services, mechanisation services and the development of cooperatives, including the appointment of cooperative managers. The Department of Water and Sanitation is responsible for planning, policy formulation, legislation, national strategy formulation, institutional development, and coordination, monitoring and auditing water resource systems (Machethe *et al.*, 2004).

2.8 Rules and Regulations and Instructional Setting in Irrigation Schemes

A multiplicity of rules and regulations interact at irrigation schemes. An understanding of the institutional setting at irrigation schemes allows a deeper understanding of how rules and regulations interact and allow for investigation of how they affect the performance of the schemes.

Granting that both formal and informal institutional arrangements administrate schemes in South Africa, formalised institutions are required at scheme level for small-scale users and policymakers to effectively interact with each other. This proposition coincides with the scenario where the management of natural resources in third world economies is shifting from the centralised and state-driven regimes towards decentralised, and mainly community-based, management systems (Dorward and Omamo, 2009). In irrigation farming, the shift in the institutional setting is influenced by the IMT and Participatory Irrigation Management (PIM) approaches (Perret and Geyser, 2007; Gomo *et al.*, 2014). Gakpo *et al.* (2001) suggested that supply-side forces dominate water allocation in South Africa and they motivated for the establishment of CMAs and WUAs to address the misalignment in institutional imperatives. Gakpo *et al.* (2001) still note that, despite the good intentions, the decision support and management tools for the proper functioning of the CMAs and WUAs in South Africa are largely inadequate. In recognition of this shortcoming at the functioning of local institutions, the South African Directorate of Catchment Management of DWAF embarked on capacity building of water users to enable the water management institutions to enhance their functional effectiveness (Backeberg, 2005; DWA, 2006). Various authors point that considerable time is required before the WUAs can efficiently allocate water, considering that institutional arrangements governing the use of community water take long to adapt to changes (Saleth and Dinar, 1999; Backeberg, 2005).

With the formal and informal rules operational at SIS's in South Africa, the participation of the irrigation farmers in irrigation depends on the local and formal rules and regulations and other factors (Muchara *et al*., 2014). Other factors, such as land tenure and socio-economic characteristics also come into play. Under IMT regime, general maintenance of the distribution system is the responsibility of the irrigation farmers in the irrigation scheme (Letsoalo and Van Averbeke, 2006) and irrigation farmers need to pay for energy if pumps are used to extract water (Machethe *et al.*, 2004). Committees at the local level have the ultimate say in terms of

the amounts that each farmer has to contribute.

2.8.1 Law, land and water in smallholder irrigation

The National Water Act 36 (1998) of South Africa states that farming households have a right to access irrigation water. This Act stipulates the formation of WUAs or effective collective management of water resources (Perret, 2001). Perret (2001) argues that WUAs might have negative effects on water management if they lead to conflicts among irrigation farmers.

Since time immemorial, water resource allocation seeks to maintain the community fabric by meeting water requirements for various purposes (Dinar *et al.*, 1997). Kulkarni (2011) pointed out that water is allocated based on a person's social, cultural and economic factors. Therefore, an understanding of these social constructs would be a pathway to understanding water allocation mechanisms in such societies.

According to Hanemann (2006), institutional settings, inclusive of governance, are critical determinants of water access than its physical availability. In this regard, Graham *et al.* (2003) and North (1990) defined governance as the processes that underlie how societies or organisations make decisions. Indeed, there is evidence to suggest that good governance underlies the performance of collectively managed endeavours (Ortmann and King, 2007; Chibanda *et al.*, 2009; Ostrom, 2007). Functional governance can contribute to the equitable allocation of resources, such as irrigation water.

Ostrom (2007) and Shah *et al.* (2004) point that governance and collective action in water provision for irrigation have more chances of success when based on simple, transparent and locally devised rules. This is more plausible since such conditions are conducive for effective and efficient monitoring and enforcement. According to Shah *et al.* (2004), clearly defined policies and rules are essential for effective institutional configuration. Furthermore, Hanemann (2006) notes that the context is a key factor as the socioeconomic conditions of the people interacting with the policies and rules also contribute to the institutional setting and its performance.

However, Saleth and Dinar (1999) brought attention to the complexity at play and cautioned against the possibility of drawing the wrong attributions. As such, a thorough understanding of the broader context and drivers is required. Nevertheless, according to Bandarogoda (2005)

and Madani and Dinar (2013), the state of water management can be a good indicator for evaluating how institutions are performing.

2.8.2 Land governance and irrigation schemes

Access to land and the rules and regulations governing the processes intertwine with the water governance on irrigation schemes. Access to land is the gateway to accessing and using irrigation water. Access to water in smallholder irrigation schemes ties up with access to land in the irrigation schemes. Muchara (2014) described irrigation farmers within and non-registered water users in the irrigation scheme, where the latter was not on the original scheme design yet extract water for irrigation purposes. This complicates the linkage between land access rules and irrigated water use. Both statutory and customary laws govern land rights in South Africa and many other developing countries (Toulmin, 2008). By extrapolation, water for irrigation is also determined similarly. Different principles underlie the two law regimes and the laws grant different rights to individuals. Statutory law confers and relies on legal or formal rights to validate property rights (Toulmin, 2008). Informal legal constructs, supported by the local authority, religious values and social norms underpin customary law.

Most rural communities in South Africa are under the jurisdiction of traditional authorities. The Traditional Leadership and Governance Framework Act 41 of 2003 recognizes traditional councils, houses of traditional leaders and the Commission on Traditional Leadership Disputes and Claims. The South African Constitution recognizes customary laws and institutions (Cousins, 2011). Traditional leaders can govern matters on land administration, agriculture and the management of natural resources (Cousins, 2011).

Some irrigation farmers have inherited land and some people that pay a fee of pledging allegiance to the traditional authority can have land allocated to them. Traditional authorities grant the Permission to Occupy (PTO) communal land to individuals and issue the PTOs in the name of the household head (Hull *et al.*, 2016), who are generally considered as males. However, in irrigation schemes, the government also plays a role in the allocation of plots (Cousins, 2013).

Most irrigation farmers are women, who can use the plots allocated to them within their families (Machethe *et al.*, 2004; Cousins, 2013). The household heads, who are usually men,

are normally the plot titleholders.

Culture also plays a critical role in land and water management in smallholder systems Verhelst and Tyndale (2002) defined culture as a combination of knowledge, wisdom, values, attitudes, customs and multiple resources which a community has inherited, adopted or created under its social and natural environment. According to Bonnekessen (2010), culture creates norms and practices for resource use. Some cultural factors suppress women, e.g. failure to emphasize their education, their marriage at young ages, and their subjugation within families and communities. Molnar (1999) points out that such factors affect how the social fabric intervenes in resource access and use, including water.

In some countries, the legal system, in particular inheritance and divorce laws, give women fewer rights to land in comparison to men (Internationale Zusammenarbeit (GIZ), 2013; Agarwal, 2003). Deere and Leon (2003) noted that gender inequality in land ownership is related to the advantaged position have in traditional systems. For example, often land is registered only the name of a male head of household (GIZ, 2013). Women also risk being disadvantaged in land conflicts. Besides, for cultural reasons, wives cannot challenge the authority of their husbands.

2.9 Framework for Studying Institutions

Muchara (2014) adopted an Institutional Analysis and Development (IAD) approach to understanding governance in water management. The framework was developed by Ostrom (1990) to analyse the management of CPRs. The IAD framework (Figure 2.2) enables the analysis of variables that affect patterns of interactions in an irrigation scheme.

The 'environment' encompasses the governance system, resource system, resource units and the resource users (Ostrom, 1990). The environment has an impact on water management (Figure 2.2). Ostrom (1990) developed eight design principles that create sufficient conditions for effective management of CPRs.

However, both the IAD framework and the design principles have weaknesses. Wilson *et al.* (2013) pointed to the failure to emphasise on social variables nor to incorporate the impact of the global phenomenon, such as climate change, water scarcity and food insecurity as weaknesses. Also, the two frameworks do not recognise the importance of psychological

capital (Luthans *et al.*, 2007). Psychological capital influences the outcomes of CPR management, including irrigation water. Psychological capital would allow for cooperation in joint management of CPRs resources (Luthans *et al.*, 2007).

There is a link between water legislative policy and governance systems on irrigation scheme and this, in turn, affects water provision to smallholder irrigation farmers. Shah (2005) defined the institutional environment (IE) as comprising players such as government and international agencies, water policies and related laws. The IE, closely linked to IA, was defined by Shah (2005) as humanly devised rules that govern the behaviour of water-users. Understanding the linkages between water policies and users is important because lack of user cooperation, especially due to a lack of knowledge on statutory instruments might impede public resource allocation.

In South Africa, despite the enactment of the NWA of 1998, water management structures are not adequately in place to make the act fully effected. As such Backeberg (2005) noted that the reform process may require up to two decades for appropriate institutions to be in place for the implementation of the water policy. According to the Act, non-compliance such as not registering as a water user with the Department of Water Affairs (DWA) may result in water being reallocated to other registered users. However, according to the NWA (1998), allocation of water for domestic use takes precedence over all other water uses. Legal recognition of the scheme is, therefore, critical to improving water security and access at local levels.

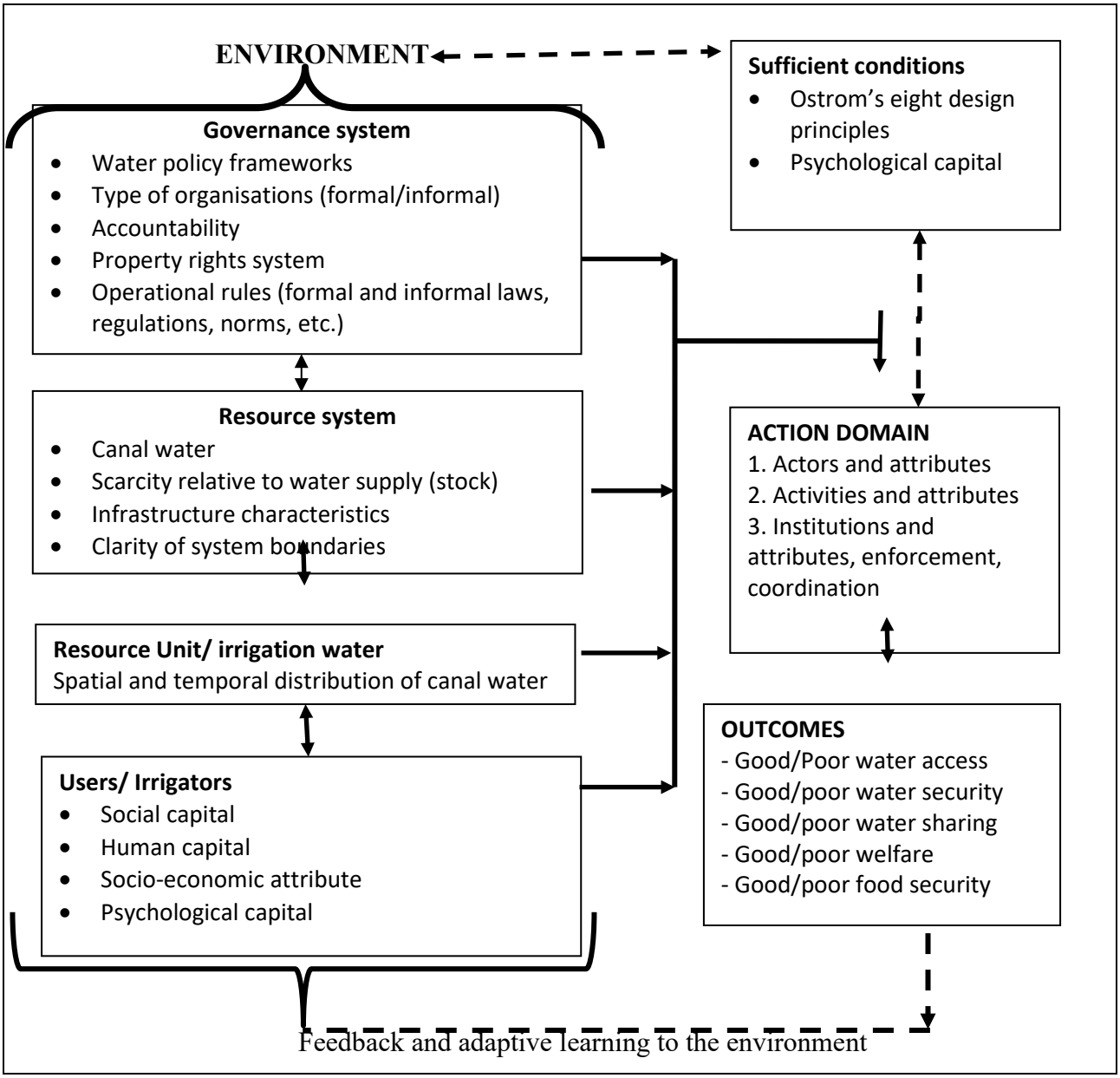


Figure 2.2: Institutional linkages in Institutional Analysis and Development framework

Source: Adapted from Muchara (2014)

2.10 Governance Outcomes in Smallholder Irrigation Schemes in South Africa

Water resource management in SA, through water legislation, focuses on ensuring its equitable and sustainable allocation through authorisation (licensing and registration) to avoid and control the risks of unsustainable management (Namara *et al.,* 2010). In the late 1990s, decentralisation was recommended as the appropriate approach to water management in irrigation schemes. The state transferred the full responsibility of irrigation management to

irrigation farmers, and it withdrew its support in smallholder irrigation schemes (SIS) and encouraged irrigation farmers to participate in water management as well as in irrigation infrastructure maintenance (Sharaunga and Mudhara, 2016).

According to Namara *et al.* (2010) irrigation farmers at the local level tend to devise their own rules, rights and regulations that best represent their interest such as local norms, customary laws and religious laws. Local norms play a significant role in ensuring equitable access to water for both domestic and production purposes in designated areas. Although informal rules have similar intentions as statutory laws regarding equity and sustainable management of water resources and resolutions in water management, they tend to be ignored by official policies and intervention strategies (Namara *et al.*, 2010).

The interaction of different policies, strategies, rules and regulations in irrigation have outcomes which have a bearing on the performance of water users and food security. The following sections outline some of the core outcomes of the policies, strategies, rules and regulations in smallholder irrigation schemes in South Africa, which are expressed through water management, water security, infrastructure management and irrigation farmer participation.

2.10.1 Irrigation Water Management

Veldwisch (2006) conducted a study at Thabina irrigation scheme in Limpopo province on local governance issues after Irrigation Management Transfer (IMT) and it illustrates the impacts of scheme governance. The scheme was informally managed by both the Management Committee (MC) consisting of thirteen members elected by scheme irrigation farmers as well as traditional authorities with the chief being the landlord. Hence, irrigation plots were held under customary land tenure where irrigation farmers had the usufructuary rights in the form of permission to occupy (PTO). With regards to irrigation water management, the scheme had a WUA established by a group of consultants that worked together with the irrigation farmer's community during the revitalisation of the scheme. Under the RESIS programme in (1998-2001) in Limpopo, the scheme infrastructure was rehabilitated, irrigation farmers were provided training on-field and system water management and the management of the scheme was handed over to the WUA. Like other irrigation schemes, Thabina irrigation farmers had an official irrigation schedule and practice rotational irrigation in which every plot received

water once a week. This practice was adopted to ensure equitable access to irrigation water among upstream and downstream irrigation farmers.

The RESIS programme had positive outcomes at the Thabina irrigation scheme. After the revitalisation of the scheme, the MC became the legal management body and, water availability was significantly increased, and the yields were significantly increased.

Makombe *et al*. (1998) pointed out water management as a common challenge across SISs as irrigation farmers often fail to match water supply and demand and the appropriate time of water application. Irrigation farmers apply water regardless of crop water requirement resulting in over irrigation or under irrigation, both not good for optimum crop production. According to Speelman (2009), the lack of effective water rights systems, water charge system and ill-defined property rights are the major sources of low water use efficiency and major problems for the water management in SISs across SA.

2.10.2 Water security

The concept of water security has received increased attention over the past decade, in both policy and academic debates. Multiple definitions of the concept exist, promoted by international organisations particularly the Global Water Partnership and the World Economic Forum (Cook and Bakker, 2012). 'Water security' is an emerging term, and has no universal definition as yet. Since the 1990s, the term water security has seemed to articulate concern about issues such as reliability, quality, quantity, safe and equitable and environmental provisioning of water (Gerlak *et al.,* 2018). Sinyolo *et al*. (2014b) articulated that water security is related to food security, in that there is a need to ensure that the population has access to sufficient water to meet all its needs, be it production or consumption. However, the difference is that unlike in food security, it is not only the absence of water that causes the insecurity but its presence as well, e.g. the destructive element of water in its natural, unmanaged state, such as floods (Grey and Sadoff, 2007).

Analysis and interpretation of water security vary according to the geographic region of study and the aims of the research. In geographical literature, the place is important to how people experience and understand both society and nature (Gerlak *et al.,* 2018). Muller *et al*. (2009) and Sinyolo *et al*. (2014b), defined water security at irrigation level as when the social and

productive potential of water has been harnessed adequately to the benefit of all the irrigation farmers, and its destructive potential is sufficiently contained and the irrigating households can assert water rights against other parties. Similarly, Grey and Sadoff (2007: 548), on the other hand, defined water security as the "availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies".

The key aspects in the definition of water security are access and reliable water supply, the ability of the irrigation farmers to pay for water, and their right or entitlement to the water, which they can assert against other parties. Water security is, therefore, a range of the above-mentioned components, where an irrigation farmer scoring high of these components is more water-secure than the counterparts.

2.10.3. Irrigation farmer participation

In recent decades, it has been widely accepted that public participation, that is, the involvement of individual and/or organised public members in the decision-making processes, brings about an opportunity to improve natural resource management by incorporating the knowledge, values and perspectives of the public (Muchara *et al*., 2014).

Participation is a process in which stakeholders influence policy formulation and management decisions affecting their communities, and they establish a certain sense of ownership. In South Africa, agriculture uses more than 80% of available land and around 60% of available water (Grain SA, 2015). Irrigation farmers are the major users of irrigation systems, therefore the collective action of irrigation farmers is required to ensure the sustainability of irrigation systems (Muchara *et al.,* 2014). Through participation, irrigation farmers can establish institutions for sustainable water management. For this reason, PIM has been adopted in South Africa.

PIM is centred on involving irrigation farmers or water users in the operation, management and maintenance of irrigation systems in tertiary and secondary levels. This translates to the irrigation farmer being a "water manager" (Gomo *et al*., 2014). The benefits of a farmer participating in the management of an irrigation system are that it builds a sense of ownership, rapid response to scheme problems, fosters collective action and improves rule compliance

(Ostrom, 1990). Irrigation farmer participation can enable users to learn from each other and also ascertain the impacts of their individual and collective actions on resource sustainability. In terms of institutions, they can realize and understand the consequences of breaking the rules, and the benefits of complying with them (Muchara *et al*., 2014). Participation also validates that users have a stake and a responsibility on the state and sustainability of the resource, and also increasing the likelihood of users adhering to the rules. Irrigation farmer participation improves compliance in that users can "keep an eye" on each other's actions, and that everyone practices collective commitments, such as attending meetings (Ostrom, 1990; Muchara *et al*., 2014).

The willingness of users to participate in managing irrigation schemes is important for the sustenance of the facilities (Van Averbeke, 2012; Muchara *et al.,* 2014). In developing irrigation schemes for communal use, it is important to get users consent for participation. Participation may be low at the design and construction phase, because of the need for technical expertise. After construction, however, activities of users and their maintenance practices are the determining factors of the systems' sustainability. Participation of irrigation farmers as core users in the maintenance of irrigation facilities and decision-making invariably is thought to have a positive influence on the performance of schemes.

2.10.4 Stakeholder participation

Governance on SISs involves multiple stakeholders, covering different disciplines. Agricultural water use on SISs is relevant to the health and welfare of smallholder producers and consumers through nutrition, which is part of the core-focusses of the Health and Social Development departments. It requires that producers in irrigation schemes have secure land tenure, therefore, touching on the mandate of the Department of Land Affairs and Rural Development. Revitalisation of irrigation schemes involves the Department of Water and Sanitation and that of Public Works. The latter is responsible for the construction of infrastructure. It requires agricultural production and significantly affects the environment, which is the mandate of the DAFF and the Departments of Environmental Affairs (DAE), respectively. It also requires the support of local key players such as district councils, local municipalities and tribal authorities (DAFF, 2011).

All the involved governmental departments have the responsibility of upholding the Batho Pele

Principles, introduced in October 1997, to foster the delivery of public goods and services. The initiative necessitates transparency, politeness and openness of public servants. SIS's governance hinges on CMAs, WUAs, DAFF, Department of Water and Sanitation (DWS), The Department of Rural Development and Land Reform (DRDLR), DEA, Agricultural Research Council (ARC) and the Water Research Commission (WRC). The ARC provides agricultural research information, the WRC directs and manages funds for water-related research. The private sector comprises of financial institutions, NGOs and tribal authorities. Given all the organisations involved in water management, water users would be better off if they interacted with the respective stakeholders and received the necessary support.

2.10.5 Infrastructure management

The interaction between the physical structures and the social aspects underlies the performance of SISs. The South African government adopted the IMT policy that placed irrigation farmers in self-governance and the NWRS promoted the formation of water management institutions. This led to the formation of WUAs and irrigation management committees, which have legal mandates. The legal mandates imply organising routine canal maintenance and organising farmer training (Balasubramanya *et al.*, 2017). The NWRS also outlines that water users should have water licenses that authorise abstraction for productive purposes. This policy resonates well with findings by Denby *et al.* (2017) who states that before farmers access "wet" water they have to possess "paper" water in the form of water licenses.

2.10.6 Impacts of governance in smallholder irrigation schemes

The performance of the scheme, including irrigation management, water security, infrastructure management and irrigation farmer participation collectively have an impact on the key output of food security and equity and sustainability.

Water and land are an important natural resource for crop production and household welfare. The management of both resources are crucial for optimal crop production and to ensure sustainable household welfare as they both play a significant role in agricultural production (Singh *et al.*, 2013). However, the current world situation regarding water resources makes it costly to use as the world is facing a rapidly increasing demand for water. This requires the implementation of water management strategies for sustainable agricultural production and equitable water distribution among various sectors (agricultural sector, non-agricultural sector,

the ecosystem, etc.). Insufficient or excess water supply to crops negatively affects crop growth, quality of produce and crop productivity. Improving water management increases crop yields as low-quality irrigation water can constrain crop productivity.

Singh *et al.* (2013) pointed out that some effective water management techniques involve the use of less labour intensive and water-saving technologies such as sprinkler or drip irrigation system. These irrigation methods can enhance water use efficiency, ensure sustainable and reliable water supply while enhancing crop productivity. Among many water management strategies, China employed a water pricing system for water resource management. The water pricing system Increased household welfare, income, and consumption. However, crop output declined as a result of water pricing system due to more water use in the non-agricultural sector than the agricultural sectors (Zhong *et al.,* 2015). Irrigation schedule, which is often used by irrigation schemes that are still using traditional irrigation methods, also improves irrigation efficiency and achieves maximum potentials of irrigation schemes (Stevens, 2006). According to FAO (1996) cited in El Afandi *et al.* (2010), irrigation schedule has been the primary tool to improve water use efficiency, increase crop yields, increase the availability of water. However, scheduling requires strong governance.

In South Africa, irrigation water is allocated according to the user-based allocation mechanism, which requires collective-action institutions to make decisions on water rights (Juana, 2008). Ebissa (2017) argued that the most appropriate solution for irrigation water management problems in SISs is the involvement of irrigation farmers in irrigation water management, the whole way from the water distribution decisions to maintaining the irrigation system. According to the NWA, irrigation farmers should participate in irrigation management through legally established WUAs comprising of the irrigation MC democratically elected by irrigation farmers.

The decision on water allocation mechanism to be employed should be based on its ability to promote economic efficiency, social equity, wealth and environmental sustainability, which are the indicators of sustainable water resource management. These indicators are consistent with the aims of the NWA and NWRS in South Africa. Irrigation schemes with irrigation farmers that are aware and understand formal water institutions are more likely to properly manage their irrigation water and to realise these irrigation water management indicators.

Equity

Although achieving maximum productivity is the primary objective of irrigation farmers in social and environmental objectives such as equity and sustainability must also be achieved. Equitable distribution of water resources among irrigation farmers and other outlets in an irrigation scheme is necessary for maximizing productivity. In the irrigation context, equity refers to the fairness in the allocation and distribution of land and water resource in the irrigation scheme, as well as the net benefits among irrigation farmers (Gorantiwar and Smout, 2005). Proper irrigation water management is also important for maximizing productivity (Ibid). Equitable allocation and distribution of land and water should improve household welfare and food security of all irrigation farmers, especially the most vulnerable.

Adequacy and Reliability

Irrigation water adequacy relates to the ability of water supply to meet crop demand, while water reliability is closely linked to the availability of irrigation water at the required times. Every irrigation farmer wishes to have reliable irrigation water sufficient for crop requirements. Against the backdrop unreliable supply in SA due to a rise in demand from other sectors, lack of proper management of water resources, seepage in the canal (Gorantiwar and Smout, 2005) are critical.

Sustainability

While water is required in irrigated agriculture, it must be used sustainably. However, the need for sustainability is often overlooked. By nature, human beings are often selfish and always seek to fulfil their individual needs at the expense of the environment. Balooni and Venkatachalam (2016) argued that inappropriate use leads to scarcity, which threatens peace in irrigation schemes by increasing the incidents of water conflicts since it leads to inequitable and unsustainable water use.

Household welfare

Despite the problem with water resources in SIS, their potential to reduce poverty, improve food security and household welfare is recognised (Lipton *et al.,* 2003; Tekana and Oladele, 2011; Sinyolo *et al.*, 2014a**).** Access to irrigation in association with access to agricultural water management technologies had a positive effect on household consumption and poverty reduction in India, Mali and Ethiopia (Gebrehiwot *et al.*, 2017). According to Sinyolo *et al.*

(2014a**),** poverty alleviation, enhancing household food security and improving household welfare in rural areas are the main objectives for the establishment of smallholder irrigation in South Africa**.** However, the rapid growing water demand accompanied by declining water supplies make managing and allocating water in an efficient, equitable and sustainable manner a challenging but urgent task (Balooni and Venkatachalam, 2016). This raises concerns about the prospects of food security, both at the household and national level since it depends on sustainable growth in agricultural production and water availability, which ensure sustainable food supply. According to FAO, food security refers to the "physical, social, and economic access for all people to sufficient, safe and nutritious foods that meets their dietary needs and food preferences for an active and healthy life" (Singh *et al*., 2013: 424).

Bacha *et al.* (2011) conducted a study to understand the poverty reduction impacts of smallscale irrigation development in Ethiopia. Through the application of the Foster, Greer and Thobeck (FGT) poverty indices and Heckman's selectivity model, the results indicated that farm size, livestock holding, land productivity, and family size significantly influence the level of household consumption expenditure, and thus on household welfare. Tekana and Oladele (2011) conducted a study to examine the socio-economic impact of Taung irrigation scheme on household welfare in the North West Province. They found that socio-economic characteristics of a household and access to financial, physical, human and natural capital influenced household welfare. Sinyolo *et al.* (2014a) assessed the impacts of smallholder irrigation schemes on household welfare. They found that poverty incidents were more severe among non-irrigation farmers, compared to irrigation farmers. Based on these results it can, therefore, be inferred that SISs reduce poverty in rural areas. However, these studies fell short of pointing out the contribution of governance towards the ability of irrigation schemes to deliver on the anticipated benefits.

2.11 Summary

Smallholder irrigation farming is key to the alleviation of rural poverty. The government of South Africa has put in place acts, policies, strategies and programmes towards ensuring that the sector achieves this role effectively. This literature review has shown that national policies inform the development of national strategies and action plans. The review showed a lack of clear systematic alignment between acts, policies, strategies and rules. Of interest is how these legal regimes translate at the scheme level, and what their net effect is on irrigation farmers/plot

holders and schemes.

Literature review points out the complexities within the smallholder farming sector. The communal tenure of resource use presents challenges, especially concerning water management. The literature review identified approaches for studying the complexities. It also points out the challenges regarding access to land emanating from the cultural setting existing in communal areas. This means that access to water, though defined in the Acts, relies on local rules and regulations. The unpacking of the interactions between different regimes gives a strong basis for this project.

The literature review also draws attention to the SLA, which is also a useful framework for understanding how the different structures, formal and informal, interact with and impact on the irrigation farming activities of the smallholder irrigation farmers.

CHAPTER 3: STUDY METHODOLOGY

3.1 Introduction

This research project was conducted in KwaZulu-Natal Province of South Africa. It proceeded from the identification of research sites that could allow data collection to address the objectives to the use of a mixed-method approach, which used both formal and informal data collection procedures. Post-graduate students were co-opted to conduct the research. This chapter presents a detailed account of the methodology followed in the study.

3.2 Literature Review

Literature review was conducted to look at the salient characteristics of smallholder irrigation farmers. Together with an understanding of the complexity of the communal management of resources, which includes the complication of collective resource management, the report review unpacked the theoretical constructs for understanding how the smallholder irrigation schemes work. The literature review also unpacked the policies, strategies, rules and regulations affecting the governance of smallholder irrigation schemes.

Further review of literature was carried out on the effects that policies, strategies, rules and regulations have on irrigation performance. The literature review was informed by a framework adopted from Small and Rimal (1996). Small and Rimal (1996) noted that water distribution rules, among other factors, affect irrigation performance. They also pointed out that the existence of conflicting or competing objectives suggest that no set of water distribution rules can be described as the best. Small and Rimal (1996) pointed out that performance of the irrigation system can be looked at from three perspectives, i.e. internal processes (process performance measures), outputs (output performance measures) and the impacts that these outputs have on the larger system within which it is nested (impact performance measures). The literature review on effects was covered through three sections that looked at the respective components, i.e. the effects at the infrastructure level, effects on production and productivity, and lastly, on the effects at the household level.

3.3 Analytical Framework

Towards the end of the 20th century, Small and Rimal (1996) had already noted that rules for water distribution, among other factors, affect irrigation performance. They also pointed out

that the existence of conflicting or competing objectives suggests that no set of water distribution rules can be described as the best.

Small and Rimal (1996) pointed tout hat performance of the irrigation system can be looked at from three perspectives, namely, internal processes (process performance measures), outputs (output performance measures) and the impacts that these outputs have on the larger system within which it is nested (impact performance measures). Table 3.1 shows the effects identified at each of the performance areas and elaborated on in this report.

Table 3.1: Areas of effect identified for each of the irrigation performance areas

Performance Areas	**Areas of effect**
• Internal processes (process performance measures)	a. Water access, water security, water sharing (the three are related) b. Irrigation infrastructure, conveyance, water availability, reliability c. Land and water resource allocation and management
• Outputs (output performance measures)	Production and productivity
• Impacts of outputs on the larger system (impact performance measures)	a. Household welfare, including food security b. Economic performance, revenue

Adapted from Small and Rimal (1996)

3.4 Research Sites

The research was centred and conducted on four irrigation schemes in KwaZulu-Natal Province, i.e. Tugela Ferry (TFIS), Mooi River (MRIS), Makhathini Flats (MFIS) and Ndumo (NIS). Selection of the schemes included in this project was based on the diversity of their characteristics. Table 3.2 presents an overview of the rules and institutions obtaining in the irrigation schemes. Examples of the differences include that MFIS irrigation farmers get land through trust and the agreements are renewed annually. The irrigation farmers in NIS pay for electricity to be able to get water into the scheme, whereas the MFIS only pay for water monthly. Water allocation is scheduled in MRIS and TFIS, where each block was allocated a weekday on which to irrigate their plots. Each scheme has an executive committee, selected by the irrigation farmers, that helps in conflict management. Although most primary conflicts are handled by the elected executive committee, some cases are reported to the respective tribal

authorities, and in some instances, the irrigation farmers have to pay fines.

Table 3.2: Institutions setting in smallholder irrigation schemes

Rules	Irrigation scheme			
	MRIS	**TFIS**	**MFIS**	**NIS**
Land allocation	Traditional Authority	Traditional Authority	Farm Trusts (under the traditional authorities)	Traditional Authority
Water allocation and access	Scheduled irrigation and partly subject to the monthly payments	Subject to payment of contributions for electricity or fuel	Partly subject to the monthly payment, and readily available	Water always accessible. Members have to pay for electricity
Conflict management	Reported to the scheme committee or traditional authority	The executive committee or traditional authority	Co-operative committee	Scheme committee
Penalties for non-compliance	Pay fines	Not enforced	Not strictly enforced	Not enforced

3.4.1 Tugela Ferry Irrigation Scheme

The TFIS was planned and constructed in the early 20th century to improve household welfare but also for the sale of surplus produce (Sinyolo *et al.*, 2014a). The TFIS is located in the Msinga Local Municipality in the Mzinyathi District in the Midlands region of KwaZulu-Natal Province (see Figure 3.1 for the location of the SISs). Msinga is characterised by high levels of poverty and high unemployment rates due to limited resources and depressed economic activity. Agriculture plays a significant role as a source of livelihoods and income generation. Msinga receives low rainfall, with a mean of 600-700 mm, accompanied by high summer temperatures of up to 44°C. The area experiences frequent droughts, which makes rain-fed crop production challenging. Irrigated crop production offers a reprieve from the challenging

climatic conditions and it allows irrigation farmers to increase their incomes and participate in the local economy (Cousins, 2013 and Sinyolo *et al.*, 2014a). TFIS comprises about 1,500 plot holders whose majority are elderly women (Cousins, no date). The scheme has 837 ha of irrigated land, divided into seven blocks along the Tugela River. However, out of a total of 837 ha the scheme has, 540 ha is under cultivation (Cousin, 2013). Irrigation farmers operate an average of 0.4 ha each. Agricultural production is both for food security and for the market.

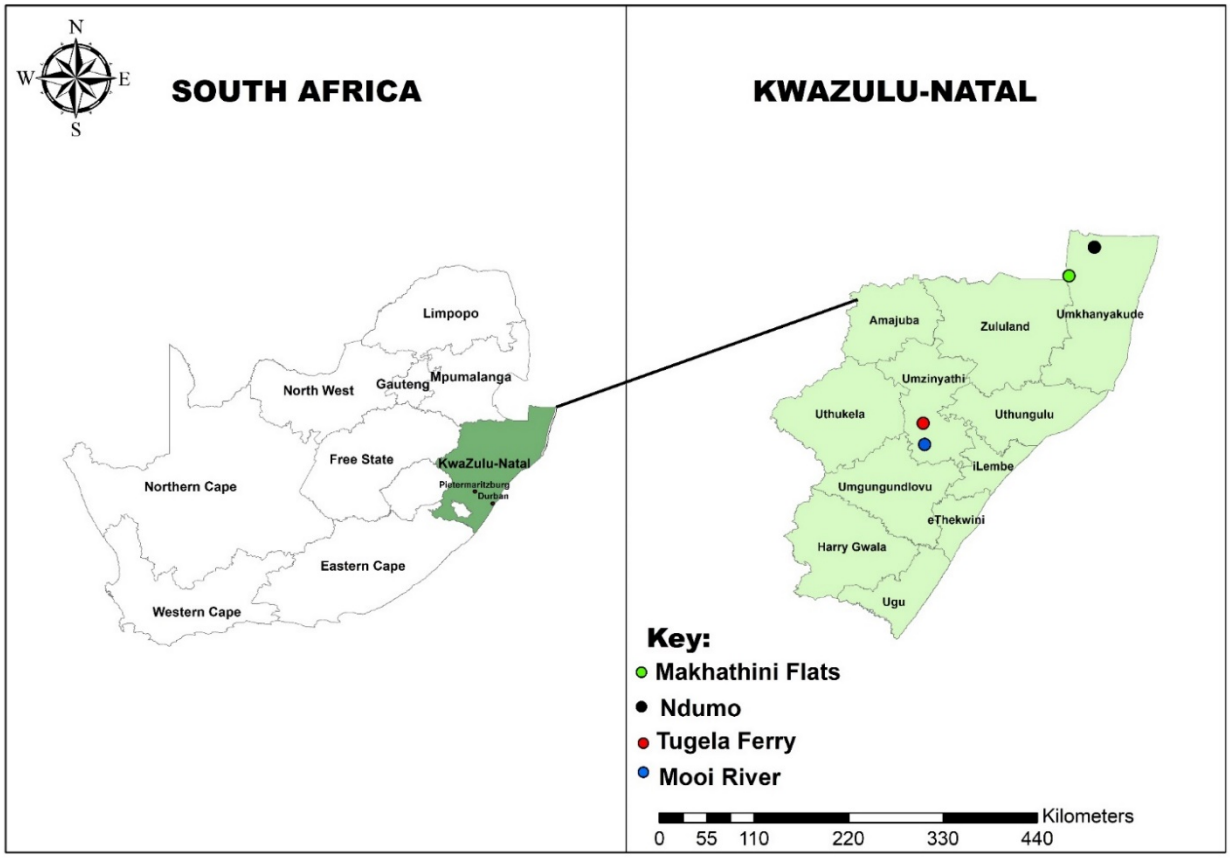


Figure 3.1: Location of study sites in KwaZulu-Natal Province

The scheme draws irrigation water from the TFIS River. Among the seven blocks, Blocks 1-3 and 5 abstract irrigation water using a 31 km gravity-fed canal, while Blocks 4 and 7 use water pumps. Members of Blocks 4 and 7 pay a fee towards pump operations. The leakage in the main canal makes it challenging to obtain adequate amounts of water to all four blocks fed by the canal. All blocks use flood/furrow irrigation system.

Irrigation farmers in TFIS receive some guidance and support from several governmental and

non-governmental sources, e.g. the provincial Department of Agricultural and Rural Development (DARD), Department of Rural Development and Land Reform (DRDLR), LIMA Rural Development Foundation and Department of Agriculture, Fisheries and Forestry (DAFF). Support is in various forms, including the provision of farm inputs (such as seeds, fertiliser and pesticides), maintenance of irrigation infrastructure and links to output markets. However, the support with farm inputs and output market is provided to irrigation farmers who belong to registered cooperatives.

3.4.2 Makhathini Flats Irrigation Scheme

MFIS is located in Jozini Municipality within the uMkhanyakude District in the far north of KwaZulu-Natal Province. The district has five local municipalities and shares borders with Swaziland and Mozambique. It is one of the poorest districts, not only in the province but also in the country. It is characterized by chronic poverty, with 85.2% of households within the municipalities earning less than R1600 per month. Jozini Local Municipality experiences a humid subtropical climate with most of its rainfall falling in summer from December to March (Lankford *et al.*, 2011).

The MFIS was established in 1978 and consists of individual and cooperative ownership of plots. Large plot sizes, where irrigation farmers own 10 ha plots individually and largely producing sugarcane, exist side-by-side with cooperatives plot owners, where irrigation farmers produce a variety of crops on shared plots. Some informal land transactions take place. The scheme is 2620 ha in extent, with about 538 ha being productively used by 603 plot holders. Challenges confront the scheme largely related to land ownership, governance and management of water. Technical aspects of the scheme are run under Mjindi Farming Trust, a quasi-government development entity that acts as the intermediary between irrigation farmers and government.

All irrigation farmers operate under similar institutional arrangements in terms of access to land and irrigation water. Cooperatives in the scheme specialize in vegetable production. Cooperative members pool some of their resources including land yet continue using some it individually. For example, the Zamukuphila Cooperative occupies 120 ha, of which 40 ha is used collectively, and the remainder is divided among cooperative members, with each member cultivating an average of two hectares. Besides sugarcane, scheme irrigation farmers produce a wide variety of crops, including cabbage, tomatoes, green pepper, butternut, potatoes, green

maize, spinach, sweet potatoes, taro, chillies and calabash.

The scheme uses the Jozini Dam on the Pongola River as the primary source of irrigation water. Water is conveyed through a canal system to the scheme. The Mjindi Farming Trust distributes water within the scheme. Irrigation farmers pay R3100 per annum per ha regardless of the extent of water abstraction. Irrigation farmers in this scheme have relatively good infrastructure and access to productive resources through government support. The scheme uses three irrigation systems, that is, centre pivot system, sprinkler system and flood irrigation.

MFIS irrigation farmers receive governmental support through government subsidy for electricity, LIMA assists with credit for buying inputs, the DRDLR provides farm inputs (such as seeds, fertiliser, pesticides, etc.) and Mjindi Farming Trust manages and maintains the scheme, including irrigation infrastructure.

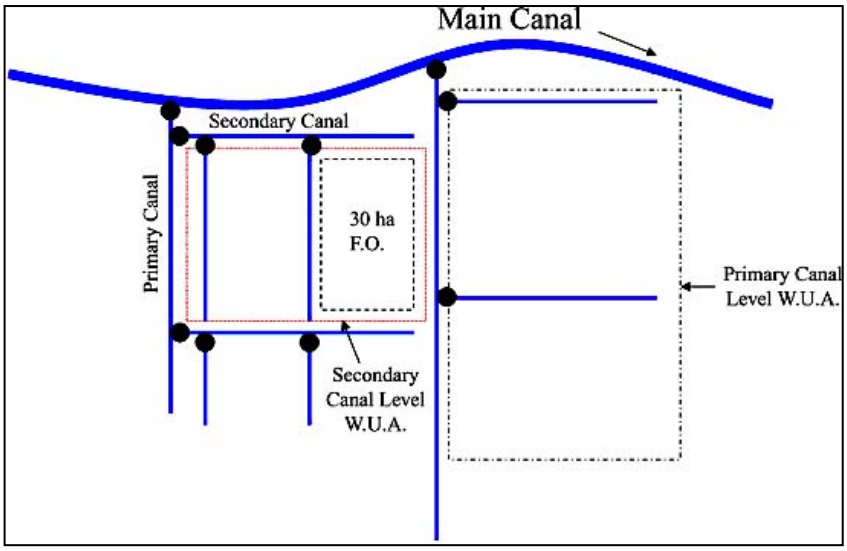
3.4.3 Mooi River Irrigation Scheme

MRIS is located in Msinga Local Municipality along the flood plains of Mooi River in the Midlands Region of KwaZulu-Natal. MRIS is located near the small town of TFIS and is characterized by inequitable water distribution along the main irrigation water canal, reflecting governance problems. The scheme is about 601 ha shared by about 824 plot holders.

Administratively the scheme consists of 15 blocks of varying sizes. Each block has its local committee responsible for water allocation. An overarching secondary scheme management committee regulates local committees. Members of the secondary committee are drawn from chairpersons and secretaries of the block committees. Water distribution is through concrete-lined canals, running from the main canal to the primary canal and ending with the secondary canal (See Figure 3.2 for an illustration). The main canal (25 km in length) feeds into secondary canals. Each irrigation farmer is entitled to 30 minutes of irrigation time per 0.1 ha plot per irrigation cycle, which is once a week.

3.4.4 Ndumo Irrigation Scheme

NIS is located in the Jozini Local Municipality, which falls within the uMkhanyakude District in the far North of KwaZulu-Natal Province, latitude 27° 37' 21.63" South and longitude 32° 01' 47. 14" East (DAFF, 2012d). NIS scheme was established to increase agricultural production and productivity (DAFF, 2003). The primary source of irrigation water is the Pongola River, from where water is pumped using an electric pump.



Source: Plusquellec (2002)

Figure 3.2: The birfurcal system

NIS comprises of 500 ha operated by 50 irrigation farmers, each with 10 ha. Irrigation farmers produce winter maize and industrial crops such as green pepper, chillies, etc. which are packed in the pack-house located at the scheme. NIS has two blocks, one new and the other old, both having 25 irrigation farmers each. The scheme receives substantial governmental support as part of the revitalisation programme. Also, the scheme receives technical and financial support from the Agribusiness Development Agency (ADA) a provincial government parastatal. A pack-house has been built at the scheme and is run by the cooperative.

3.5 Reconnaissance Visit

A reconnaissance visit to both districts preceded inception workshops held with the stakeholders to inform them of the project. Reconnaissance visits were undertaken to irrigation schemes in Msinga and Jozini, on May 13 and 16, 2016, respectively. The visits allowed the project team to introduce the research project informally to stakeholders, particularly irrigation

farmers, and to inform and invite them to the forthcoming inception meetings. A three-person project team took part in the visit. First, the project members visited TFIS and MRIS in Msinga Local Municipality. At TFIS, the team had a brief meeting with eight irrigation farmer leaders (three males and five females) and five extension officers at the Department of Agricultural and Rural Development offices. At MRIS the project team attended a War Room meeting, which was in session. A War Room is a ward-based forum of different departments and community structures to share perspectives on local developments. An extension officer of the MRIS was also attending the War Room meeting. At these gatherings, the team members informed the irrigation farmer leaders and stakeholders of the date of the planned inception workshop. At MRIS, three female irrigation farmer leaders were also met after the War Room meeting. The project team also arranged for a workshop venue at Department of Agriculture and Rural Development (DARD) offices in TFIS.

On May 16, 2016, the team met a community leader who agreed to assist in getting hold of different stakeholders to arrange the next meeting. The key stakeholders and institutions to be invited to the inception workshop were identified and tasks for contacting them were allocated accordingly.

Furthermore, the team travelled to NIS. The chairperson of the trust and the secretary of the cooperative were informed about the inception workshop meeting and were requested to diarize the date and to spread the word to their peers.

Lastly, a venue that would be convenient for holding the inception meeting was identified. Mjindi hall was preferred from among the available options as it is located amid the MFIS, and would be convenient for irrigation farmers.

3.6 Irrigation Scheme-level Meetings with Stakeholders

The research team met with irrigation farmers in the four schemes on various occasions. The main objective of the meetings was to discuss governance issues in the irrigation scheme, focussing on rules, policies, strategies related to water and land, set by the government for smallholder irrigation schemes. The aim was also to find out if irrigation farmers are aware of the institutional arrangements affecting the irrigation schemes and to get perspectives from the irrigation farmer representatives (chairpersons and steering committees). Lastly, the project team used the meetings to reiterate the roadmap that the research was going to take and to

confirm irrigation farmers' willingness to participate.

On 7 March 2017, the project team held a meeting with the irrigation farmers at MRIS. Thirty irrigation farmers attended the meeting, of whom 78% were elderly women. The group composition was indicative of the gender and intergenerational imbalances within the scheme. Table 3.3 shows the schedule of meetings and the numbers of participants.

Table 3.3: Schedule of meetings and the numbers of participants

Area	Date of Meeting	Number of participants		
		Male	Female	Total
MRIS	7 March 2017	7	23	30
	30 May 2017	4	5	9
TFIS	9 March 2017	5	14	19
NIS	16 March 2017	7	7	14
	1 June 2017	4	3	7
MFIS	17 March 2017	2	10	12
Msinga Provincial DARD	5 May 2017			12
DARD, Cedara	5 June 2017	1		1

On 9 March 2017, project team members had a meeting with 19 irrigation farmers at TFIS scheme in an irrigation farmer's plot. As with the MRIS meeting, the majority of the attendees were elderly females. On 16 March 2017, the team met with NIS irrigation farmers at a local community hall. Fifteen irrigation farmers attended, distributed evenly across age and gender. On 17 March 2017, the team met with irrigation farmers from MFIS. Amongst the attendees were two large-scale irrigation farmers and a group of women who are part of Zamukuphila Agricultural Cooperative.

On 30 May 2017, the project team met with chairpersons from different blocks in the MRIS. The majority of the chairpersons of the 15 blocks attended, as well as two officials from DARD. Women represented half of the blocks, indicating that both genders are equally represented in the executive committees across different blocks. This suggests that males and females participate in decision-making processes equitably. Team members also met with irrigation

farmers from NIS on the 1 June 2017.

The project team members also held meetings with government officials in the relevant offices, i.e. the provincial Department of Agriculture, in Msinga, Jozini and Cedara. On 5 May 2017, the project team met with officials from the DARD. The purpose of the meeting was to introduce the project to the department as well as to ask for their cooperation and help throughout the project, such as organizing irrigation farmer meetings. On May 31, 2017, the project team met with a DARD Officer. The officer was an irrigation farmer in MFIS until 2015. The meeting discussed governance of the irrigation scheme, especially the rules, policies on land and water implemented in the scheme, from the perspective of a government official. A final meeting was held with the Acting Director, Technical Services, within DARD. The meeting was held on 5 June 2017.

A discussion guide based on identified issues was used to facilitate the interactions. The issues in the guide included respondents' understanding of water laws, policies and strategies and institutional arrangements in the scheme regarding land allocation, water allocation and conflict management. The guide also included questions for stakeholders involved in the SISs.

3.7 Formal Survey

Irrigation farmers in the four irrigation schemes were randomly selected from the respective irrigation schemes. In MRIS and TFIS, irrigation farmers were proportionately selected from the respective blocks. Systematic random sampling was employed in MFIS and NIS. A sample of 318 households was drawn out as listed in Table 3.4.

Table 3.4: Sampling design

Irrigation scheme	Population size	Sample size
Mooi River	850	120
TFIS	1500	120
MFIS	714	44
NIS	100	34
Total		**318**

Data were collected using a pretested questionnaire (Appendix A). The questionnaire was

administered by trained enumerators. The analysis was conducted using SPSS Version 26 Descriptive statistics were drawn out for interpretation. Preliminary results were presented to groups of irrigation farmers to triangulate the survey findings with irrigation farmer collective perceptions (Appendix B). Feedback sessions were also conducted with a group of extension officers.

An intensive inspection of the scheme and consultation with stakeholders was carried out to evaluate the condition of the infrastructure. An infrastructure assessment based on condition scoring (CS) was adopted.

3.8 Data Analysis

Descriptive statistics were used for analyzing the data from the survey. The Chi-square and t-tests were employed for testing relationships between variables and testing differences between means, respectively.

CHAPTER 4: REVIEW OF THE EFFECTS OF POLICIES, STRATEGIES, RULES AND REGULATIONS AND GOVERNANCE PROGRAMMES ON IRRIGATION SCHEMES

4.1 Introduction

This chapter is a literature review of the effects of various policies, rules and regulations on the performance of SISs. The chapter complements the prior discussions on the policies, rules and regulations in place.

4.2 Assessment of Irrigation Scheme Performance

Institutions affect the different entities involved in a particular irrigation system. They have the potential to affect transaction and production costs, as well as the behaviour of decision-making entities. In comparing any sets of institutions, the likelihood of better performance is higher where transaction costs are lower, which comes as a result of favourable institutional arrangements (Bandaragoda, 2001). As much as SIS's perform below expected levels in South Africa (Muchara *et al.*, 2014; Sinyolo *et al.*, 2014a), irrigation farmers in the scheme also perform below par due to water-supply related issues and other related challenges such as lack of market access, high transaction costs, and low capital endowments (Van Averbeke *et al.*, 2011; Sinyolo *et al*., 2014). In addition to these challenges, institutional arrangements and water management also influence irrigation farmers' performance, particularly agricultural and economic performance (Lecina *et al*., 2011).

South Africa's water policies are highly rated with regards to addressing equity matters (Schreiner, 2013). However, there have been challenges hampering the success of irrigation schemes because of weak internal coordination, lack of support for irrigation farmers and lack of irrigation training (Department of Water Affairs (DWA), 2006). As such, the challenges lead to compromised SIS performance. Good performance at scheme level also translates to good performance of the irrigation farmers, and thus the economic wellbeing and welfare of the latter. Performance assessment can be conducted through a process-view, which would include internal systems and processes, or can be assessed through an output view, where focus is

placed on the quality and quantity measurements of the final output (Small and Svendsen, 1992).

Due to the multi-dimensional nature of performance in irrigation schemes, various indicators have been used worldwide (Kuscu *et al.*, 2009; Gomo *et al*., 2014). These include financial, technical and agricultural indicators (Kuscu *et al*., 2009; Gomo *et al*., 2014). These indicators attach numerical measures to quantify objectively the performance of irrigation systems. Gomo *et al*. (2014) used technical performance indicators as well as irrigation farmers perceptions of performance to derive best management practices in the Moo River Irrigation Scheme. Studies widely use agricultural, water-use and financial indicators (Sam-Amoah and Gowing, 2001; Kuscu *et al*., 2009; Gomo *et al*., 2014). The following are commonly used performance indicators:

Agricultural performance indicators:

- Output per cropped area (ha), which gives the ratio of production[1] to the irrigated crop area.
- Output per unit command[2], given by the ratio of production to the area of the whole scheme.
- Output per unit irrigation water supply given by the ratio of production to diverted irrigation water supply[3].
- Output per unit water consumed given by the ratio of production to volume of water consumed.

Water-use performance indicators:

- Relative water supply ratio, indicating the total water supply over crop demand (Borgia *et al.*, 2013).
- Relative irrigation supply ratio, which represents the ratio of water supply of water demanded.

[1] Production is given by the net value of the output of the irrigated area.

[2] The command area represents the area that was designed to be irrigated.

[3] The volume of surface irrigation water diverted to the command Area.

Financial performance indicators:

- Gross Return on Investment (%), given by the ratio between production and the cost of infrastructure.
- Financial efficiency (%), given by the ratio of revenue from irrigation and total expenditure.

Economic performance indicators

- Water fee collection efficiency (%), given by the ratio of irrigation fees due to those collected (Tortajada, 2006; Özmen and Kaman, 2015).
- Service area per person (ha/person), given by the ratio of total irrigation command area to number of persons servicing that area (Özmen and Kaman, 2015).
- Irrigation water productivity, given by the ratio of the annual value of final irrigated agricultural production and the annual volume of irrigation water inflow (Lorite *et al.*, 2012).

4.3 Internal Processes in Smallholder Irrigation Schemes

4.3.1 Irrigation infrastructure, conveyance, water availability, reliability

Poor irrigation performance can be attributed to irrigation systems that function sub-optimally. The infrastructure in place and the governance framework are often in disharmony. Globally, countries adopted the IMT approach to enhance accountability of the irrigation farmers and, in the process, improve the management of irrigation infrastructure and the effectiveness of water allocation, but also to reduce the financial burden on the government. Overtime, IMT has become the norm in running schemes. Theoretically, IMT is expected to work when accompanied by a sound legal framework for water rights and an empowered local management (Shah *et al.*, 2002). Irrigation farmers, as beneficiaries, have the direct interaction with the irrigation through IMT and, as such, they are expected to ensure correct irrigation function.

In the irrigation context, Van Koppen (2002) defined institutions as "the collective arrangements that govern the construction and operation and maintenance of irrigation infrastructure, water distribution and resource mobilisation". Institutions can be formal (written laws, rules and procedures) or informal (established procedures, norms, practices and patterns

of behaviour); they may be created or evolve over time (North, 1990 and Nhundu, 2013). These institutions are primarily established with an intention to address problems of inequitable access, high pollution levels, seasonal water scarcity and water conflicts among irrigation farmers (Mutondo *et al.*, 2016).

Prior to the establishment of SISs the South African government established various water policies, Acts and strategies for SISs which have been modified over the years to reflect a shift to transformation, empowerment and economic growth. These water policies, Acts and strategies include the Irrigation and Water Conservation Act (Act 8 of 1912), Water Act (Act 54 of 1956), National Water Act (Act 36 of 1998), National Water Policy (1997), National Growth Path (2010) National Development Plan (2013) and the National Water Resource Strategy 2 (2013). All these Acts, policies and strategies were primarily established to protect and prevent over-utilisation of the water resource, to promote efficient and sustainable use of water, and to promote equitable access to water in a representative manner with respect to gender, age, race and community (Thompson *et al*., 2001; Goldin, 2010; Hendriks, 2013; Tempelhoff, 2017).

IMT entail that irrigation farmer-organised committees work through sub-committees to undertake activities like irrigation scheme operation and maintenance. The execution of such functions influences infrastructure conditions and performance. Mexico and Taiwan implemented large scale transfers of irrigation schemes to irrigation farmers since the irrigation farmer-elected governance boards had strong institutions and above par management capabilities (Vermillion, 1997). Countries in the sub-Sahara have difficulties in organising cooperation amongst irrigation farmers for IMT because of weak institutions and unreliable rules and regulations. Thus, the strategies involved in operation and maintenance tend to favour certain sections of the scheme, making IMT ineffective.

4.3.2 Infrastructure

Good infrastructure is required to ensure reliable and adequate water availability (Molden and Gates, 1990). In addition, to ensure proper water conveyance the operation and maintenance strategies need to be optimum. Irrigation Management Committees (IMCs) mobilize resources from irrigation farmers to ensure maintenance of infrastructure. However, compliance is an issue as irrigation farmers may refuse to pay for canal maintenance and the institutions may engage in cost cutting mechanism, which have detrimental effects on the integrity of irrigation

infrastructure. Vermillion (1997) reported accelerated deterioration of infrastructure in situations where non-compliance is prevalent and where institutions embark on cost cutting measures.

Various authors suggest that adequate irrigation infrastructure, on its own, has proved insufficient in South Africa to ensure satisfactory scheme performance (Denison and Manona, 2007; Innocencio *et al.*, 2007; Faurès and Santini, 2008; Zeiton, 2011). They argue water infrastructure development should be accompanied by institutional strengthening (Grey and Sadoff, 2007; Zeiton, 2011). Irrigation infrastructure is related to the geographic location of an individual irrigation farmer along the water channel. Poorly functioning institutions and governance, the location of the farm along the canal becomes a more critical determinant of access and reliability of irrigation water (Mbatha and Antrobus, 2008).

4.3.3 Water distribution

Water distribution is based on three constituent elements, names, (1) water source, which determines water availability for irrigation, (2) technology, which influences water conveyance and its sharing amongst various users, and (3) social relation as irrigation resources are shared by many people (Manzungu, 1999). Water availability is seasonal, and some schemes employ strategies that ensure perennial availability or minimize delivery disruptions. Balancing dams are included in irrigation scheme infrastructure to ensure that water users at the head-end have dependable water supply.

A typical water network in open irrigation systems is composed of the main canal, inter-farm, farm, and on-farm distribution canals (distributors). The conveyance system has different components that comprise the canals, weirs and sluice gates (termed water control infrastructure). Each component has a unique hydraulic behaviour. Hydraulic behaviour determines how the system reacts hydraulically upon changes in flow (Horst, 1998). The malfunctioning of any component of the infrastructure results in the infrastructure failing to deliver water effectively, leading to downstream effects on the performance of the irrigation scheme.

The condition of infrastructure and conveyance depends on the governance framework (Tortajada, 2016). Changes in flow regimes within the conveyance system can be sudden and unpredictable. The hydraulic behaviour of an irrigation system determines the consequences of

the conveyance. Hydraulic structures can be classified according to their functions namely water conveyance, flow measurement and flow regulation (Table 4.1).

IMT and PIM seek to involve irrigation users in all aspects of irrigation management (Rivera, 1996). This entails planning and design of new irrigation projects and improvements, as well as the construction, supervision, financing, decision rules, operational and maintenance, monitoring and evaluation of the system (Gupta and Srivastava, 1999). Engaging irrigation farmers facilitates and enhances their understanding of the system (its operability and requirements) hence the conveyance nature of the water delivery system and consequently it leads to a reliable water supply, enabling them to implement appropriate interventions to improve conveyance.

Table 4.1: Types and functions of hydraulic structures

Function	Hydraulic structure
Flow measurement	Weirs and flumes
Flow measurement and regulation	Headworks, offtakes and turnouts
Flow division and measurement	Division structures
Removal of excess flow	Escapes and spillways
Upstream water level control and discharge of excess flow	Check structures, cross regulators and drop structures

Source: Boiten (1993)

Studies show that irrigation schemes where PIM has been implemented showed greater irrigation farmer responsibility in managing, controlling and maintaining the scheme, which has a positive impact on the water control infrastructure, and subsequently on conveyance. In the Philippines, PIM transferred irrigation management responsibility to communally managed water committees (Bagadion, 1988). This subsequently increased the personal and community level sense of responsibility for the productive and financial success of the irrigation systems (Korten and Siy, 1989).

4.3.4 Reliability of irrigation water provision

Reliability of irrigation water provision is a key parameter of the functionality of irrigation schemes. Water governance, which involves the strategies, polices, rules and regulation involved in water management, is a key determinant of irrigation water reliability. Renault and Hemakumara (1997) attributed sub-optimal canal performance and, by extrapolation, canal reliability to poor canal operation, which indirectly relates to the human dimension. The human

dimension is a major contributor to irrigation performance. Optimal irrigation performance is achieved when hydraulic structure, human dimension and operational strategies are in harmony (Figure 4.1). The strategies and techniques employed in SIS's have a huge effect on the performance indicators of the scheme. Operability, which is a function of the human dimension, is dependent on the type of water scheduling the scheme adopts and its operation of the infrastructure (Horst, 1998). Human dimension considers the ease of operation of the system and whether operators fully understand the system. A full understanding of the system operations and requirement avoids unwarranted disruption in water supply and leads to a reliable water supply system.

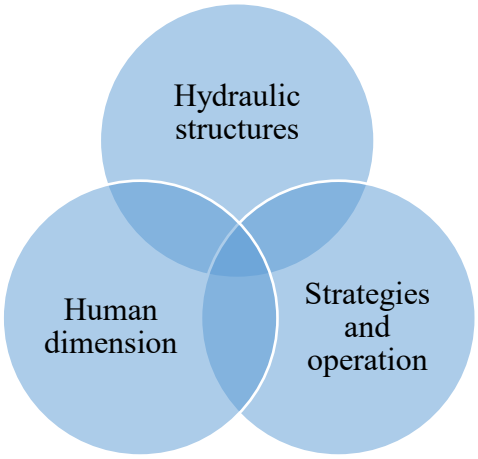


Figure 4.1: Decisive factors that ensure optimal irrigation performance

Source: Horst (1998)

4.3.5 Water availability

Irrigation farmers often link the irrigation scheme technical system to their social patterns (Minae and Ubels, 1993). Irrigation farmer managed schemes often require collective scheme operation and maintenance, i.e. it is the irrigation farmers' responsibility to ensure the scheme provide the correct irrigation function. A correct irrigation function is the ability of the delivery system to ensure that adequate amounts of water are available for irrigation (source).

Irrigation management is a complex multi-player multi-stakeholder system. It comprises management domains where different actors have varying responsibilities (Manzungu, 1999). Hence, water availability varies according to institutional arrangements and coordination. The transformation of state-centered water resources processes into society-centered ones saw the formation of WUA and IMCs in the hope of enhancing water availability.

4.3.6 Water control

According to Mollinga (2003), water control refers to three components, namely; (1) physical control of water flow by means of irrigation technology, with emphasis on different methods of technical control of water, (2) from the irrigation management perspective, water control refers to managerial control of water distribution and related organisational issues, (3) water control refers to political control dealing with how power is wielded over access and utilisation of water. Water security and water access are sub-domains of water control.

The design sets conditions and fixes requirements for daily use and subsequently influences the activities and processes to be undertaken to ensure smooth water conveyance (Kimani and Ubels, 1993).

Maintenance can be placed into two categories, namely, mechanized maintenance and mending leaking canals. The former involves the repairing of pump and the latter require technical expertise and non-mechanized maintenance, focuses on earthworks namely, canal cleaning, reparation of erosion. IMT programmes, which allowed the governments to transfer their role of maintaining irrigation schemes to irrigation farmer communities, have a direct consequence on scheme maintanence and water control.

The technical competences in place have major effects on the labour, skill, knowledge and equipment available to ensure the system is operating at optimal levels. Accounts of deteriorating infrastructure are prevalent in African irrigation schemes. Poor maintenance practices have seen silt and weeds accumulate in canals, thus severely reducing the water conveyance capacity of the system (Horst, 1998). This affects water control through compromised efficiency and equity in water distribution and subsequently water security.

4.4 Water Access, Water Security, Water Sharing

Hope *et al*. (2008) indicated that participating in smallholder irrigation results in higher expected incomes and food production for irrigation farmers with secure water access. Therefore, it is important that irrigation farmers have secure access to adequate and reliable water. The reliability of access enables irrigation farmers to invest in higher-yielding crop varieties, or new high-value crops (Tyler, 2007). This, in turn, leads to increased productivity, overall higher production and greater returns from farming (Hussain and Hanjra, 2004; Tyler, 2007)

In contrast, uncertainties regarding how much water would be available results in low incentives to invest in improved inputs and technologies (Faurès and Santini, 2008). Faurès and Santini (2008) pointed out that uncertainty regarding access to a reliable irrigation water supply makes an irrigation farmer reluctant to apply larger quantities of seed and fertilizer. It has been noted that access to irrigation, together with socio-economic, institutional and physical factors increases the chances of a household being water secure. Namara *et al.* (2011) however pointed out that there are many countries that have water resources yet still have high incidences of poverty. They further note that equity in water access is critical, and that the severity of poverty is influenced by the rules governing the control of water resources rather than the resource itself.

4.4.1 Water access

Improved irrigation performance is premised on adequate supply of water on a regular and sustainable basis. This calls for a proper coordination amongst institutions, strategies and waters users (Draper, 2002). Policies and procedures involved can facilitate adequate planning, utilisation, conservation, development, management, and control of water resources in a manner that is reasonable and equitable and does not harm other users. However, policy formulation without active enforcement is fruitless (Kilgour, 1994). Unauthorized withdrawals are rampant in SISs and this limits water availability for downstream users.(Source) Kilgour and Dinar (2001) suggest that publicizing water allocation arrangements at the scheme level can ensure fair and welfare-maximizing outcomes.

4.4.2 Water security

Water security has been defined as the availability of an acceptable quantity and quality of water (Grey and Sadoff, 2007). Food security cannot be achieved without irrigation farmers attaining water security. Muller *et al.* (2009) states that having little water is better than having no water at all. Unavailability in the storage make irrigation scheduling unreliable. Effective demand management entails a strict irrigation schedule and could even include an increase in water tariffs to discourage water consumption. Regions that have difficult water availability periods can adopt water-saving regulations. In areas with favourable agricultural markets, controlled access to water can be employed to encourage compliance as irrigation farmers would not risk returns on investment when reliability is doubtful. In other words, water

reliability can be a solution for addressing water shortages and can be an effect of poor governance of irrigation schemes.

Muller *et al.* (2009) note that during periods of constrained water availability, governments in developed countries encourage irrigation farmers to participate in water allocation trading to promote water use efficiency through pricing. Despite the trading being regulated to ensure a level playing field, some irrigation farmers are said to have lost the means of production through such exercise.

Irrigation water insecurity influences the success of smallholder food production and household food insecurity (Sinyolo *et al*., 2014b). Multiple definitions of water security exist (Grey and Sadoff, 2007). Water security entails access to reliable and adequate water supply, and to exercise the right or entitlement to the water against other parties.

4.5 Land and Water Resource Allocation and Management

Toulmin (2008) points out that statutory law and customary law govern land rights in many developing countries, such as South Africa, which tends to be problematic. Law regimes are premised on different understandings and therefore, confer different rights. For examples, statutory law accords legal or formal rights (Toulmin, 2008), while the customary law is informal and relies of local authority, religious values and social norms.

Informal institutional arrangements (customary institutions) often dominate in the South African SIS's and seem to be more effective in the management of water resources relative to national water legislation and policy since water markets do not exist Likewise, with land market, customary rules of land tenure dominate in Africa relative to formal legislations. Formal legislation tend to promote equitable access to land and water resources for all users, while customary laws tend to be biased in favour of male users/irrigation farmers (Huggins, 2002; Mutangadura, 2004). Mutangadura (2004) further inferred that statutory laws in combination with customary laws, traditional and social practices, norms and power structures within communities and households, restrict women's access to land in Southern Africa, and prohibit them from having power in decision-making and control over land usage and some of the outputs.

4.5.1 Land allocation

South Africa often experience challenges with water and land distribution. Land is one of the most crucial input resources in agricultural production as it influences productivity and overall scheme performance. In the rural areas of South Africa, land is state-owned, but all land administrations are governed by the traditional authorities. Customary rules on land tenure dominate in Africa relative to formal legislations and, yet sometimes these rules are not recognized by the state as they may contradict state rules. The majority of irrigation farmers do not have legal land and property rights. The traditional authorities often grant permission to occupy (PTO) and use land. Under this system, they are not formally recognized as legal holders of rights to the land (Hull *et al.*, 2016). The applicant pays a certain amount of money as registration and allocation fee to the traditional authority office. At the end of the allocation process, rules and regulations and boundaries pertaining to that piece of land are explained verbally to the land applicant. However, verbal agreements are usually associated with the problem of misinterpretation of responsibilities and specification and tend to result in confusion and misunderstanding if the agreements are not clearly explained. Furthermore, people tend not to adhere to the verbal rules, leading to inconsistences in their administration.

Land is highly unequally distributed in South Africa. Land ownership is also unequally distributed across gender and ages (Mnkeni *et al*., 2010). Customary laws often exclude women from accessing land as well as owning it. Although women dominate smallholder farming and perform large proportion (65%) of farming activities, the distribution of land ownership is highly skewed towards men (Denison and Manona, 2007). Permission to occupy communal land is often issued in the name of the heads of households, while the majority of women have use rights only and obtain lifelong tenure security rights through their in-laws. Moreover, the amount of land they obtain is relatively small (Machethe *et al.,* 2004; Raidimi, 2014). It is often rare to find women and youth who have freehold (landowners) tenure, most of them acquire agricultural land through inheritance, state or borrowing from other irrigation farmers (Mnkeni *et al*., 2010). Likewise, land ownership often excludes youth, and this prohibits them from participating in irrigated agriculture. Those who participate in agriculture usually access land through renting or from inheritance. Insecure land tenure status results in lack of access to credit. With insecure land tenure status and lack of land ownership, women and youth irrigation farmers are unable to use their allocated land as collateral and, as a result, they are not able to access credit. This negatively affects their productivity since access to credit is critical for

irrigation farmers with insufficient finances as it enables them to purchase inputs and to make an investment in technologies that can improve their productivity.

In some countries, the legal system, in particular inheritance and divorce laws, give women fewer rights to land than men (Agarwal, 2003). Deere and Leon (2003) noted that gender inequality in land ownership is related to male preference in inheritance, male privilege in marriage, male bias in community and state programs of land distribution as well as gender bias in the land market, with women less likely than men to be successful land buyers. Land titles are often registered in the name of a male-head of household, even if the wife has brought the land into the family or has purchased it from her income. Women are often restricted to so-called secondary land rights, i.e. they hold these rights through male family members, and thus risk losing the land in case of divorce, widowhood or their husband's migration (Agarwal, 2003). Cousins and Hornby (2009) revealed that the Msinga community use marital status for land allocation.

Land rights determine investment in agriculture (Besley, 1995). In the commercial sector in South Africa, uncertainty over leases may be a source of insecurity (Zikhali, 2008). In the communal areas, property rights are not transferable, and individual rights within the government resettlement schemes are perceived as even less secure (Ako, 2009). Fenske (2011) concludes that security of land tenure under traditional systems are conditional on use.

4.5.2 Water allocation

South Africa is a water scarce country with an increasing number of water users from different sectors with the irrigation being the major consumer of water, consuming about 60% of the country's water resources (Yokwe, 2009). The government has committed to promoting the expansion of smallholder irrigation schemes as a strategy to improve incomes and food security of irrigation farmers in rural areas. South Africa has 1.3 million hectares of commercial and smallholder irrigated farming land (South Africa Human Rights Commissions (SAHRC), 2014). Van Averbeke *et al.* (2011), points that about 83% potentially irrigable land is already developed. Smallholder irrigation use only 3% of the developed irrigation area (Backeberg and Sanewe, 2010).

The current unclear legal status of water users in rural areas means that there is high likelihood of congestion over natural water resources, which may in turn lead to over utilisation of this resource. In communal irrigation schemes, water management is often a challenge and there is a need for sustainable and efficient use of available water resources (Huggins, 2002).

In South Africa, access to water was traditionally free for domestic use and anyone readily accessed it (Source). Water use was regulated and controlled by community leaders. The majority of smallholder irrigation farmers still have riparian rights linking land and water ownership. In Kenya, water availability on inherited land is traditionally regarded as 'God-given' (Huggins, 2002). In South Africa, riparian rights worked during the apartheid regime and were part of the Water Act (Act 54 of 1956). Following the democratization of the country, Act 54 of 1956 was abolished and replaced by the National Water Act (Act 36 of 1998). Tewari (2009) argued that the new Act bestowed privileges to largescale riparian irrigation farmers and excludes the majority of South Africans from accessing water.

Following the IMT, irrigation farmers in SISs are responsible for managing the distribution of water. Typically, irrigation water allocation starts with water diversion from the river to the canal and then to the plots or from the river to the micro dam which fills during the night. According to Mul *et al.* (2011), water allocation in SIS's in Tanzania is often facilitated by the scheme committee. It formulates/ discusses irrigation schedule and decides on which blocks/ zones will receive water on any day. Each block must have its own elected representative who will be responsible for the distribution of water among its members. Irrigation farmers are also involved and allowed to raise their opinions in water allocation meetings as well as in meeting where rules and regulations are made since other issues such as communal work and conflicts are also discussed. Usually, rules regarding water allocation are fair across all irrigation farmers in the scheme but obviously, the irrigation farmers located in the upstream (head) are at an advantage to use water relative to those in the middle and the tail. Institutional integrity is required to ensure equality and to avoid conflict between irrigation farmers across zones (Huggins, 2002).

Informal institutional arrangements (customary institutions) often dominate in South Africa SISs and seem to be more effective in the management of water resources relative to national water legislation and policy since water markets do not exist. Water is classified as a public good and there is no legal possession of water, only rights of use. The National Water Act 36

(1998) of South Africa gives farming households a right to access irrigation water. However, this Act requires irrigation farmers to form and register WUAs (Perret, 2001). WUAs are to enable irrigation farmers to pool financial and human resources for effectively carrying out water related activities. Perret (2001) argues that WUAs could turn out to be sources of conflicts among irrigation farmers.

In contrast to Taweri (2009), Perret (2002) states that according to the new Act of 1998, smallholder irrigation farmers are authorized to abstract water for irrigation without registration, licensing or payment. In some cases, they are required to pay a fee to get water (for instance, the fee required by a WUA) or may need to invest in equipment to withdraw water and to use it for production (Faysse, 2004). While in other SISs irrigation farmers pay nothing to get water as long as they participate in the scheme management. Although irrigation farmers in SISs can abstract water without licences or permits, they are aware that they are required to form WUAs so they can apply for water license, which will determine the amount of water each user is entitled to withdraw from normal situations as well as their collective rights to the water resource and their obligation. In most cases, formal and informal water institutions contradict as formal rules tend to be overruled by informal norms, values and practices, which form a strong constitutional basis for organisational and social behaviour (Bandaragoda and Firdousi, 1992). Most contradictions tend to appear from those formal institutions that encourage gender equity (Huggins, 2002). Irrigation scheme committee structures are also supported by the authority of customary institutions, which tend to be male dominated.

4.5.3 Water management

Water management in SISs was previously a fundamental part of customary laws and behavioral norms of each tribal authority since water resources were rarely owned by irrigation farmers (Huggins, 2002). In South Africa, some of these norms still exist while others have been discarded/modified following the National Water Act of 1998, which created two user-driven water resource management organisations, namely; the WUAs at the local level and the CMA at a larger catchment level. It also encouraged smallholder irrigation farmers to form WUAs primarily to take over most irrigation management functions, namely water allocation and distribution, maintenance, water charging systems and financial management (Perret, 2006). WUAs were presumed to lead to improved water management rules and schedules,

which are often sources of conflicts and discontentment in irrigation communities. Water management entities in each province had to assist previously disadvantaged irrigation farmers with the water licensing process (Johnson, 2016). This process of compulsory water licenses allows government to assess water allocation and use in a catchment area, and to reallocate water, if necessary. Moreover, Section 34 of the 1998 National Water Act allowed historical water users to continue to use water as a recognised form of historical entitlement until its replacement with a water use license (Johnson, 2016). The WUAs bring together individual water users to undertake water related activities such as improving, rehabilitating, operating and maintaining watercourses; establishing water delivery schedules, and supervising water allocation and distribution; ensuring that all members get their share of water in a timely manner; removing obstructions on courses; employing labour for maintenance activities; and ensuring that all members contribute for their mutual benefit (Mekonnen *et al.*, 2015). In the past, WUAs were known as irrigation boards (IB) and fulfilled an important role in the administration of water resources and in the distribution and use of water. At the local level, WUAs operate as water management institutions. WUAs require water users to have a constitution and apply for water licenses and obtain details of members who have rights to water and other services (Gildenhuys, 1997 and Van Koppen, 2002). Shah *et al.* (2002) discussed the effects of WUAs in improving water management, conflict resolution, improved fee collection, which in turn lead to better operation and management and ultimately enhanced land productivity.

Zaman *et al.* (1998) cited in Mekonnen *et al*. (2015) reported that WUAs in the Hakra 4-R distributary (in Pakistan) were successful in mobilizing labour and monetary resources for maintenance as well as for conflict resolution among irrigation farmers. On the other hand, Samad and Vermillion (1999) supported this finding and that WUAs have improved yields and resulted in more efficient water utilisation and increased production in a dry year and conflict resolution. However, the success of WUAs largely depends on governance within WUAs. Mekonnen *et al.* (2015) found that in Pakistan on average, WUA improves irrigation water management but the impacts differ depending on the location along the watercourse. About 67% of the respondents reported that WUAs had improved water management as it reduced water theft and conflicts around water, and improved maintenance and timing of water delivery. Mekonnen *et al*. (2015) noted that WUA was reported to have led to a 10 percent productivity increase. In the head and the middle of the irrigation schemes, productivity increases also

depended on investments that follow the formation of the associations.

CMAs act as basin water authorities to manage, develop and protect water resources within defined water management areas. They primarily manage water resources at catchment level in allocation with local stakeholders, with a specific focus on involving local communities in the decision-making processes, in terms of meeting basic human needs, promoting equitable access to water and facilitating social and economic development (Njiraini, 2016). They ensure water charge collection, water authorisation and licensing among other functions. In South Africa, the implementation of CMA has not been a success as they had to be self-financing. CMAs failed due to poor administration, mismanagement, lack of training of among their personnel or poor coordination.

4.6 Outputs of Irrigation

In communally managed water resources, development of efficient water institutions is crucial for proper management of water resources, avoiding its possible overutilisation as well as enhancing productivity and production. Governance programs and water institutions indirectly have considerable impacts on the production and productivity of SISs, which will be discussed in the next two sections.

4.6.1 Production

Despite the worldwide recognized potential of SISs in improving agricultural production and incomes, on average their production levels are unsatisfactory. The majority of SISs produce below potential levels. A number of factors such as outdated irrigation infrastructure, lack of extension services, lack of access to credit, formal and informal institutional arrangements, e.g. water scheduling are responsible for uneven production levels. For example, Mudau (2010) found extremely low production levels in Mamuhohi irrigation scheme with some irrigation farmers earning average net income of approximately R75.05 per season from maize production, while the costs of production were high and did not correspond with the irrigation farmers' production potential. Dlamini (2013) also reported that smallholder irrigation schemes in Swaziland experienced low production levels as compared to high costs of maintenance and operating the infrastructure and for electricity to pump irrigation water.

In Vhembe irrigation scheme, water scheduling had a major influence on the production of irrigation farmers. Irrigation farmers were allowed to only irrigate once per week and irrigation

farmers regarded this as the best practice especially for green maize since it used less water and gave the highest irrigation water use efficiency of all the methods that were tested (WRC, 2014). However, this was not the case with regards to Chinese cabbage which required more water, it required to be irrigated at least twice per week, which is more often than irrigation farmers' access to irrigation water. In such cases, irrigation scheduling negatively impacted on the production as it strains the potential for the crop (Ibid.).

4.6.2 Productivity

Access to irrigation has been shown to allow irrigation farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. Secure access to adequate and reliable irrigation water has been identified as being critical. Access to reliable water under irrigation determines irrigation farmers' incentives to use improved inputs and technologies (Hussain and Hanjra, 2004; Tyler, 2007). Uncertainties of water of availability reduce incentives to invest in improved inputs and technologies, e.g. seed and fertilizer (Faurès and Santini, 2008), pointing to the importance for irrigation water security.

Different irrigation schemes also show differences in their productivity levels because of differences in irrigation technologies, efficient use of water resources, cropping systems, etc. In Thabina and Zanyokwe irrigation schemes in Limpopo and Eastern Cape Provinces, respectively, Yokwe (2009) found that irrigated agriculture enables irrigation farmers to achieve higher yields and thus higher incomes. Total revenue realized from irrigated agriculture was above that achieved from rain-fed agriculture, irrespective of the type of crop planted and cropping system. High water productivity was observed for irrigated crops using sprinkler systems compared to gravity-based systems. The latter had higher water losses due to evaporation and infiltration from earthen irrigation channels. Surprisingly, cost of production inputs was lower for irrigated relative to rain-fed agriculture. Such performance of irrigation schemes was attributed to the understanding of NWA and irrigation farmers' willingness to pay for water resources, maintenance of irrigation infrastructures, which seemed to provide high returns to their investments (Yokwe, 2009).

Machethe *et al.* (2004) argue that productivity of smallholder irrigation farmers is low and has been declining over the past decades, which implies low smallholder agricultural profitability.

They attributed this low productivity of smallholder irrigation farmers to a number of factors or challenges. These factors and challenges included the lack of access to reliable good quality support services for irrigation farmers such as extension; finance and marketing; and low levels of investment in rural infrastructure resulting in high transaction costs. They also recommended a need for improving the policy and regulatory framework for agriculture to encourage participation of local communities in rural areas and the private sector. Among institutional arrangements affecting SISs in SA, NWA was reported to have a major impact through its provision for the establishment of CMAs and WUAs primarily to manage water resources at river-basin level. The Act reallocated existing land rights to water rights in the form of user rights.

Empirical studies carried out in Sub-Saharan African countries indicated that there are discrepancies in farm productivity between male and female irrigation farmers. Female irrigation farmers were found to have lower yields relative to their male counterpart due to unequal access to productive input resources (Dossah and Mohammed, 2016). Jamison and Lau (1982) cited in Njuki *et al.* (2006) indicated that male household heads were more productive than female household heads in mechanized farms in Korea. In addition, Van Koppen (2002) cited evidence from studies that were conducted in Burkina Faso, which showed that women were as efficient producers as men, if they have equitable access to productive resources such as land, appropriate technologies, modern farming methods, credit, agricultural extension services and human capital, and have a say over output. Doss (2015) added that women have the potential to achieve higher productivity if given the necessary resources and this could raise total agricultural output by 2.5-4% in developing countries. Van Koppen (2002) also pointed out that sometimes women's farm productivity is not accurately measured. Not all female irrigation farmers are decision makers on the plots they cultivate. The difference between women who are decision makers and women who work under the authority of male next of kin as unpaid family labourers are often neglected. This difference is important to note because women as farm decision makers are most motivated to invest capital in infrastructure and to invest in time and fees in the membership of Water User Association when they are the primary beneficiaries of these investments.

Thapa (2008) in his study outlined possible factors that could be responsible for differences in irrigation farmer productivity assuming men and women have the same agricultural production

function and use the same technique for the same crop. These factors included the following:

i. The quality of inputs (e.g. fertilizers, seeds, or labour) utilized by men and women may differ;

ii. The quality of inputs may differ, e.g. land quality may differ between men and women, including, but not limited to, soil quality, topography, and proximity to access points such as water sources, roads, and housing;

iii. Crop choice differs by gender, which may be influenced by cultural norms or by other factors such as the lack of resources to cultivate specific crops and the culturally accepted division of labour and finally

iv. Even if both genders have the same agricultural production function, shadow prices of inputs and credit may lead to the women's production frontier to lie beneath the men's frontier, implying that women are less productive.

Dossah and Mohammed (2016) also indicated socioeconomic factors (such as age, household size, marital status, farm size, years of farming experience, educational level, and membership of cooperative, extension contact, access to credit, and nonfarm income) that influenced irrigation farmers' production decision as well as their overall production efficiency in Nigeria. They also emphasized the central role that educational level and human capital play in the management of plots, and resource allocation. Education and farming experience influenced the understanding of governance. Educated irrigation farmers are likely to understand water policies, institutions, rules and regulations better. While, more experienced irrigation farmers more efficiently allocate their input, and thus, become more productive.

Young people are a sub-section of the total population in the country that is considered as both physically and mentally productive, yet they are reluctant to engage in agricultural activities and considering agriculture as their main careers due to a number of reasons (Mkra, 2014). Those who are interested are limited by lack of access to productive land (Adekunle *et al.*, 2009). However, both young African men and women are critical to the development of agriculture in Africa and improving water security and stimulating their interest in agriculture could improve their skills in farming and uplift agricultural productivity. Youth involvement in irrigated agriculture could also improve the efficiency of irrigation water management and its utilisation as they are expected to better understand water policies and institutions as well

as adopting innovative water saving irrigation technologies (Adekunle *et al.*, 2009). The poor performance of SISs could also be attributed to the limited participation of young people in farming, currently, the average age of people dominating SISs is 62 years.

4.7 Impacts on Household Welfare

The governance in an irrigation scheme includes the formation and amendment of rules, decision-making, resolving disputes, mobilising financial and labour resources, as well as maintaining infrastructure. Institutional arrangements are key to the performance of SISs (Plusquellec, 2002). As such, this section focuses on the effects of institutions, rules and regulations, policies and programmes on irrigation performance, and them on the welfare of beneficiaries.

SIS in South Africa were developed to ensure access to irrigation water by small-scale, resource-poor, food insecure irrigation farmers (Machethe *et al.*, 2004) and were meant to improve agricultural productivity in rural areas. Sinyolo *et al.* (2014a) pointed to the potential of SIS's to alleviate poverty and improve household food security in rural areas. As such, the South African government set to rehabilitate and revitalize schemes, in an effort to enhance agricultural production. Agricultural productivity, which is influenced by the governance of a system, directly influences economic performance as well as a household's welfare, and advancements in agricultural productivity play a critical role in promoting food security at household level (Morioka and Kondo, 2017).

The governance affects different facets of the irrigation scheme. It affects operational management, water management as well as infrastructure management. These facets influence water access, water scheduling, water adequacy and water reliability, which in turn affect water use and, ultimately, agricultural production, through improving land productivity as well as decreasing the probability of crop failure (Weligamage *et al.*, 2014).

Oladele and Mudhara (2016) highlight that irrigation can alleviate poverty, through increasing production and income and reduction of food prices. This ensures that poor households can afford to purchase food and meet their basic dietary needs, thus improving overall household welfare. Besides increasing cropping intensity and productivity of crops, increased agricultural activity requires labour, and therefore community members benefit through wage rates (*ibid*).

4.7.1 Household welfare and food security

Various authors propose that ensuring smallholder irrigation farmers' access to irrigation leads to poverty reduction and household food security (Hussain and Hanjra, 2004; Muller *et al.*, 2009). In other words, irrigation water complements technologies, institutions and policies that underpins increased agricultural output. Thus, effective governance guarantees access to irrigation water, which is itself an important socio-economic good, with a positive role in poverty alleviation (Hussain and Hanjra, 2004). Hussain and Hanjra (2004) point to the effects of access to irrigation on poverty reduction.

Through good irrigation governance, water access and availability improve, thus enhancing agricultural production. Rehabilitation is one of the dimensions whose implementation is affected by the governance and strategies followed in an irrigation scheme, and in turn determined scheme performance. It is an engineering-centred concept, involving the restructuring of infrastructure to ensure adequate water supply and the redesign of systems (DAFF, 2012d). García-Bolaños *et al.* (2011) assessed the performance of 22 small and medium-size community-managed irrigation schemes in different areas in Mauritania and found that rehabilitated schemes performed slightly better than non-rehabilitated schemes. Using distribution losses, reliability and adequacy of a system and irrigation farmer perception as performance indicators, Mateos *et al*. (2010) showed that more families gained access to irrigation after rehabilitation, thus improving their agricultural performance.

After the South African government rehabilitated irrigations schemes around the country, the schemes still under-perform, and, as such, social dynamics were included in the development of SIS's. This resulted in a process called revitalisation, which is a philosophy that includes both the re-design of existing infrastructure and engagement with the organisational and social dynamics of water distribution and allocation (DAFF, 2012d). The revitalisation and development of irrigation schemes has been associated with the implementation of programmes to encourage irrigation farmer participation in irrigation management, also called IMT programmes.

In Mexico, agricultural productivity increased after the implementation of the IMT programme, which was implemented together with two complimentary programmes involving

rehabilitation and farm improvement programme. Average crop yields and water productivity increased by 39% and 62%, respectively, in seven years (FAO, 2003). After the technical and institutional restructuring in the Office du Niger scheme in Mali, financial balance was maintained in irrigation schemes and market opportunities were established, which led to the success of the scheme (*ibid*) and improved household welfare. In Nepal, the adoption of IMT led to "improved water delivery, equity in water distribution, better maintenance of the irrigation infrastructure, and increase in agricultural production" (Bastakoti *et al.*, 2010: 420).

The Zimbabwe/EU Micro-projects Programme funded smallholder irrigation projects since 1982 to improve the food security. A comparative analysis between irrigation farmers and non-irrigation farmers conducted in the Mopane Irrigation Scheme using gross margin analysis, found that irrigation farmers performed better in terms of incomes than non-irrigation farmers (Nhundu *et al.*, 2010). Irrigation farmers involved in rehabilitation and water management of their irrigation schemes gain a sense of ownership, which leads to increased responsibility required for good water management (Muchara *et al*., 2014; Mutambara *et al*., 2016). On one hand, irrigation schemes are governed by informal institutions, however, on the other hand, irrigation farmers and communities interact with traditional leaders and also have rules, norms and cultures that play a role in the governance of the scheme, making up the informal institutions.

In Thailand and Nepal, traditional leaders play a central role in the management of schemes and the communities comply with the water management rules. Bastakoti *et al.* (2010) found that local level institutions' involvement influenced the improved performance of irrigation schemes. Their results also showed that irrigation farmer-managed irrigation systems were in better condition and had better agricultural output. This was attributed to mutual understanding guided by social norms and values. The mix of traditional strategies and WUAs improved performance in Thailand. The WUA were effective in designing water allocation methods, and working with the traditional leaders, being experienced irrigation farmers themselves, led to the efficient maintenance of the system and improved irrigation farmer productivity (*ibid*).

"Rules that are created by irrigation farmers who live and work in an irrigation system for years are more likely to be followed than rules imposed by irrigation officials who seldom visit the

system" (Lam, 1996: 1309). In Nepal, Lam (1996) found that an irrigation farmer-managed governance structure is better than an agency governed structure. However, understanding underlying institutional designs that provide incentives for irrigation farmers and associations to work together is critical. Social factors such as irrigation farmer groups and cooperatives can also improve farm performance (Debebe *et al.*, 2015; Herbert *et al.,* 2015). In the Democratic Republic of Congo, Burundi and Rwanda, Herbert *et al*. (2015) showed that irrigation farmers who were irrigation farmer group members performed better and had a higher probability of being efficient than those that were not.

Several studies have noted the critical role of availability and accessibility of irrigation water for achieving food security (Hussain and Hanjra, 2004; Bacha *et al*., 2011; Sinyolo *et al*., 2014a). Sinyolo *et al*. (2014b) argued for water security, while Moyo (2006) and Murugani *et al*. (2014) emphasized the importance of land access and security for successful smallholder agriculture and food security.

4.7.2 Economic performance and revenue

In the 1980s irrigation schemes in Australia were characterized by low profitability, high debt and environmental degradation. However, under a new system that allowed leasing of water rights, diversion licenses, and sale entitlements between irrigation farmers, the financial burden and revenue shortfalls substantially decreased (FAO, 2003), resulting in improved economic performance of irrigation farmers. The emergence of water markets in India, Pakistan and Bangladesh gave access to irrigation for irrigation farmers that previously did not have it (Mukherji and Shah, 2005). This led to the increase in net irrigation surplus, thus improving irrigation farmer performance. The established water markets also contributed to rural poverty alleviation (Palmer-Jones, 2001). Water pricing policy has yielded different impacts across the world (Dinar and Mody, 2004). In Europe, it resulted in improved water efficiency. However, in Morocco pricing alone did not improve performance (Massarutto, 2002). It was recommended that other measures be adopted for success of pricing policy in impacting performance (Dinar and Mody, 2004).

Lire (2005) showed that crop yields and farm profits significantly increased in villages with closer proximity to the dams than in those further away from the dam water resource. The study

suggests that carefully designed irrigation dams could significantly improve agricultural production and economic performance. Hagos and Holden (2003) showed determinants of poverty in Tigray, and indicted that physical asset endowment, in terms of access to irrigation, positively effects household welfare. Irrigation not only contributes to increased crop production but may also reduce variability in production through improved control of the crop environment. In this respect, an empirical study carried out in Nigeria showed that the proportion of irrigation beneficiaries that experienced crop failure and poor harvest dramatically declined in comparison to the pre-irrigation status (Babatunde *et al.*, 2008).

Mupaso *et al*. (2014) used gross margin analysis, as well as cost-benefit analysis to evaluate the economic performance of irrigation farmers on different irrigation systems and found that irrigation farmers that used the sprinkler system obtained the highest total gross margin per hectare, followed by the flood system with returns that were 21% lower. Their economic analysis indicated that irrigation farmers irrigating under the flood system were better compared to those irrigating using the sprinkler system in terms of their Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit-Cost Ratio (BCR).

4.8 Summary

Smallholder farmer irrigation is key to the alleviation of rural poverty. The government of South Africa has put in place Acts, policies, strategies and programmes towards ensuring that the sector achieves this role effectively. This literature review has shown that national policies are then used for the development of national strategies and action plans.

The research points out the complexities within the smallholder farming sector. The communal nature of resource use presents challenges, especially concerning water management. The literature review identified approaches that can be used for studying the complexities. It also points out the challenges regarding access to land emanating from the cultural setting existing in communal areas. This means that access to water, though defined in the Acts, is also influenced by local rules and regulations. The unpacking of these interactions between different regimes gives a strong basis for the current research project.

CHAPTER 5: FACTORS THAT INFLUENCE THE EFFECTIVENESS OF POLICIES, STRATEGIES, RULES AND REGULATIONS

5.1 Introduction

To describe the factors that affect the effectiveness of policies, strategies, rules and regulations and governance programmes in smallholder irrigation schemes in KwaZulu-Natal, the study used both formal and informal survey work conducted across the four irrigation schemes. The results of the information collected from the irrigation schemes was crosschecked with irrigation farmers and extension officers as part of a triangulation process. Appendix A presents the reports of the feedbacks to irrigation farmers. The framework adopted in conducting the review is presented first, followed by a methodology section, then a results section dissecting the various facets of governance and its effects on irrigation farmers.

The irrigated agricultural sector of most developing countries, including South Africa, suffers from limited water supply, which precludes SISs from achieving their central objective. Therefore, proper management of water resources is essential for improved crop productivity and food security since water problems are anticipated to worsen in the future (Samian *et al*., 2014). In water-stressed regions, the implementation of policies, regulations, and by-laws on the allocation and the use of water are required to ensure proper water management (Mwadini, 2016).

Several factors influencing the effectiveness of water resource management have been identified in literature, although the effectiveness of these factors differs across countries due to differences in circumstances such as water policies, the communication, and implementation of government policies as well as institutional settings. Among the identified factors, government policies, irrigation farmer participation in maintenance of canals and water resources, education, extension programmes, training in irrigation management, irrigation methods used as well as the existence and functionality of WUAs were perceived to be vital for improving water use efficiency (Ntai, 2011; Muchara, 2014; Samian *et al.*, 2014). Berjak (2003) asserted that the success and sustainability of water resources management in SA is dependent on cooperative governance, integration of environmental factors, public participation and education, administrative compliance and financial capacity. Muchara (2014)

recognized water policy frameworks, type of organisations, accountability system, property rights system and operational rules to be the key principles creating sufficient conditions for effective management of CPR, irrigation infrastructure included.

Osooli *et al.* (2011) found that economic, technical, agricultural, sociocultural factors, as well as educational and extension factors influence sustainable water resource management in agriculture. Among these factors, technical ones had the highest while socio-cultural factors had the least effects. Samian *et al*. (2014) also identified factors affecting optimal management of agricultural water and found the fairness in scheme rules and water allocation, irrigation farmer contributions in irrigation and infrastructure maintenance, government policies and strategies, informal rules and training as having significant influence on optimal management of agricultural water at scheme level.

Although irrigation management is now a full responsibility of irrigation farmers through IMT, there is still widespread concern that water resources are poorly managed. Proper management of irrigation water is essential for achieving the social, economic, environmental and management objectives (Gorantiwar and Smout, 2005). According to Abernethy (1986) cited by Gorantiwar and Smout (2005), evaluation of irrigation management should be based on whether equitable water distribution is met, and if the water delivery system is reliable and adequate for crop requirements. Hence, irrigation water management performance measures relate to the allocation of the resources (e.g. equity, etc.) and scheduling of the resources (e.g. adequacy, reliability, etc.) and productivity (Gorantiwar and Smout, 2005).

5.2 Conceptual Framework

A framework that shows the effects identified at each performance area was developed (Figure 5.1). The framework has four layers. The first layer has scheme governance instruments namely, strategies, rules and regulations and institutions (cooperatives, NGOs, IMCs and WUAs). The second layer has performance areas that potentially influence SISs performance. According to Small and Rimal (1996), scheme performance can be gauged from multi-pronged approach, namely, internal processes (process performance measures), outputs (output performance measures) and the impacts that these outputs have on the larger system within which it is nested (impact performance measures). The third layer has areas of effect related to the performance area. The last layer has factors that influence the areas of effect.

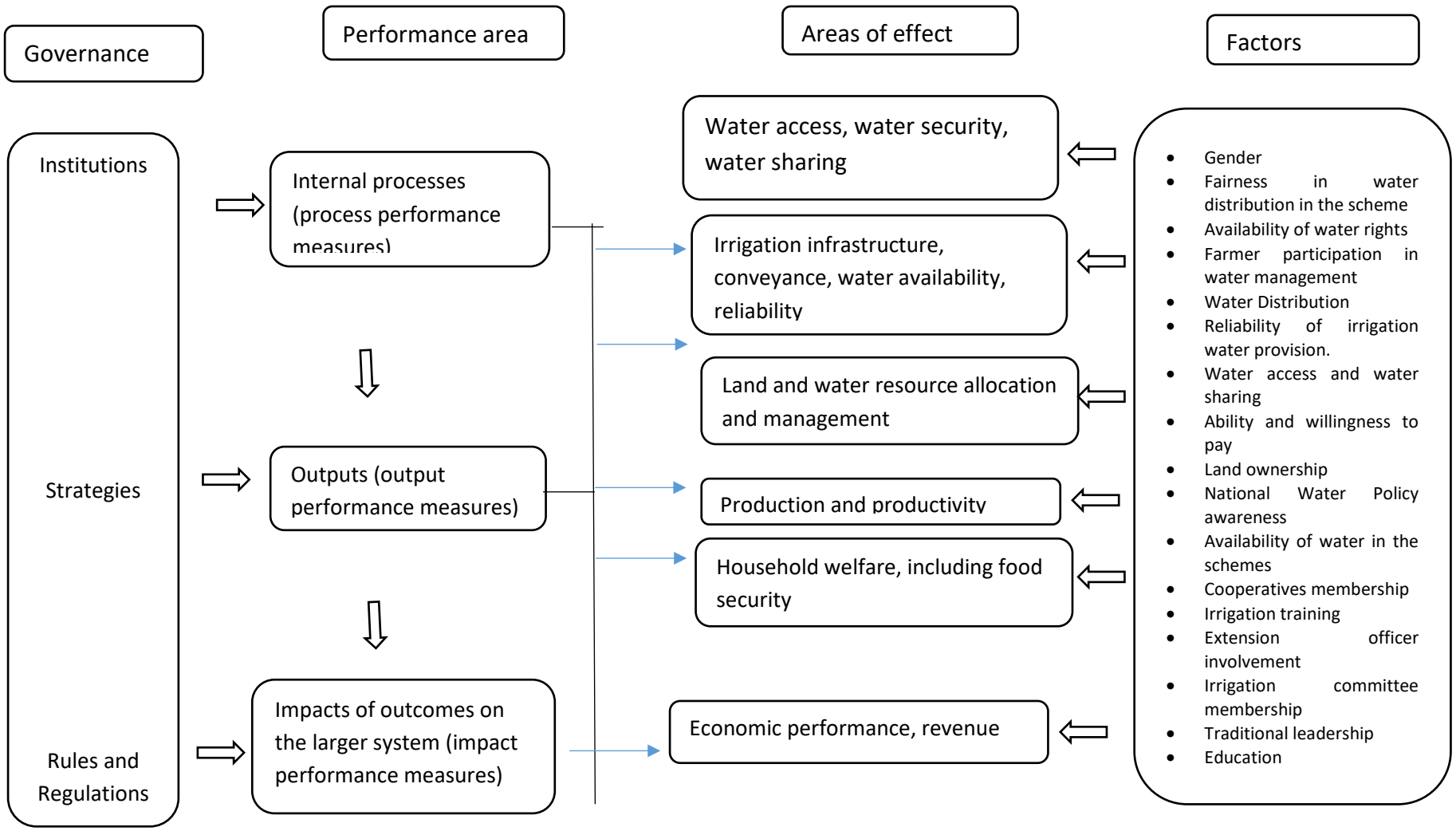


Figure 5.1: Framework showing the effects identified at each of the performance areas in SISs

5.3 Findings

5.3.1 Irrigation scheme governance

WUAs are meant to be the link between irrigation farmers and stakeholders in terms of irrigation management. Table 5.1 presents the knowledge of and membership of WUAs by irrigation farmers. The results showed that overall only 0.3% of the irrigation farmers were members of WUAs and only 4% had any knowledge about WUAs. This is consistent with a study conducted by Mjoli *et al.* (2009) in Limpopo and KwaZulu-Natal which found that WUAs and CMA's were not functional.

Table 5.1: **Knowledge and membership of WUAs in SISs in KZN (n=341)**

Knowledge	Yes (%)	No (%)
Members of WUAs	0.3	99.7
Knowledge of WUAs	4	96

The irrigation farmers' lack of knowledge about water-user rights or licensing is reflected by the dysfunctionality of the WUAs. Most irrigation farmers indicated that their right to use water was due to the occupation of the plot or land they use for agricultural purposes, rather than other institutional arrangement or an explicitly stated water rights.

Although the NWA is recognised globally as a progressive water policy, it is hardly known in SIS's (Denby, 2013). Meinzen-Dick and Nkonya (2005) argued that if the range and complexity of institutions governing the use of water resources are not understood, any efforts to improve water allocations will be ineffective and not yield the desired outcomes. Evidence from MRIS, TFIS, MFIS and NIS irrigation schemes is also consistent with Denby (2013) and Meinzen-Dick and Nkonya (2005).

Table 5.2 indicates that NWA, NWRS, government aims for SISs and WUAs are unknown across the irrigation schemes apart from NIS irrigation scheme. The statistically significant variations across irrigation schemes could be attributed to differences in participant demographic

composition, stakeholder participation in irrigation schemes and access to information. WUAs do not exist in these irrigation schemes. Only irrigation farmer cooperatives exist and are functional across the irrigation schemes. Only 4% of irrigation farmers knew about WUAs and there was no statistically significant variation across irrigation schemes. Hence, irrigation farmers across these irrigation schemes had no legally recognised right (water rights or licences) to water resources.

Table 5.2: Irrigation farmer awareness of water policies and strategies across irrigation schemes

Irrigation Scheme	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	X^2 significance Level
Awareness of the NWA						
MRIS	40.8	34.2	8.3	14.2	2.5	***
TFIS	53.3	32.5	12.5	1.7	0	
MFIS	47.4	29.8	12.3	10.5	0	
NIS	36.6	17.1	7.3	24.4	14.6	
Awareness of the NWRS						
MRIS	42.5	36.7	9.2	10	1.7	***
TFIS	55	36.7	7.5	0.8	0	
MFIS	42.1	38.6	10.5	8.8	0	
NIS	34.1	34.1	7.3	12.2	12.2	
Knowledge of government aims for SIS						
MRIS	18.3	43.3	14.2	18.3	5.8	***
TFIS	27.5	38.3	22.5	8.3	3.3	
MFIS	31.6	31.6	26.3	10.5	0	
NIS	2.4	24.4	9.8	58.5	4.9	

*Note: *** = $p < 0.001$*

Source: Survey data (2017)

Despite the lack of awareness of formal water institutions, irrigation farmers devised their own

policies, rules and regulations stipulated in the scheme constitution to ensure proper scheme management and irrigation water use. Although both formal and informal water institutions are all important in managing water at scheme level, informal institutional arrangements (customary institutions) and local institutions tend to be more valuable, influential and powerful compared to formal institutions due to low diffusion of the state laws. Studies have shown that irrigation farmers have an incentive to follow and enforce rules they formulated than those handed down from an outside authority (Tang and Ostrom, 1993; Sokile *et al*., 2005; Deribe 2008). Irrigation schemes are managed by the scheme committees elected by the irrigation farmers. The key responsibilities of the scheme committees include formulating rules, making the scheme decisions, enforcing rules and penalties, planning and organising and resolving conflicts in the scheme, particularly about water access. Irrigation farmers are satisfied with the scheme committee and believe that they are effective in management of water resources (Table 5.3).

Irrigation farmers across the four irrigation schemes are satisfied with the land and water allocation, believe that the scheme rules are fair, not hard to enforce, and that irrigation farmers generally comply with the scheme rules.

5.3.2 Water management in irrigation schemes

Irrigation water management is a practice of managing allocation of water and related inputs to maximise economic returns from irrigated crop production while minimising environmental impacts. It relates to the volume of water given to a crop, the frequency of applying water and the appropriate time of application (Schaible and Aillery, 2007). An increasing water scarcity has raised concerns about how water resources are managed. Although IMT was implemented in the late 1990s and irrigation farmers are supposed to be aware of the state withdrawal from the management of irrigation schemes, irrigation farmers are still not ready to take over the responsibility of the scheme management due to high levels of illiteracy among them and lack of technical and managerial skills or training to capacitate irrigation farmers on irrigation and water management (Perret, 2006).

Table 5.3: Irrigation farmer understanding and satisfaction with informal institution in the scheme (n=341)

Irrigation Scheme	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	X^2 significance Level
			Satisfied with land allocations			
MRIS	2.5	22.5	20	43.3	11.7	
TFIS	10.8	30	9.2	43.3	6.7	***
MFIS	19.6	33.9	37.5	8.9	0	
NIS	7.5	17.5	7.5	67.5	0	
			Fairness in water allocation rules			
MRIS	6.7	11.7	21.7	45	15	
TFIS	2.5	1.7	10	60.8	25	***
MFIS	5.3	35.1	12.3	36.8	10.5	
NIS	5	20	5	57.5	12.5	
			Fairness in the scheme rules			
MRIS	5	11.7	17.5	52.5	13.3	
TFIS	2.5	2.5	10.8	65	19.2	***
MFIS	1.8	26.3	22.8	36.8	12.3	
NIS	0	20	12.5	55	12.5	
			Rules in the scheme are hard to enforce			
MRIS	8.3	30	26.7	25.8	9.2	
TFIS	19.2	38.3	22.5	9.2	10.8	***
MFIS	7	24.6	10.5	50.9	7	
NIS	12.5	47.5	5	27.5	7.5	
			Compliance to the scheme rules			
MRIS	0.8	0	10.8	31.7	56.7	
TFIS	0	3.3	15.0	25.8	55.8	***
MFIS	0	12.3	14.0	54.4	19.3	

Irrigation Scheme	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	X^2 significance Level
NIS	0	0	2.5	37.5	60.0	
	Satisfied with the current executive committee					
MRIS	3.3	8.3	11.7	37.5	39.2	ns
TFIS	1.7	5.8	10.8	45	36.7	
MFIS	0	14	10.5	52.6	22.8	
NIS	4.9	9.8	2.4	56.1	26.8	
	The constitution is effective in management of water resources					
MRIS	1.7	6.7	44.2	36.7	10.8	**
TFIS	0	15	32.5	36.7	15.8	
MFIS	1.8	17.5	28.1	38.6	14	
NIS	2.5	5	15	60	17.5	

*Note: *** = p <0.01; ** = p< 0.05; ns = not statistically significant*

Source: Survey data (2017)

IMT involves the state withdrawal from irrigation management, promotion of water users' participation in irrigation management, development of water management entities at local level as well as the transfer of ownership and management. Across the four irrigation schemes most irrigation farmers indicated that they had never received formal training on irrigation and water management (Figure 5.2). Likewise, with agricultural training, most irrigation farmers from MFIS received agricultural training while less than half of irrigation farmers from Msinga received such training. This was also confirmed in the feedback workshops held across these irrigation schemes. Government officials, particularly from the DWAS do not communicate with irrigation farmers and do not inform irrigation farmers about water policies nor government aims and strategies.

Some irrigation schemes (particularly those using gravity-flow canals for water conveyance) rely on irrigation schedules for proper water management as well as to ensure equitable distribution of water. A weekly roster specifying who should irrigate on a particular day is set and agreed upon

between irrigation farmers, irrigation committee and the traditional authorities. Sokile *et al.* (2005) and Deribe (2008) identified rotational irrigation to be often practiced when water stresses are high and to ensure that all irrigation farmers receive enough water to irrigate their fields and it was recognised as successful in informal water management.

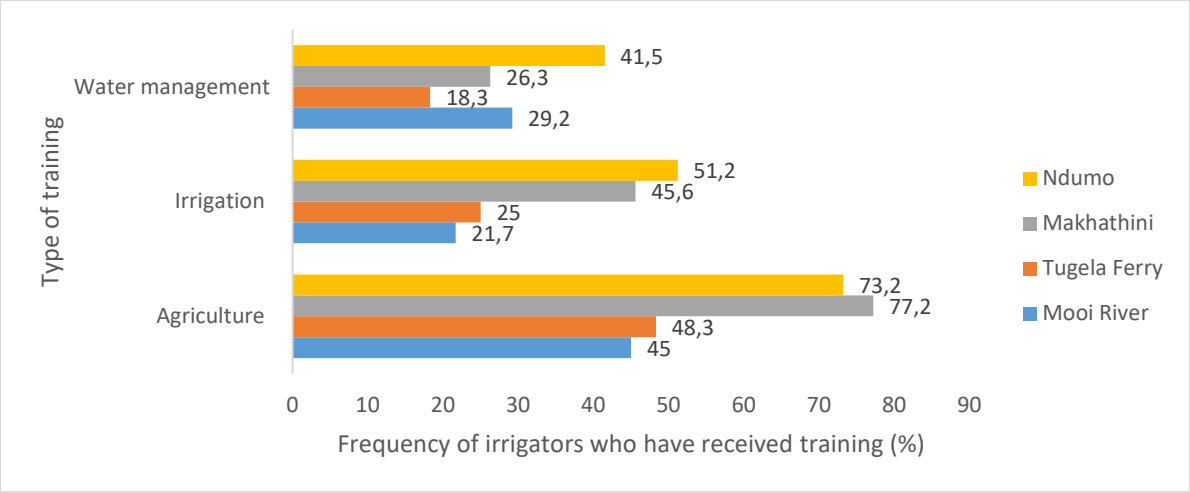


Figure 5.2: Training received across irrigation schemes

Source: Survey data (2017)

Across the four irrigation schemes in this research, MRIS and part of TFIS irrigation schemes use rotational irrigation schedule for water allocation. Most irrigation farmers across the four irrigation schemes are satisfied with the irrigation schedule in their schemes (Table 5.4). The statistically significant differences in the satisfaction ($p = 0.001$) can be attributed to the variation in irrigation water supply and the extent of water scarcity across the schemes. MRIS irrigation farmers are least satisfied with the water schedules. Field observations showed that the water availability is limited and is exacerbated by non-compliance to schedules among upper block irrigation farmers.

Violation of rules, failure to adhere to irrigation scheduling and the resultant shortages of water supply are the major sources of conflicts in SISs. Such conflicts are resolved informally by the scheme committee with the assistance of traditional authorities before they erupt into serious conflicts. Although both formal and informal institutions interact significantly in conflict

resolution at the local level, irrigation farmers often prefer informal routes over formal ones (Boyer, 2007; Deribe, 2008). Across the four irrigation schemes, conflicts were managed informally, and most irrigation farmers were satisfied with the way conflicts are managed. The least satisfaction was in Makathini Irrigation Scheme.

Table 5.4: Irrigation farmer satisfaction with irrigation schedule and conflict management across irrigation schemes

Irrigation Scheme	The extent of satisfaction (%)				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Irrigation farmer satisfaction with irrigation schedule					
MRIS	20.8	31.7	10.8	30.0	6.7
TFIS	2.5	5.0	5.0	53.3	34.2
MFIS	7.1	23.2	23.2	46.4	0
NIS	2.5	2.5	17.5	60.0	17.5
Irrigation farmer satisfaction with conflict management					
MRIS	6.7	12.5	15.0	47.5	18.3
TFIS	1.7	6.7	21.7	44.2	25.8
MFIS	5.3	35.1	22.8	33.3	3.5
NIS	2.4	0	22.0	63.4	12.2

Source: Survey data (2017)

5.3.3 Gender in irrigation water management

Gender is one important dimension in irrigation schemes that cannot be overlooked since there are inherent inequalities when it concerns the distribution of resources, participation in scheme leadership, decision-making processes and attending water-related training. The SA government, through the national water policy and the equity principle of the NWA, recognizes the importance of women's voices in water management structures. It is believed that fair distribution of resources and equal participation of women in water management and giving them a voice in decisions on

use and allocation of water resources could improve their status (Mjoli *et al.*, 2009).

By default, gender plays an important role on resource ownership and participation in leadership in rural communities. Women are generally treated as inferior, their abilities and potential as farmers/irrigation farmers have been overlooked and seen as housewives and helpers the farms. Where women are agricultural producers, they are subordinated to their husbands who control the production process and the resulting output. The government also stressed that management committee in the schemes or in WUAs must reflect gender ratio of irrigation farmers, unlike in Nepal where it is compulsory to elect one women member in the management committee (Van Koppen and Hussain, 2007).

Mjoli *et al.* (2009) found that in KZN and Limpopo men had land and water rights, thus had the power to influence the decisions on the allocation of water resources. On the other hand, women did not get any benefits from their involvement in WUAs due to lack of land and water rights in their individual capacity. In MRIS irrigation scheme, no evidence of gender discrimination in accessing irrigation water existed. Both men and women had the same privileges since water rights are linked to the cultivated land and water is allocated or distributed according to an irrigation schedule (Muchara, 2014).

Rural areas face challenges of the patriarchal traditional African law which tend to favour men over women. This is more notable when regarding access to and use of land. Under customary law, land is generally allocated to men, the household heads. Women and daughters cannot access land on their own, they depend on their husbands and male kins (Arends, 2009). The SA land reform programme, which intends to redress imbalances of the past in land accessibility often concentrate on race as the main source of inequity while ignoring the gender divide. Enhancing women's access to land and water rights is critical for rural livelihoods improvement.

Surprisingly though, in this study, both the survey results and focus group discussions indicated the existence of minimal gender inequalities. Both men and women were satisfied about land and water allocations and pointed that they acquired land on similar terms (through traditional allocation, inheritance and from relatives for women while through renting for men). All genders are satisfied with land tenure security and there were no statistically different variations across the

two groups. Gender inequity was evident on land ownership status, with 55.4% male with land registered in their names while only 44.1% women had land registered in their names. In the scheme leadership, both genders are represented except in the secondary committee, which comprise more men than women (Table 5.5).

Table 5.5: Gender representation in irrigation schemes

Role in the irrigation scheme	Gender		X^2 test
	Female	Male	significance
Primary committee member (%)	10.2	12.8	
Secondary committee member (%)	0.4	5.8	***

Note: *** = p <0.001

Source: Survey data (2017)

5.2.4 Women's land and water security

There was no statistical difference between male and females in terms of perceived land tenure security, water adequacy and willingness to pay for water. Seventy four percent of the women claimed to be satisfied with their land tenure security while 58% feel that their water access is adequate. However, some 46% were using plots that are in their names, showing that the objectives of the WAR programme of ensuring that more than 50% of water and land in the irrigation schemes in KwaZulu-Natal is used by females is close to becoming a reality. However, measures still need to be taken to increase the number of women who own land. Table 5.6 presents the percentage of women and their satisfaction with land tenure and water adequacy, and land ownership in the irrigation schemes.

Table 5.6: Women's land and water satisfaction in SISs in KZN

Criteria	Yes (%)	(No)%
Land tenure satisfaction	74	25
Water adequacy	58	42
Land ownership	46	54

Source: Survey data (2017)

5.3.5 Water security

Table 5.7 reflects the survey respondents' perceptions on the relative importance of the presence of agricultural extension officers and irrigation committees in the management of irrigation water. The perceptions were measured on a score of 0 to 4, where 0 is for strongly disagree and 4 is for strongly agree. The irrigation farmers relied on canal attendants for daily allocation of water to the different blocks according to the schedule, while irrigation committees were expected to enforce compliance to the schedule (Muchara, 2014). Irrigation farmers perceived the role of the scheme attendants committee in water management as more important than ordinary members as shown by the relatively moderate score of 1.82. Hence there might still be a need to maintain canal attendants as part of local water management structures.

Table 5.7: Irrigation farmer evaluation of effectiveness of water management structures in KZN Smallholder Irrigation Schemes, 2017 (n= 321)

Factor	Average Score
Extension officers	2.84
Irrigation committee	2.64
Water User Associations	0.46
Traditional leadership	0.38
Cooperative member	0.36
Infrastructure/canal committee	1.82

Note: 0= Strongly Disagree, 1= Disagree, 2= Neutral, 3= Agree, 4= Strongly Agree

Source: Survey data (2017)

The results indicate that there is room to strengthen irrigation water management by further empowering the local irrigation committees and government departments and enhancing the role of WUAs and traditional authorities to manage water resources. Although, the results reflect general perceptions of irrigation farmers on the role of various stakeholders in water management, it is quite possible that some respondents were generally unaware of the roles of some structures, and their perceptions may be biased according to the frequency with which employees of the various structures interact with members of the irrigation schemes.

5.3.6 Factors determining water security

Principal component analysis is a statistical technique that linearly transforms an original set of explanatory variables into a new set of orthogonal composite variables called principal components that are ordered such that the first few PCs capture most of the variation present in all of the original variables. PCs are mostly used to economize the number of explanatory variables without losing too much information, to remedy multicollinearity and to identify underlying dimensions in the data if the PCs can be meaningfully interpreted. PCA has been comprehensively used in previous research to construct a poverty index, food security index, an asset-based poverty index (Source/s).

The first Principal Component (PC) explained 54% of the variation and was found closely related to the physical availability of water among irrigation farmers and their willingness to pay for water (Table 5.8). This PC1 is primarily related to reliability of water, sufficiency of water, willingness to pay, consistency of water and frequency of water. It measures the distribution of water security for irrigating farmers. It also indicates reliable water, sufficient water, willingness to pay, water consistency and frequency of water use dimension. The second PC explains 16% of the variation and was found to be primarily related with the infrastructural maintenance satisfaction of the irrigation farmers. PC2 measures the irrigation farmer's water security status when they move in the opposite direction. The above-mentioned indicators are positively associated with water security among smallholder irrigation farmers in the irrigation schemes.

Results from the principal components indicated that water secure irrigation farmers in the irrigation schemes perceive water supply to be reliable, are characterised by consistent flow of water to their plots, the water they get in their plots is sufficient, and they are registered water users who are willing to pay for water use. This PC (PC1), indicates that the irrigation farmers' satisfaction with infrastructural maintenance and water distribution is relatively less dominant when compared to the other water security variables. This implies that smallholder irrigation farmer's level of satisfaction with water distribution and maintenance of the infrastructure does not have much impact on the water security status of the irrigation farmers. Similarly, Sinyolo *et al.* (2014b) highlighted that the informal traditional structures play an important and bigger role in

shaping the perceptions of water security.

Table 5.8: PCA results showing two principal components extracted

Variable	Explanation	Principal components	
		PC1	PC2
Wreliable	Reliability of water	**0.51**	-0.05
Wsuff	Sufficiency of water	**0.44**	0.06
Wconsist	Consistency of water	**0.39**	-0.01
Waccess	Water access	0.26	-0.22
Maintasatis	Satisfaction with maintenance	0.16	**0.93**
Wdistrisat	Water distribution	0.10	-0.08
Willtopay	Willingness to pay	**0.40**	0.04
Regwateruser	Frequency of water use	**0.37**	-0.28
Eigen values		5.76	1.67
% of variation explained		54.12	15.58
Cumulative % of variation explained		54.12	69.70

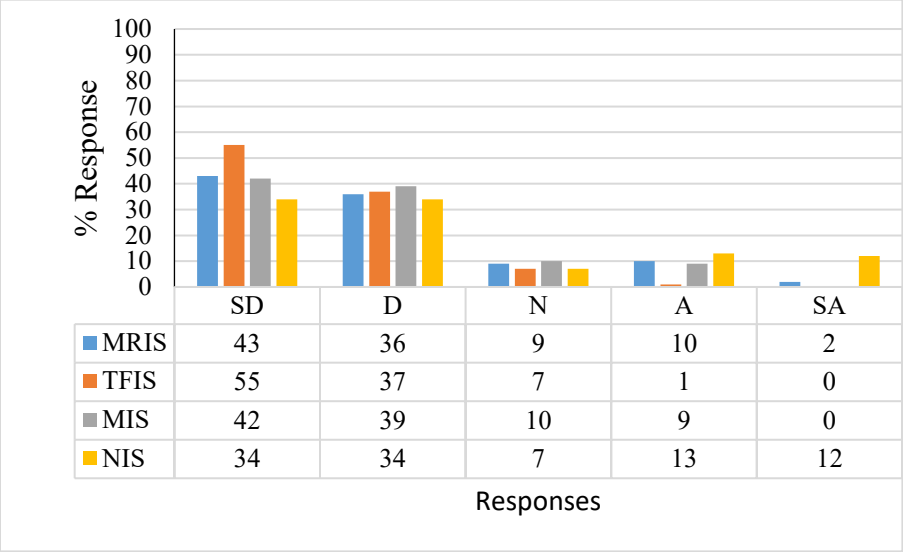
Note: Component loading greater than |0.3| are highlighted in bold print

Source: Survey data (2017)

5.3.7 Infrastructure management

The survey revealed that 55% of TFIS strongly disagreed to being aware of the NWRS, 43% of irrigation farmers in MRIS, 42% in MFIS and 34% in NIS also strongly disagreed to having awareness of NWRS (Figure 5.3). A small proportion in NIS (13%) agreed to knowing the NWRS and only 1% in TFIS showed awareness of the policy and its requirements.

The implication is water payments influence the sustainability of the irrigation scheme because they primarily depend on the condition of the infrastructure. The water payments support the operation and maintenance (O&M) budget. Irrigation farmer knowledge about government's strategy for SISs could lead to better handling of irrigation infrastructure.



Note: SD= Strongly Disagree, D= Disagree, N= Neutral, A= Agree, SA= Strongly Agree

Figure 5.3: Irrigation farmer responses to awareness of NWRS

5.3.8 Current Infrastructure Condition in Study Sites

The condition scoring technique makes it possible to identify defects (Le Gauffre *et al.*, 2007). The condition scoring based on a rating scale used by Le Gauffre *et al*. (2007) and Abbott *et al*. (2007) was adopted for this study (Table 5.9).

In Msinga Local Municipality, MRIS showed that the canals at the upper reaches of the scheme (Blocks 2, 3 and 4) were marginally deteriorated (Figure 5.4). The canals at the middle section and tail end of the scheme were in bad condition (Blocks 5, 9, 11 and 15), with condition ratings (CR) of 0.2, 0.2, 0.4 and 0.3, respectively, thus needed immediate maintenance. The sluice gates in Blocks 2 $(CR = 0.4)$, 3 $(CR = 0.3)$, 4 $(CR = 0.4)$, 5 $(CR = 0.4)$, 9$(CR = 0.2)$, and 11 $(CR = 0.2)$, were all in critically bad condition except for the gates in Block 15. The regulators also showed signs of deterioration with marginal severity. All siphons were functional with some components exhibiting deterioration due to abuse and vandalism.

Table 5.9: Irrigation infrastructure condition scoring adopted in the study

	Description	Condition rating
Excellent	Components may still be new or may have been recently maintained	1
Good	Hydraulic structures exhibit superficial wear and tear, minor defects observed	0.8
Fair	Significant portions require maintenance. Infrastructure has suffered abuse or disrepair	0.6
Bad	Significant portions have deteriorated badly. Maintenance needed. The infrastructure and some components have exceeded service life	0.4
Very bad	Critically damaged components(s). Immediate repair needed.	0.2

The facility condition assessment for TFIS (Figure 5.5) revealed deteriorated condition of the hydrants (abstraction points). Due to the varying infrastructure characteristics, the dysfunctional status varied across the scheme. The secondary canal system for the Blocks 1 ($CR = 0.4$), and 2 ($CR = 0.4$), at the head end exhibited defective canal linings that needed repairing and replacement. The hosepipes used for water application in the field had a CR of 0.2, thus exhibited critical damage and required replacement. The $CR = 0.4$ for hydrants indicated significant damage had occurred and maintenance was due. The PVC pipes for Block 4B were deteriorated however, the infrastructure did not show signs of having exceeded the service life

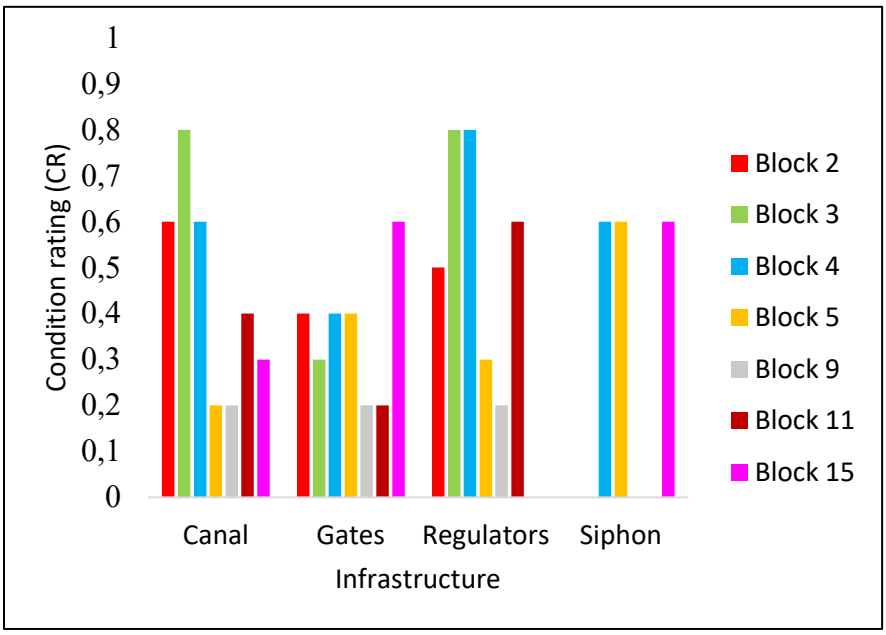


Figure 5.4: Infrastructure Condition Assessment (ICA) results for Mooi-River Irrigation Scheme

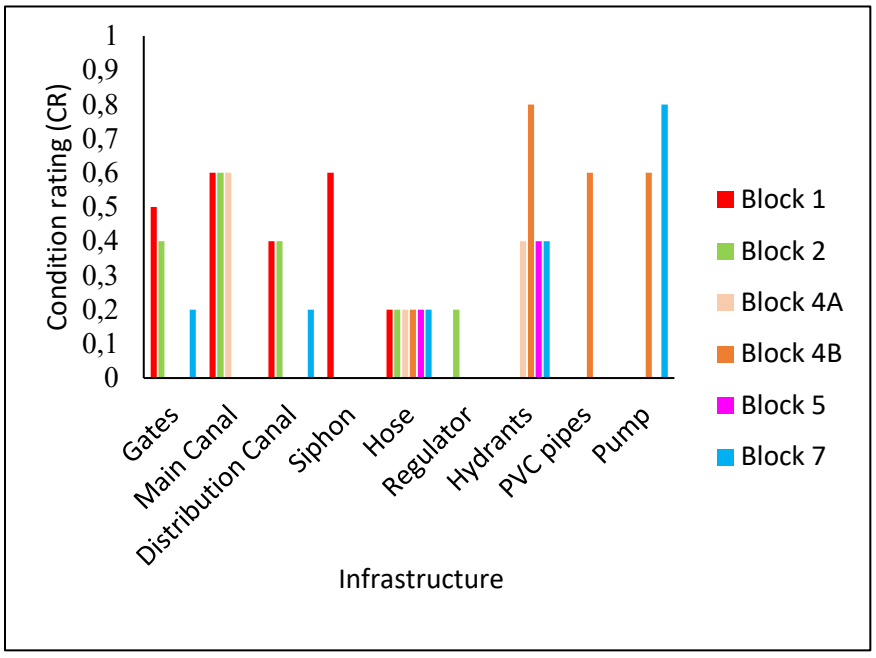


Figure 5.5: Infrastructure Condition Assessment (ICA) results for TFIS

In Jozini Local Municipality, namely MFIS and NIS, discussions with scheme managers, revealed that infrastructure was in a bad state. For instance, the underground piping network at MFIS was leaking, outdated and needed repair. According to the condition scale, the infrastructure had

condition scoring (CR) of 0.4. Furthermore, the scheme manager highlighted how the MFIS centre pivots were occasionally vandalised and how irrigation farmers failed to contribute to their maintenance, and had a score of. 0.6. The main canal conveying water to the fields was leaking leading to severe water losses (Figure 5.6). The scheme managers at NIS pointed out how the underground water conveyance system had deteriorated, as it has been in use since 1992 and no replacements had been done. Hence this rendered the infrastructure at NIS old and had exceeded service life. According to subjective assessment during the study, this would score the NIS sub-surface infrastructure (CR=0.4). In addition, the main laterals supplying draglines in the fields were old and had missing components.

(a) Leaking canal in MRIS (b) NIS sprinkler with a makeshift component

Figure 5.6: Dilapidated conditions of infrastructure

5.3.9 Irrigation farmer participation

Irrigation farmers generally participate in the scheme management and operation, which are the basis of IMT and PIM. However, survey results showed that irrigation farmers decide how they will participate in the scheme, i.e. whether they participate more in management, maintenance, operations or information distribution. Table 5.10 indicates the proportion of irrigation farmers participating in scheme management. This includes attending meetings, elections of executive committee members, formulating scheme rules, water scheduling as well as irrigation farmers willing to be part of the scheme committees. Of the respondents, fewer water-users do not attend

meetings across the schemes compared to 65% of those who always attend meetings. Most water users (60%) always participate in electing committee members, while 11% never do. About 45% of the water users always participate in formulating scheme rules, while about 40% only do so sometimes. Overall, this is an indication that most irrigation farmers in the irrigation schemes participate in scheme management, in one way or the other.

Table 5.10: Participation in scheme management

Irrigation scheme	Never participate (%)	Sometimes participate (%)	Always participate (%)	n	X2 Significance Level
Attend irrigation meetings					
MRIS	1.7	35.0	63.3	120	
TFIS	1.7	22.5	75.8	120	
MFIS	10.7	30.4	58.9	60	***
NIS	12.2	36.6	51.2	41	
Electing/removing committee members					
MRIS	8.3	27.5	64.2	120	
TFIS	10.0	35.0	55.0	120	
MFIS	19.3	24.6	56.1	60	***
NIS	9.8	12.2	78.0	41	
Formulating scheme rules					
MRIS	12.5	45.8	41.7	120	
TFIS	12.5	45.0	42.5	120	
MFIS	26.3	24.6	49.1	60	***
NIS	9.8	26.8	63.4	41	
Irrigation Water scheduling					
MRIS	17.5	45.8	36.7	120	***
TFIS	18.3	40.8	40.8	120	
MFIS	29.8	29.8	40.4	60	
NIS	31.7	12.2	56.1	41	

Note: *** = $p < 0.01$; Source: Survey data (2017)

Table 5.11 presents results on how irrigation farmers participate in regulation in the scheme, this includes, reporting leakages and other infrastructure issues, reporting unlawful behaviour, as well as engaging authorities about water related issues in the scheme. Fifty six percent of water users in the irrigation schemes always report leakages and other infrastructure issues, while 62% always or sometimes report unlawful behaviour, with about 23% irrigation farmers who never engage authorities about water issues.

Table 5.11: Irrigation farmer participation in regulation in SISs in KZN

Irrigation scheme	Never participate (%)	Sometimes participate (%)	Always participate (%)	Total (n)	Significance of X^2 test
Reporting leakages and other infrastructure issues					
MRIS	18.3	37.5	44.2	120	
TFIS	7.5	31.7	60.8	120	
MFIS	17.9	17.9	64.3	56	
NIS	2.7	2.7	78.4	37	***
Reporting unlawful behaviour					
MRIS	46.7	20.0	33.3	120	
TFIS	38.3	31.7	30.0	120	
MFIS	28.6	14.3	57.1	56	
NIS	13.2	28.9	57.9	38	***
Engaging authorities about water related issues					
MRIS	34.2	40.0	25.8	120	
TFIS	12.5	49.2	38.3	120	
MFIS	29.8	52.6	17.5	57	
NIS	17.1	29.3	53.7	41	***

*Note: *** = $p < 0.01$*

Source: Survey data (2017)

5.3.10 Production and productivity

The fundamental role played by irrigation in stabilizing crop production, increasing yields and in improving incomes and welfare has been recognized across the globe. Irrigation gives irrigation farmers an opportunity to increase cropping intensity. Sinyolo *et al.* (2014a) also inferred that irrigation is essential for increasing crop productivity and improving overall agricultural performance as it increases the area under cultivation and crop intensity and decreases crop losses. Given that smallholder irrigation farmers have small irrigation plots and face difficulties with extending them, the only option to obtain higher yields is through increasing yields application of irrigation water and the appropriate farm management practices, including water management.

In general, one of the primary reasons for investment in irrigated agriculture was to enhance crop yields by transforming subsistence farming to commercial farming. However, irrigated agriculture has not reached its expected targets of productivity (Saeed, 2010). Despite government's considerable investments in irrigation and government strategies to transform SISs from subsistence to commercial farming, SISs in South Africa are still farming on a subsistence scale and still focusing on food crop production (mainly vegetables) for direct consumption (Source). In South Africa, the expected returns on investments in irrigation have not been realised since irrigation schemes are still poorly performing. According to Fanadzo *et al.* (2010), the Zanyokwe Irrigation Scheme (ZIS) in the Eastern Cape Province has not delivered on its development objectives of increasing crop production and improving rural livelihoods. Fanadzo *et al*. (2010) attributed this unsatisfactory performance to poor water management since the irrigation scheduling used for water application did not take crop type and growth stage into account. According to Ebissa (2017), frequent or delayed irrigation are not good for crops performance as it could reduce the efficiency of irrigation and affect crop yields. In-field water management at scheme level is generally weak, the irrigation equipment used is old and the irrigation schedules followed often result in over-irrigation during the early crop growth stages and under-irrigation during the advanced growth stages (Fanadzo *et al*., 2010). Chambers (1988) cited by Bacha *et al*. (2011) inferred that proper irrigation water management can enhance crop production by reducing the risk of crop failure and thus improve the livelihoods of the rural households.

Irrigation farmers in MRIS and TFIS farm for food self-sufficiency at the household level and for

the market. They obtain relatively low yields from irrigation and therefore produce at marginal levels On the contrary, irrigation farmers in MFIS and NIS obtain much higher yields, consider farming as a business and produce purely for income generation. Table 5.12 presents the distribution of the most prevalent crops grown in the study areas as well as their yield. Potato, maize, tomato, cabbage, and bean were grown by most irrigation farmers. This could be attributed to the availability of output market and easier access to the market. Based on the field observations and household surveys suggested that MRIS and TFIS are poorly functioning and are far from delivering the core objectives for their establishment (increasing crop production and improving rural livelihoods) compared to MFIS and NIS.

Table 5.12: Average crop yield for the dominant crops grown across irrigation scheme

Crop name	Irrigation scheme	MRIS	TFIS	MFIS	NIS
		Average crop yield (Ton/ha)			
Potato	Mean	6.5	4.8	-	6.3
	Std. Deviation	9.3	6.8	-	-
	n	74	36	-	1
Maize	Mean	8.1	7.3	9.388.75	6.6
	Std. Deviation	9.8	14.8	9.466.01	2.9
	n	25	61	8	7
Tomato	Mean	12.6	15.1	7.566.67	8.0
	Std. Deviation	22.4	26.2	10.229.48	2.8
	n	37	46	2	2
Cabbage	Mean	12.5	10.5	11.014.91	10.1
	Std. Deviation	24026.45	14977.20	7653.49	8114.01
	n	22	16	19	8
Bean	Mean	3018.84	5413.99	8611.11	5100.00
	Std. Deviation	4152.99	6620.42	6737.66	3457.79
	n	23	10	9	12

5.4 Factors that Affect the Effectiveness of Policies, Strategies, Rules and Regulations in Smallholder Irrigation Schemes

An understanding of the factors affecting agricultural water management can provide strategies for improving agricultural water. The government implemented water policies and strategies to ensure effective water management both at the national and scheme level. Irrigation farmers have their own institutional arrangements at scheme level to ensure equitable distribution and efficient use of water. Reporting unlawful behaviour such as unauthorised handling of infrastructure, enforcement of scheme rules and penalties for noncompliance by the scheme committee improve compliance and proper management of water resources. Irrigation farmers in SISs, usually employ irrigation water schedules to ensure equitable distribution of irrigation water among irrigation farmers and as a strategy to ensure optimal water management at local level. Irrigation scheduling practices were found to play an important role in improving water use efficiency on the farm as it dictates the frequency of irrigation and the volume of water applied (Stevens, 2006). Therefore, satisfaction with irrigation schedule and involvement of irrigation farmers in formulating irrigation schedule is also crucial for ensuring equitable distribution of irrigation water and to avoid theft and water conflicts over irrigation water. The study identified various factors that underlie the effectiveness of policies, rules and regulations.

5.4.1 Gender

Like other sectors, the water sector is also gendered. Although government always encourages gender equality in water management, women and men tend to have different interests and derive different benefits from its availability, use and management (Panda, 2007). Gender equity in irrigation farmer involvement in water management still mostly exists on paper. Equal representation of both male and female irrigation farmers in the maintenance and management of communal water resources is crucial for effective water management in irrigation schemes. Moreover, the involvement of women in water resource development had been recognised as having the potential to lead to designing effective solutions to water problems; making irrigation schemes more sustainable; ensuring that infrastructure development yields the maximum social and economic returns; etc. (Panda, 2007). In this study, the gender variable pointed to the significant involvement of male irrigation farmers in the scheme.

5.4.2 Fairness in water distribution in the scheme

Equity in water distribution is essential in achieving effective water resource management at scheme level as it reduces the incidents of water theft and conflicts among irrigation farmers. Both formal and informal water institutions seek to ensure equitable water distribution among irrigation farmers. Fairness in water distribution in the scheme was observed to improve irrigation water management in this study. MRIS exhibited the most unequal distribution of water among irrigation farmers. The ineffectiveness of the primary and secondary committees in enforcing rules was the main cause.

5.4.3 Availability of water rights (permits)

In general, availability of water rights improves water use efficiency and the water resource management as it specifies how much water each user is permitted to use. However, the unavailability of water rights in this study had a negative influence on water resource management. This can be attributed to the fact that irrigation farmers across MRIS, TFIS, MFIS and NIS irrigation schemes were not aware of the NWA and were not members of WUA, hence had no legally recognised rights to irrigation water. All irrigation farmers had informal water rights that are linked to ownership of an irrigation plot in the scheme. Any cost from poor management of water resources is shared by all irrigation farmers in the scheme. As a result, there is no incentive to promote water use efficiency and effective water resource management. Bulk supplied water in SISs makes exclusion and adherence to set schedules ineffective. Rules are unenforceable as there are no mechanisms of determining divergence of practice. Even when irrigation days are specified, the schemes lack mechanisms of ensuring that people adhere to set rules. In other words the cost if non-adherence is very low, which gives an incentive to cheat.

5.4.4 Irrigation farmer participation in irrigation management

Ebissa (2017) argued that the most appropriate solution for irrigation water management problems in SISs is the involvement of irrigation farmers in irrigation water management from the water distribution decisions as well as giving them the responsibility for maintaining the irrigation system. According to NWA, irrigation farmers should participate in irrigation management through legally established WUAs comprising the irrigation committee democratically elected by irrigation farmers themselves. Irrigation farmers are also encouraged to be organised into

cooperatives. In this study, irrigation farmer participation in irrigation management had a positive influence in irrigation water management. The contribution of finances to irrigation management increases the care irrigation farmers give to the scheme infrastructure and irrigation water. As a result, irrigation farmers become more active in reporting unauthorised handling of infrastructure and water theft. Irrigation farmers believe that the awareness of formal water institutions and reporting unlawful behaviour will increase compliance and lead to effective water management. This finding is consistent with Ntai (2011), Muchara (2014) and Samian *et al.* (2014).

The effectiveness of the factors influencing water management at scheme level differs across irrigation scheme due to differences in biophysical factors and institutional arrangements. Irrigation water management was poor in MRIS, TFIS and MFIS compared to NIS due to lack of awareness formal water institutions across these irrigation schemes. However, only poor water management in MRIS was a significant factor, this could be attributed to the fact that Msinga is a dry area and unlawful water extraction is not reported due to penalties that are not fully enforced. According to Balooni and Venkatachalam (2016) limited water supply makes development inequitable and unsustainable, which often increases the incidents of water conflicts among irrigation farmers.

Causal factors were quantified using Relative Causal Index (RCI). The RCI ranked the causal factors and the results are shown in Table 5.13. Based on the ranking for TFIS, MRIS, MFIS and NIS, the top causal factors, as perceived by irrigation farmers, were lack of knowledge of the NWA and the NWRS. In addition, irrigation farmers' lack of knowledge of government's aim in SISs was a top contributing factor in all the irrigation schemes. The implication is that irrigation farmers' are not fully aware of the policies and strategies in place and as such have divergent goals to those of government and its programmes.

Table 5.13: RCI of causal factors by extension workers and external stakeholders for TFIS, MRIS, MFIS and NIS

Factor	Irrigation scheme RCI			
	MRIS	TFIS	MFIS	NIS
Unaware of the NWA	0.8	0.9	0.8	0.7
Unaware of the NWRS	0.8	0.9	0.8	0.8
Don't know the government aims in SISs	0.7	0.8	0.7	0.6
Unsatisfied with the cooperation between blocks and farmers	0.4	0.4	0.5	0.5
Water users unwilling to contribute for O&M	0.5	0.4	0.5	0.5
Unsatisfied with tribal authority in irrigation scheme	0.5	0.5	0.7	0.6
Unsatisfied with govt involvement in SISs	0.6	0.5	0.6	0.5
Not satisfied with how farmers and traditional authority work together	0.4	0.5	0.7	0.6
Difficulties in Rule enforcement in SIS	0.6	0.7	0.6	0.6

There is no one size fits all as the causal factors rank differently across the schemes, for instance the factor "satisfaction with farmers and traditional authority interaction" ranked higher in MFIS and NIS, which is evidence that there is friction between the two institutions. The RCI for rule enforcement was approximately equal across the four scheme. This revealed that rule enforcement, monitoring and sanctioning mechanisms across the schemes were ineffective. Sharaunga and Mudhara (2016) argued that "soft state" environment led to repeat offenders who were not brought to book and contributed to poor scheme performance.

5.4.5 Reliability of irrigation water provision

Reliability of irrigation water provision is a key parameter of the functionality of irrigation schemes. Water governance, which involves the strategies, policies, rules and regulation involved in water management, is a key determinant of irrigation water reliability. Operability, a function of human dimension, is dependent on the type of water scheduling that the scheme adopts and its

operation of the infrastructure (Sinyolo *et al.*, 2014b). The reliability of water access enables irrigation farmers to invest in higher-yielding crop varieties, this in turn leads to increased productivity, overall higher production hence poverty reduction (Fanadzo, 2012).

5.4.6 Water access and water sharing

Faurès and Santini (2008) highlighted that uncertainties regarding access to a reliable irrigation water supply makes an irrigation farmer reluctant to join irrigation schemes. It has been noted that access to irrigation, together with socio-economic, institutional and physical factors increase the chances of a household being water secure.

5.4.7 Ability and willingness to pay

Charging irrigation farmers for irrigation water should be done carefully because if prices are set too low, revenues may not be sufficient to cover the full costs of supplying water (Manzungu, 1999). On the other hand, if water prices are set too high, irrigation farmers may not be able to afford the new improved irrigation water supply. Therefore, to set the required water price, information on the ability of irrigation farmers to pay for such services is essential. Since pricing of water is a key component of an appropriate incentive for efficiency, sustainability and accountability, there is a need to research the demand for the service in order to understand the fundamental value that irrigation farmers place on the improved water service, so that the price that reflects the ability of the irrigation farmers to pay for the improved water services can be established. However, determination of the level of willingness to pay requires strong institutions that can allow a negotiated payment rate to be determined. The committees across the irrigation schemes in the study were not yet equipped to fulfil this mandate.

5.4.8 Land ownership

Property rights of water and land can improve ownership and accountability among users. Irrigation farmers in MRIS have rights to use land and water, but the access is not privately secured, hence traditional authorities can reallocate land to other users if it was deemed to be underutilised. Furthermore, water-use security was not guaranteed in the irrigation schemes, and the “use it or lose it” principle applies to all canal water users (Muchara, 2014). Lack of clarity of

the water access rights negatively impacts water management due to unreliability of supply and lack of commitment by some users to invest in infrastructure maintenance. Irrigation farmers who are satisfied with their land tenure participate more in irrigation management, than those who are not. Irrigation farmers with secure land tenure are willing to take responsibility of their water resource and partake in the governance of the scheme.

5.4.9 Awareness of national water policy

The water legislative policy in South Africa is linked to the current governance systems in irrigation schemes and how the whole system impacts provision of water to SIS. Understanding the linkages between water policies and users is important because lack of user cooperation, especially due to a knowledge gap about statutory instruments between users and regulatory bodies, can hamper public allocation of resources. This is in line with Backeberg and Sanewe (2010), who noted in his theoretical analysis of the South African National Water Act of 1998, that the reform process may take 10-20 years for the design of appropriate institutions and implementation of the water policy. Irrigation farmers that have a high governance index, which encompasses, satisfaction of stakeholder interaction in the schemes, satisfaction of informal institutions and the awareness of policy, have higher irrigation farmer participation. Irrigation farmers with a higher index participate more in management activities in the schemes.

5.4.10 Availability of water in the schemes

Water security (shown by the physical availability of water as well as irrigation farmers' willingness to pay for water) is influenced by socio-economic factors and institutional arrangements that are related to water access for irrigation farmers. Irrigation farmers who received irrigation training more positively view water availability and security. Irrigation farmers who perceived their access to and availability of water to be high are more likely to invest in irrigation agriculture and seek irrigation training; hence, they will tend to earn more in their framing.

5.4.11 Cooperatives membership

Irrigation farmers that belong to or are members of cooperatives are perceived to be more water secure. This is in line with the expected improvements to water access from membership.

Irrigation farmers who are part of cooperatives also participate more in scheme management.

5.4.12 Irrigation training

Irrigation training has a positive effect on the irrigation farmers' water security status. This implies that irrigation farmers who have had irrigation training tend to be more water secure. Irrigation farmers who have received irrigation training are also more likely to participate in water management than their counterparts. Irrigation training by irrigation farmers is perceived to improve efficient water utilisation at farm level, while well-defined appropriation rules is perceived to minimise free-riding, hence improve water-use security among users. Irrigation training improves irrigation farmers' understanding of the characteristics and requirements of water control infrastructure. Figure 5.7 revealed the varying proportions of irrigation farmers received irrigation training received across the SISs. MRIS had the highest percentage of irrigation farmers' who did not receive irrigation training (78.3%), followed by TFIS (75%), respectively.

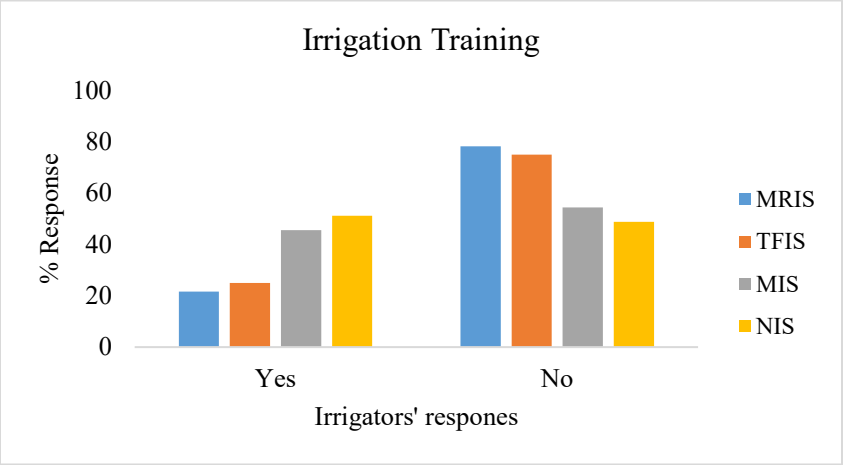


Figure 5.7: Irrigation farmers' responses with respect to irrigation training

Furthermore, the budget is constrained by unwillingness to pay leading to the non-payment for water (Figure 5.8). Water fees augment the O&M budget. Water subsidies are low and fail to cover the full cost of O&M, which subsequently leads to infrastructure deterioration. For MRIS one of the leading causal factors is poor institutional (government) engagement in the scheme. Institutional constraints such as lack of incentives motivates apathy towards infrastructure

maintenance. NIS recorded a high number of irrigation farmers willing to pay for water and contribute towards infrastructure maintenance, whereas MRIS had a high percentage of irrigation farmers unwilling to contribute towards infrastructure maintenance. This is evidenced by the poor infrastructure condition ratings in those schemes. This is the dilemma in irrigation as there is a cyclical endogenous relationship between participation in scheme activities, e.g. committee, payment of fees, etc. on one hand, and effectiveness of institutions. Poor irrigation service makes people unwilling to participate.

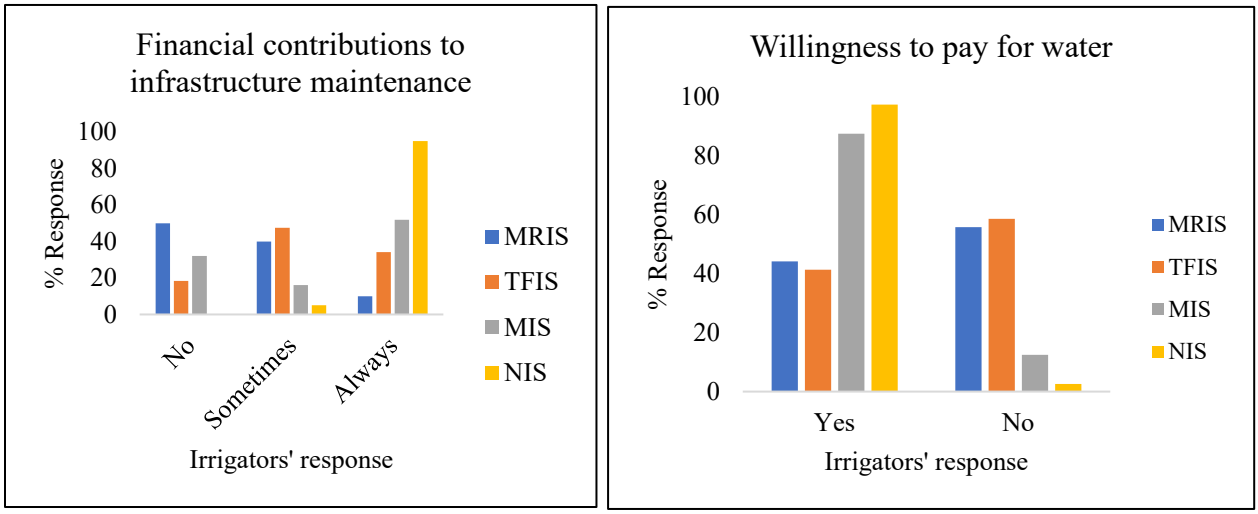


Figure 5.8: Irrigation farmers' responses with respect to irrigation service subsidy

The effects of poor financial contributions can be described by the vicious cycle illustrated in Figure 5.9. The cycle depicts a cause and effect scenario whereby water fees, financial contributions and irrigation fees determine the condition of the infrastructure. Poor institutional setting leads to poor irigation service, which in turn causes low crop yields, low incomes and low ability to pay for water. This determines willingness to pay for water. This loop leads to low cost recovery as irrigators cannot make contributes to operations and maintanance, and therefore ask for low water charges. The net effect is a low ability to pay for operations and maintanannce, which lead to poowr water conveynance. The cycle repeats itself.

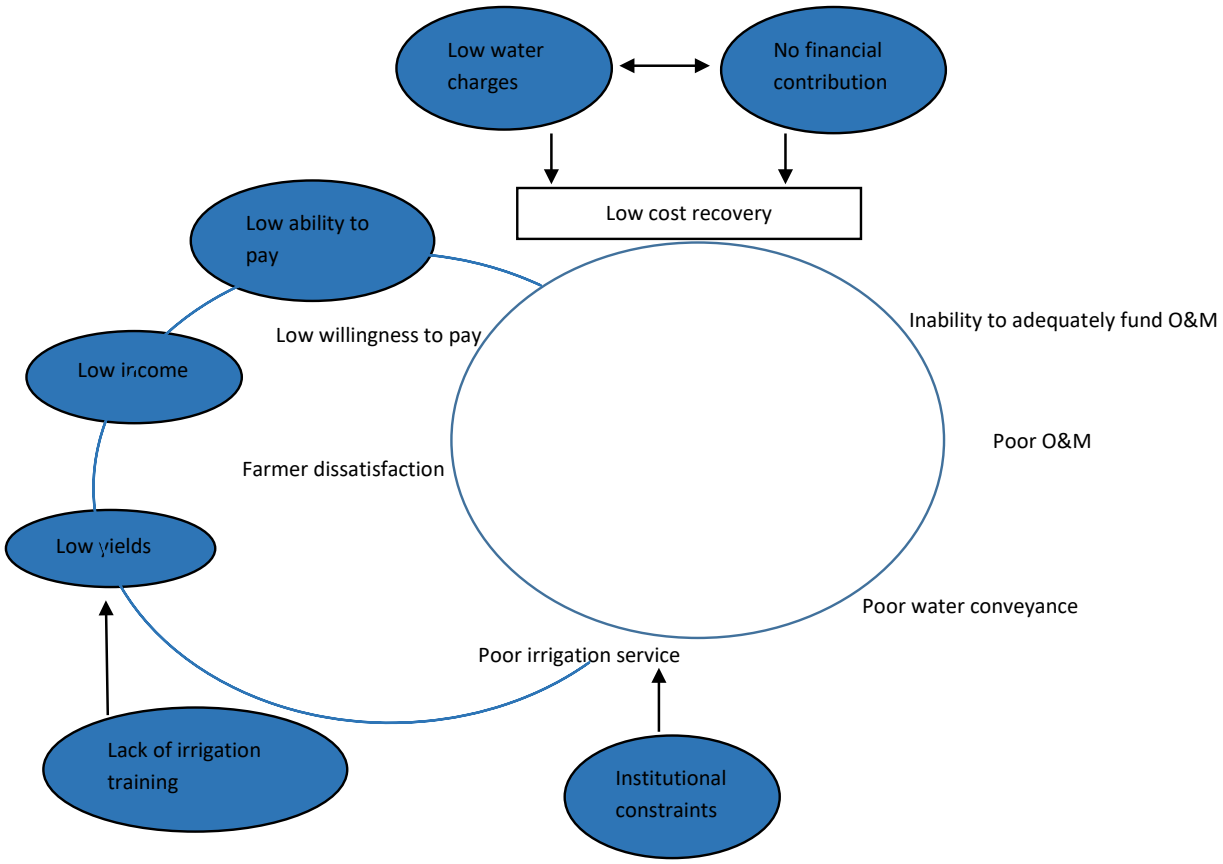
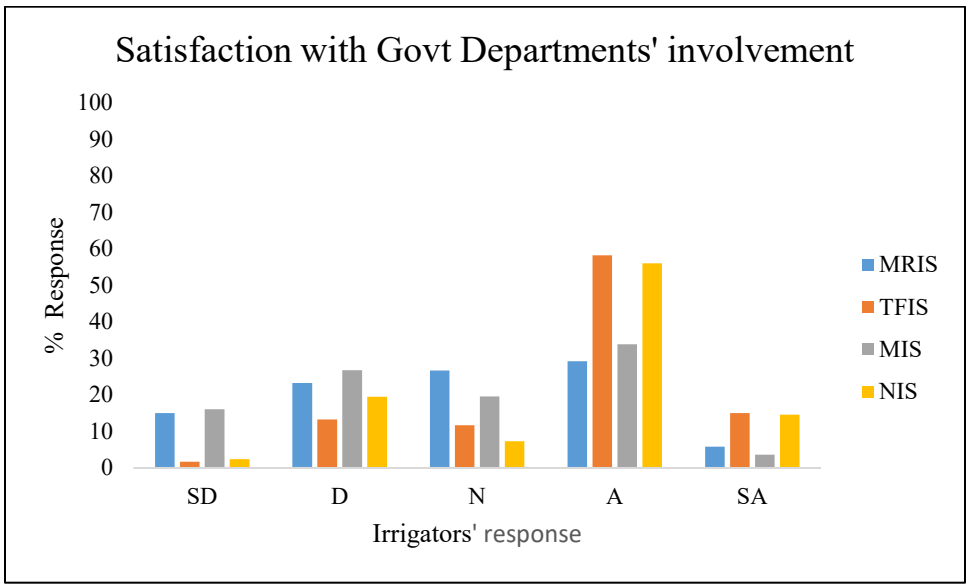


Figure 5.9: System cause-effect cycle in irrigation infrastructure management and scheme performance

NIS and MFIS have infrastructure that is relatively in good condition because irrigation farmers make water payments. Institutional involvement impacts on the condition of the irrigation scheme. Satisfaction with the government's involvement varied across the irrigation schemes. TFIS and NIS responded positively 58% and 56%, respectively, towards government's involvement in the irrigation schemes (Figure 5.10). MRIS had a high percentage of irrigation farmers who neither agreed nor disagreed (27%). Institutional involvement, as depicted in the vicious cycle, contributes significantly to infrastructure condition. In situations where irrigation farmers' perceive institutional support and involvement in scheme management as inadequate, poor infrastructure handling and management follows.



(Note: SD= Strongly Disagree, D= Disagree, N= Neutral, A= Agree, SA= Strongly Agree

Figure 5.10: Government's involvement in SISs

5.4.13 Extension support

The involvement of extension officers in the schemes is positively related to the irrigation farmers' water security status. Irrigation farmers in Msinga value the involvement of extension officers in irrigation schemes. NIS irrigation farmers expressed that they do not receive visits from extension officers and that they would like to get more services and help from the officers. However, the absence of extension officers has not adversely affected the irrigation water management as the irrigation farmers have set up strong management committees. Nevertheless, a regular check of irrigation activities by irrigation farmers could motivate them to perform better.

5.4.14 Irrigation committee membership

Perceptions were also pursued on the effectiveness of irrigation committees, and their capacity to ensure and improve water security and achieve improved irrigation performance. Respondents who perceive the committees to be effective also tend to perceive that they have greater water availability. Furthermore, the causality is more likely to reflect that respondents who perceive to have greater water availability are more likely to be satisfied with the performance of the irrigation committees and will tend to perceive them to be efficient. Weak committees signify ineffective

institutions, often lacking the will and capacity to enforce appropriation rules that ensure equitable sharing of water resources and costs. The more irrigation farmers make themselves available to irrigation committees, the higher the likelihood of them being water secure.

5.4.15 Traditional leadership

The irrigation schemes are governed by both informal and formal rules known to the users. However, rule enforcement is always viewed as the major challenge leading to the collapse of infrastructure and inequitable sharing of resources in the schemes. Traditional leadership is positively related to water security. This is supported by Muchara (2014a). The study also found traditional leaderships were also positively related to water use security. Although irrigation committees serve as recognised and accepted institutions to address problems of provision and sharing of irrigation water, a number of other players were involved in the formulation and enforcement of water use rules.

5.4.16 Factors affecting welfare of water users

Subsistence agriculture, involving both crop and livestock production, forms the basis of the rural area people's livelihood and plays a significant role in the welfare of the poor. The participation of smallholder irrigation farmers in irrigation schemes is perceived as one of the most important government intervention for poverty alleviation. Sinyolo *et al. (*2014a) indicated that smallholder irrigation access plays a positive role in improving household welfare. The implication of this finding is that, when operational, smallholder irrigation schemes play an important role in poverty reduction in the rural areas of South Africa.

The results suggests that an ageing irrigation farmer population dominates irrigation farmers, with the much younger generation moving to more lucrative and higher paying ventures in the non-farm sectors. Most of the irrigation farmers participating in the smallholder irrigation schemes were between the ages 60-69, followed by the 50-59 age group. The smallest age group is 80-89, which is the elderly, followed by the youth between the ages 20-29. The mean age among these irrigation farmers is 54. Discussions with the irrigation farmers indicated that the youth are shunning away from the agricultural sector because it pays less compared to other sectors. NIS irrigation farmers felt that the government is not doing enough to educate and equip the youth with

the requisite skills and to attract the youth into undertaking farming as a long-term business. The limited viability of agriculture, particularly due to lack of markets, demotivate participants, particularly the youth from exerting effort to excel in irrigation farming.

5.4.17 Education

Majority of the irrigation farmers are not educated. Most of these irrigation farmers have no formal education but rather use their indigenous knowledge when farming. Although they receive agricultural training from the government, it is not sufficient on its own. They lack tertiary education, which could increase their financial knowledge as well as enhance their farming practices.

5.5 Summary

The study assessed various facets that have a bearing on the effectiveness of governance dimensions in SIS. These governance dimensions comprise Acts, policies, strategies, rules and regulations. First, formal and informal institutional settings co-exist at irrigation schemes. This co-existence of two types of institutions with overlapping functions partly causes dysfunction in the implementation of strategies, rules and regulations. Government policies, rules and regulations tend to be dynamic and have to interact with static traditional institutions and rules. Government instituted programmes, such as IMT, PIM and WUAs, have not become across irrigation schemes. Instead, local concocted governance setting prevail, namely, rules, regulations and institutions. The perceptions of the effectiveness of traditional rules among irrigation farmers differs with level of commercialisation in the scheme. In irrigation schemes operating close to the subsistence level, namely, MRIS and TFIS, both males and females are satisfied with land allocation, which happens through the traditional authorities. However, irrigation farmers in more commercial-oriented schemes (NIS and MFIS) find lack of title deeds and the vagueness in tenure systems to be frustrating and to be hindrances to their investment decisions.

The effectiveness of governance could express itself through many aspects of irrigation, namely, water management, water security, irrigation farmer and stakeholder participation, infrastructure management, etc. Some of these effects translate to different levels of equity in resource allocation in schemes, adequacy and reliability of water provision, sustainability in scheme management and

household welfare. It is evident that the relationship between rules and regulations in governance and the factors determining their effectiveness is not linear but cyclical and complex. Factors that contribute to the effectiveness of policies, rules and regulations are many and include the training people received and their perceptions of various issues taking place in the schemes, for example gender, fairness in water distribution in the scheme, availability of water rights, irrigation farmer participation in irrigation management, water distribution, reliability of irrigation water provision, water access and water sharing, ability and willingness to pay, land ownership, awareness of National Water Policy, availability of water in the schemes, irrigation training and education and irrigation committee membership. These factors interact on their own, as they tend to be endogenously determined, thus can be mutually reinforcing or contradictory. In any case, the level of effectiveness of governance is based on perceptions that irrigation farmers have, which also depends on many factors characterizing irrigation farmers. On the other hand, the perceived effectiveness has a self-reinforcing feedback effect on how people respond to different roles and responsibilities within the schemes.

It is recommended that the informal and formal institutions in irrigation schemes be harmonized. In addition, gender equity should be prioritized. Educational programmes should be undertaken to make irrigation farmers aware of the different government initiatives. Emphasis should be placed on irrigation and water management training. Stakeholder should also be sensitized and be fully aware of government initiatives and the need for coordinated execution of interventions.

CHAPTER 6: EFFECTS THAT POLICIES, STRATEGIES, RULES AND REGULATIONS CAN HAVE ON IRRIGATION PERFORMANCE

6.1 Introduction

This chapter looks at the effects that policies, strategies, rules and regulations have on irrigation performance. The framework adopted in conducting the study is first presented. +

6.2 Findings

6.2.1 Descriptive analysis of household demographics characteristics

Survey results revealed that 92% of the irrigation farmers in TFIS rely on family labour to work the lands, 66% in MRIS, 29% in NIS and 27% in Makhatini. The study revealed that MRIS had the largest proportion of elderly irrigation farmers with 58% of the irrigating population being 56 years and older (Table 6.1). NIS had the highest youth population involved in irrigation (32%) and Makhatini had highest proportion of middle-aged irrigation farmers across the schemes. Overall, the bulk of irrigation farmers in MRIS were females (84%) as compared to males (16%). TFIS, Mooi and MFIS had high proportions of female irrigation farmers. On the other hand, NIS was different as it had 68% of males irrigating.

Table 6.1: Sample size drawn from different irrigation schemes

Irrigation scheme	Population size	Sample Size
MRIS	850	120
TFIS	1500	120
MFIS	714	44
NIS	100	34
Total		318

Mooi River Irrigation Scheme (MRIS), Tugela Ferry Irrigation Scheme (TFIS), Flats Irrigation Scheme (MFIS) and NIS Irrigation Schemes (NIS)

Mooi-River and TFIS irrigation farmers had the least formal education with 65% and 59% of the irrigation farmers with no formal education, respectively. NIS had the highest percentage of its irrigation farmers that received tertiary education (21%). Nineteen percent (19%) of irrigation

farmers in MRIS had primary school education, 28% in TFIS, 24% in NIS and 39% in MFIS. The numbers drop marginally for secondary education (Table 6.2).

Table 6.2: Survey results of the scheme demographics

Variable		Irrigation scheme			
		MRIS (n=120)	TFIS (n=120)	NIS (n=34)	MFIS (n=44)
Age (%)	Youth (18-35)	10	8	32	18
	Mid-aged adults (36-55)	32	34	38	36
	Older adults 56+	58	50	30	46
Gender (%)	Male	16	12	68	23
	Female	84	88	32	77
Education level (%)	No formal	64.7	59.2	23.5	25
	Primary	19.3	28.3	23.5	38.6
	Secondary	13.4	11.7	32.3	29.5
	Tertiary	2.5	0.8	20.6	6.8

Mooi River Irrigation Scheme (MRIS), Tugela Ferry Irrigation Scheme (TFIS), Makhathini Flats Irrigation Scheme (MFIS) and NIS Irrigation Schemes (NIS)

In NIS 32% of its irrigation farmers classified as having attained secondary schooling and 30% for MFIS. Age and education level showed a statistically significant negative correlation ($p < 0.01$). The older members tend to have lower education levels. This negative relationship occurs across all the irrigation schemes (Table 6.3).

Table 6.3: Correlations between age and education

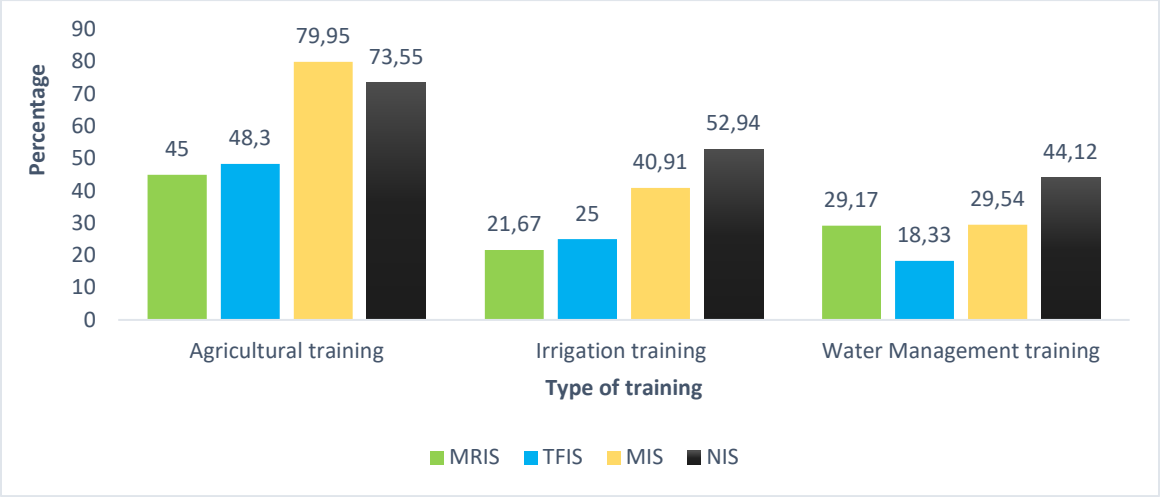
Irrigation scheme	Correlation coefficient	Sig. level
MRIS	-0.380	***
TFIS	-0.422	***
MFIS	-0.687	***
NIS	-0.580	***
Overall	-0.504	***

*** = p<0.01; Mooi River Irrigation Scheme (MRIS), TFIS Irrigation Scheme (TFIS), Makhathini Flats Irrigation Scheme (MFIS) and Ndumo Irrigation Schemes (NIS)

6.2.2 Skills and training, land ownership, income and expenditure information, social capital

6.2.2.1 Training

Irrigation farmers require training as it is a vital element for skills development that they need throughout in their work. Training is assumed to positively contribute towards the performance of irrigation farmers and for sustainable agricultural development. Figure 16 shows the types of training that irrigation farmers have received across the four irrigation schemes.



Mooi River Irrigation Scheme (MRIS), TFIS Irrigation Scheme (TFIS), Makhathini Flats Irrigation Scheme (MFIS) and Ndumo Irrigation Schemes (NIS)

Figure 6.1: Frequency of irrigation farmers who received training across irrigation scheme

The results revealed that the majority of irrigation farmers have not received agricultural, irrigation and water management related training. Only irrigation farmers from NIS and MFIS had a majority who received agricultural training. According to Chirigo (2014), MFIS irrigation farmers receive training programmes from the Department of Agriculture and agricultural extension officers from Mjindi Farming Trust. Less than 50% of irrigation farmers from Mooi Tiver, TFIS and MFIS indicated that they received irrigation and water management related training. In NIS, 53% of irrigation farmers received water management training. Furthermore, these variations in skills and training obtained across irrigation schemes were statistically significant ($p<0.01$). This supports Mvelase (2016) who states that the majority of SISs irrigation farmers lack skills and knowledge

in crop production, irrigation, water management and farm management. Therefore, irrigation farmer training is needed to improve the knowledge they have, to promote the optimal and efficient use of scarce water resources.

6.2.2.2 Land Ownership

SIS irrigation farmers occupy relatively small plots, which tend to inhibit expansion of their farming operations to commercial scale (Mvelase, 2016). Survey results indicated that irrigation farmers in MRIS, TFIS and MFIS occupy relatively small plots with an average size of 0.54, 0.23 and 1.04 ha, respectively. However, in MRIS and TFIS they perceived the amount of land they have as enough for their needs. Irrigation farmers in MFIS perceived their plot sizes as too small. On the other hand, irrigation farmers from NIS consider themselves as commercial farmers, thus believed that the average size (8.83 ha) of plots they have are also too small. Plot sizes across irrigation schemes were statistically significantly different ($p<0.01$). This suggests that irrigation farmers do not have uniform plot sizes across these irrigation schemes. NIS stands out with its irrigation farmers having bigger plots.

The four irrigation schemes are all located in rural areas where traditional authorities are responsible and have a major stake in land allocations (Mvelase, 2016). This is indicated by the dominant type of land ownership across these irrigation schemes. Figure 17 shows that most irrigation farmers from all the four irrigation schemes held land in the form of traditional allocation, inherited and given by relative. Leasing land was only dominant in MFIS.

Despite occupying traditionally allocated land, inherited land or land given by a relative, not all land is registered in the irrigation farmers' names. Only 45%, 51%, 32% and 79% irrigation farmers from MRIS, TFIS, MFIS and NIS, respectively, indicated that the plots they were using were registered in their names. Moreover, these variations in land ownership across irrigation schemes were statistically significant ($p<0.01$), implying that the way irrigation farmers acquire land for farming varies across irrigation schemes.

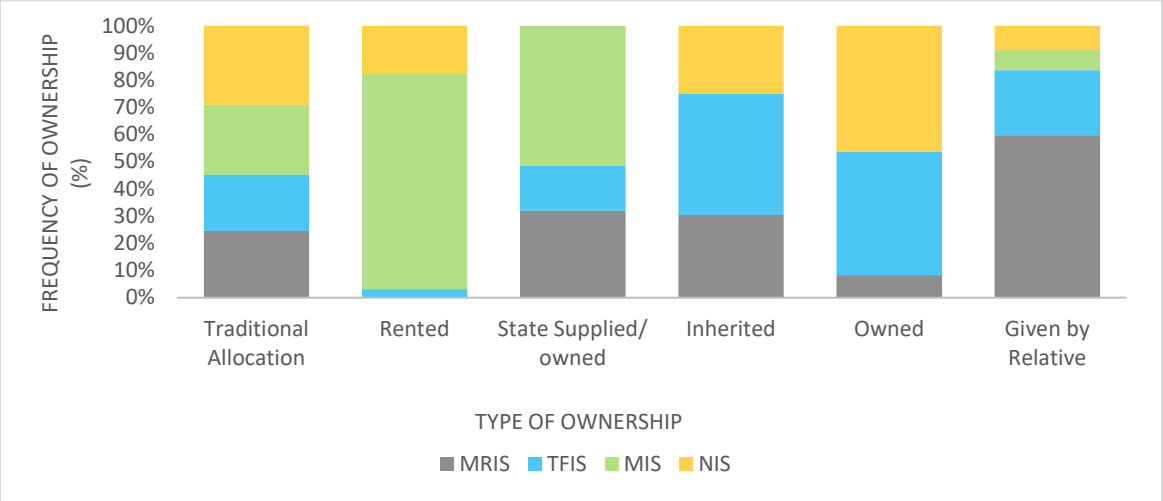


Figure 6.2: The distribution of land ownership across irrigation schemes

The survey also revealed statistically significant variations (at 1% level) in irrigation farmers' responses with respect to their satisfaction with land allocation across the four irrigation schemes. About 43.3%, 43.3%, 11.6% and 66.7% irrigation farmers from MRIS, TFIS, MFIS and NIS, respectively, "agree" that they were satisfied with how land was allocated among irrigation farmers. However, only 11.7 and 6.7 percent irrigation farmers from MRIS and TFIS "strongly agreed" to be satisfied with land allocations. These findings (Table 6.4) indicate some level of disgruntlement with land allocation among irrigation farmers across these irrigation schemes.

The responses from Table 6.4 were further supported by the land tenure satisfaction indicated by irrigation farmers across the irrigation schemes. According to Roth and Haase (1998), "land tenure security is the individual's perception of his/her rights to a piece of land on a continual basis, free from imposition or interference from outside sources, as well as the ability to reap the benefits of labour or capital invested in land, either in use or upon alienation". In this study, about 80%, 75.8% and 90.9% from MRIS, TFIS and NIS, respectively indicated that they were satisfied with the tenure security of their land. While in MFIS, 34.9% irrigation farmers disagreed, and 16.3% irrigation farmers strongly disagreed that they were satisfied with land allocation. This suggests that for MFIS irrigation, irrigation farmers terms of land allocation are not protected and they fear that someone would come and claim their land. Furthermore, only 48.8% irrigation farmers indicated that they were satisfied with their land tenure security.

Table 6.4: Distribution of irrigation farmers' level of satisfaction with land allocation across irrigation schemes

Satisfaction with land allocations	MRIS (%)	TFIS (%)	MFIS (%)	NIS (%)	X^2 Sig. level
Strongly disagree	2.5	10.8	16.3	6.10	***
Disagree	22.5	30.0	34.9	21.2	
Neutral	20.0	9.2	37.2	6.10	
Agree	43.3	43.3	11.6	66.7	
Strongly agree	11.7	6.7	0	0	

***Statistically significant at p<0.01

The results also suggest that the types of land ownership not a significant determinant of security of tenure. Despite traditional land allocation being dominant, most irrigation farmers were contented with their security of tenure.

6.2.2.3 Social Capital

Social capital relates to the social interrelations in which people draw in pursuit of different livelihood strategies. Social groups act as safety nets mechanism to meet shortfalls in the consumption needs as it provides access to other assets/ resources. In rural areas, membership of smallholder irrigation farmers to social groups usually outweighs that of more formalized irrigation farmer associations and cooperatives. When comparing social capital across irrigation schemes; the majority of irrigation farmers from MRIS and TFIS were social group members while irrigation farmers in MFIS and NIS were mostly cooperative group members (Table 6.5). Some irrigation farmers belonged to both groups, while others did not belong to any.

Table 6.5: Distribution of membership in social and cooperative capital across the scheme

Membership	Irrigation scheme				X^2 Sig. level
	MRIS (%)	TFIS (%)	MFIS (%)	NIS (%)	
Cooperative member	18.33	21.67	79.55	85.29	***
Social group member	61.67	61.67	59.09	39.39	ns

*** *statistically significant at p<0.01; ns= not significance*

In addition, these distributions in cooperative membership across the four irrigation schemes were

statistically significant ($p<0.01$). Irrigation farmers from NIS mostly rely on farmer organisations, while those from Msinga depend less on cooperatives. A large percentage of MFIS and NIS irrigation farmers involved in farmer groups could be that they consider them as convenient ways of accessing new information and other resources (Stevens and Ntal, 2011). Government programmes may also contribute to the extent to which irrigation farmers belong to cooperatives.

6.2.2.4 Information

Information is a vital element for the success and sustainability of irrigation schemes. Through information, irrigation farmers are always updated on important information they need such as product prices in the market, outbreak and prevention of diseases. In this study, irrigation farmers were asked to indicate their perception about the importance of information source in providing useful agriculture-related information. Table 6.6 summarizes the responses irrigation farmers across the schemes provided.

Table 6.6 show statistically significant variation on irrigation farmer perceptions about the importance of information source in providing useful agriculture-related information. Irrigation farmers rely on different information sources across irrigation schemes. The availability and accessibility of information sources in each irrigation scheme influences irrigation farmer perceptions. NIS irrigation farmers perceived all information sources except academic institutions, as providing important information about farming activities. Likewise, MRIS and TFIS irrigation farmers perceived all information sources, except private organisations, academic institutions and NGOs (for MRIS) as providing important information about farming activities. While, MFIS irrigation farmers perceived internet, academic institutions and traditional leaders as not providing important information about farming activities. Academic institutions were perceived as an unimportant information source in all irrigation schemes.

Table 6.6: Irrigation farmer perception about the importance of household information sources

Information source	Irrigation Scheme				X^2 Sig. level
	MRIS **(%)**	TFIS **(%)**	MFIS **(%)**	NIS **(%)**	
Extension Officers	63.30	81.70	56.80	79.40	***
Media	50.00	53.30	52.30	70.60	***
Internet	58.00	50.00	18.20	50.50	***
Fellow Farmers	79.20	79.20	61.40	82.40	***
Community Meetings	75.80	83.30	56.80	87.90	***
Irrigation committee	60.80	74.20	72.70	91.20	***
NGOs	33.30	55.50	61.40	82.40	***
Private Organisations	17.50	24.20	45.50	76.50	***
Academic Institutions	12.50	29.20	29.50	64.70	***
Traditional Leaders	58.30	56.70	20.50	64.70	***
Cooperatives	50.00	60.80	68.20	94.10	***

*** = $p < 0.01$

6.2.3 Challenges experienced in the SIS

Challenges were ranked using a 5-point Likert scale, where 5 means strongly agree and 1 means strongly disagree. Significant differences in perceptions of challenges exist across schemes for all dimensions of challenges (Table 6.7). MFIS and TFIS tended to agree that plots are not readily available. TFIS irrigation farmers tended to agree that their irrigation scheme is too far from homesteads. MRIS irrigation farmers tended to stand out in their belief that people use water illegally.

Irrigation farmers generally pointed that members paid for water use, especially in TFIS and NIS, and less so in MRIS and MFIS. Farmers in MRIS generally tended to think that people did not participate in the irrigation scheme compared to other schemes, especially NIS.

MRIS and MFIS irrigation farmers tended to feel that their irrigation schemes are in poor condition, compared to TFIS and NIS. TFIS was rehabilitated in 2015, while NIS is a relatively new scheme. NIS and MRIS irrigation farmers tended to agree that there is a water shortage. TFIS and MFIS farmers are close to neutral. Only NIS and MFIS irrigation farmers do not see unauthorised handling of the infrastructure. All other schemes are confronted with unauthorised handling of water infrastructure.

Table 6.7: Challenges faced across that irrigation schemes

Challenge	MRIS	TFIS	MFIS	NIS	Level of sig.
Not enough plots available in the scheme	3.01	3.77	3.53	3.26	***
Irrigation scheme is too far from the homestead	2.67	3.62	2.25	2.18	***
People use water illegally	3.37	2.23	1.73	1.71	***
There is lack of market access for farm produce	3.68	3.97	3.77	3.97	n.s.
Farmers are not willing to pay for water use	2.68	2.08	2.73	1.97	***
People benefit from irrigation water but do not participate in the scheme	3.43	2.75	2.86	1.79	***
Infrastructure is in poor condition	3.24	2.59	3.18	1.85	***
There is not adequate water supply in the scheme	3.41	2.55	3.05	3.65	***
Unauthorized handling of water infrastructure	2.76	2.57	2.64	2.00	***
Not satisfied with the condition of infrastructure	3.10	2.78	2.93	3.68	***
Management does not commit to infrastructure upgrade, rehabilitation and maintenance	2.93	2.68	3.14	3.71	***
n	120	120	43	34	

**** = p <0.01; ns = not statistically significant*

NIS scheme irrigation farmers tended to stand out in their belief that infrastructure is not is satisfactory condition. On the other hand, MRIS irrigation farmers are in second place in perceiving that the irrigation infrastructure is not in good condition. MRIS and TFIS irrigation farmers are more inclined to believe that their management are less committed to infrastructure upgrading, compared to those in MFIS and NIS.

6.2.4 Constituents of effectiveness

This section discusses how water availability and irrigation, scheme governance, irrigation farmer participation, irrigation water law and how they underpin scheme effectiveness.

6.2.4.1 Water Availability

Water is less reliable in Mooi and MFIS than the other two irrigation schemes. TFIS and NIS had the highest proportions of irrigation farmers who strongly "agreed" that water was reliable (Table 6.8). A similar pattern emerged regarding getting water, with irrigation farmers in Mooi and MFIS, either "disagreeing" or "strongly disagreeing" that water was reliable. Mooi stood out in "disagreeing" that "water is sufficient" for cropping activities. Other areas agree that water is "sufficient for cropping requirements".

The commercialisation of the irrigation dictated the ability of the irrigation farmers to pay for water. Mooi and TFIS have the highest percentage of producers operating at below commercial levels. Therefore, one also sees that they are less concerned about water.

NIS irrigation farmers are more prone to perceive that water distribution/sharing is fair. All irrigation farmers agreed with the statement that "water distribution is fair". This suggests that water allocation is more equitable in NIS. TFIS irrigation farmers also tended to believe that water allocation was fair. Mooi irrigation had the highest proportion who disagreed that water distribution is fair. This was expected. MRIS irrigation has up-stream irrigation farmers accessing water perpetually, while those at the tail end have no access to water or very unreliable access.

Accountability of agencies can be credited for the satisfactory performance of NIS, MFIS and TFIS irrigation schemes (Uphoff *et al.*, 1991). The irrigation farmers identify themselves more as clients and the agencies (Mjindi) depend on water payment collections compelling them to provide an effective service for their clients. The development supports Alba *et al.* (2016) who stated that agencies operating in typical smallholder irrigation schemes double efforts involved in O&M to increase the irrigation farmers capacity to pay for fees.

Table 6.8: Water Availability across irrigation schemes

Irrigation Scheme	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	n	X^2 sig. level
Water is reliable							
MRIS	15.8	28.3	6.7	37.5	11.7	120	
TFIS	2.5	1.7	6.7	59.2	30.0	120	***1
MFIS	6.8	27.3	20.5	45.5	0.0	44	
NIS	0.0	2.9	5.9	61.8	29.4	34	
Always get water in the plot							
MRIS	27.5	33.3	4.2	25.0	10.0	120	
TFIS	2.5	5.0	8.3	45.0	39.2	120	***
MFIS	2.3	31.8	6.8	59.1	0.0	44	
NIS	0.0	0.0	9.4	65.6	25.0	32	
Water is sufficient for cropping requirements							
MRIS	17.5	42.5	10.8	23.3	5.8	120	
TFIS	1.7	5.9	7.6	51.3	33.6	119	***
MFIS	4.5	6.8	13.6	75.0	0.0	44	
NIS	0.0	2.9	5.9	64.7	26.5	34	
Have the ability to pay for water-related services							
MRIS	28.3	30.8	16.7	20.0	4.2	120	
TFIS	21.7	19.2	14.2	41.7	3.3	120	***
MFIS	2.3	4.5	6.8	70.5	15.9	44	
NIS	0.0	2.9	2.9	70.6	23.5	34	
Water distribution/sharing at farm level is fair							
MRIS	15.8	24.2	16.7	39.2	4.2	120	
TFIS	4.2	6.7	10.0	45.8	33.3	120	***
MFIS	2.3	11.4	29.5	50.0	6.8	44	
NIS	0.0	0.0	5.9	67.6	26.5	34	

*** = $p < 0.01$

6.2.4.2 Scheme governance and participation

NIS farmers are most inclined to be aware of the National Water Law (NWA) (Table 6.9). TFIS and MFIS farmers are least aware of the NWA. MRIS farmers are also more likely to be unaware of the NWA. A similar pattern emerges for awareness of National Water Resources Strategy (NWRS), with NIS farmers being most aware compared to the other areas. NIS farmers are most

inclined to be knowledgeable of government aims with respect to smallholder irrigation schemes. TFIS and MFIS farmers are lest aware of the NWA. MRIS farmers are also more likely to be unaware of the NWA. MRIS farmers were mostly neutral, while TFIS and MFIS were more likely to be unaware of government intentions of irrigation schemes.

MFIS irrigation farmers are less inclined to be satisfied with land allocation. This is possibly because of the existence of different tenure regimes coexisting in the same scheme. All other schemes are more inclined to be satisfied with land allocation. Nevertheless, irrigation farmers across all schemes tend to agree that the manner in which land is allocated should be changed. There is need to pursue this issue to determine the manner in which they envisage the change to be. There are differences in the assessment of fairness of water allocation within the irrigation schemes. However, in general, irrigation farmers have a positive outlook regarding water allocation. TFIS farmers are most inclined to perceive that water allocation as poor, while MFIS farmers are least inclined to perceive water allocation to be fair.

There are differences in the assessment of fairness of scheme rules. Irrigation farmers have a positive outlook regarding scheme rules. NIS farmers are most inclined to perceive that scheme rules are fair, while MFIS farmers are least inclined to perceive scheme rules to be fair. Farmers in MFIS have a negative outlook regarding the ease of enforcing scheme rules. All other schemes tend to me only marginally negative in their assessment of the ease of enforcing scheme rules. All irrigation farmers marginally agree that penalties for failure to comply with rules are fair. Farmers in MRIS mostly hold this opinion, which is least in MFIS. Generally, irrigation farmers have a positive outlook in their perceptions of cooperation between blocks and between farmers. However, TFIS irrigation farmers stand out in their satisfaction with the level of cooperation between blocks and between farmers. NIS and TFIS farmers are more of the opinion that water users are always willing to contribute to the maintenance of infrastructure and equipment. MFIS farmers are least likely to believe so. MFIS farmers are least likely to be satisfied with the manner in which water conflicts are handled.

Table 6.9: Comparisons of governance measures across different irrigation schemes

Variables[1]	MRIS	TFIS	MFIS	NIS	Level of sig.
Awareness of NWA	2.03	1.63	1.75	2.91	***
Awareness of NWRS	1.92	1.54	1.84	2.47	***
Knowledge of Government Aims	2.50	2.22	2.20	3.47	***
Availability of Water license	2.81	2.60	2.64	2.47	n.s.
Satisfied with Land Allocations	3.39	3.05	2.44	3.33	***
Should Terms of Land Allocation Change	3.48	3.30	3.57	3.67	n.s.
Fairness in Water Allocation Rules	3.50	4.04	3.25	3.64	***
Fairness in the Scheme Rules	3.58	3.96	3.34	3.79	***
Rules in the Scheme are Hard to Enforce	2.98	2.54	3.52	2.67	***
Penalties for failure to comply with the rules are fair	3.72	3.68	3.11	3.64	***
Satisfied with the Cooperation between Blocks and Farmers	3.80	4.27	3.63	3.88	***
Water users are always willing to contribute to the maintenance of infrastructure and equipment in the scheme	3.52	4.10	3.32	4.18	***
Satisfied with the management of water conflicts	3.58	3.86	3.11	3.88	***
Satisfied with the involvement of Tribal Authority	3.53	3.43	2.09	3.76	***
Satisfied with the involvement of DAFF	2.61	3.34	2.84	4.12	***
Satisfied with the involvement of DRDLR	2.43	3.18	2.57	3.62	***
Satisfied with the involvement of DWAS	2.44	2.93	2.43	2.38	***
Satisfied with the involvement of Government Departments	2.88	3.72	2.77	3.79	***
Satisfied with the involvement of NGOs	2.88	3.27	3.37	3.91	***
Satisfied with the involvement of Farmers in Making Rules	3.88	4.15	3.66	3.94	***
Satisfied with the Current Executive Committee	4.01	4.09	4.00	4.06	n.s.
The election process of the executive committee is fair	4.12	4.22	3.93	4.41	*
Satisfaction with the contribution of the traditional council in irrigation management	3.78	3.57	2.42	3.35	***
Satisfied with the traditional council's level of understanding of the rules	3.77	3.61	2.23	3.32	***
Satisfied with the level of contribution of the traditional council in rule enforcement	3.82	3.40	2.25	3.21	***
Satisfied with the way the farmers and traditional authorities work in the scheme	3.81	3.47	2.45	3.29	***

Variables[1]	MRIS	TFIS	MFIS	NIS	Level of sig.
Satisfied with the youth's involvement in irrigation scheme management	2.93	3.42	3.16	3.35	**
Satisfied with the youth's level of understanding of scheme rules	2.92	3.48	3.18	3.48	***

*** = p <0.01; ** = p< 0.05; * = p< 0.1; ns = not statistically significant*

[1]Measured on a likert scale of 0-5, where 5 is strongly agree, 3 is neutral and o is strongly disagree

MFIS irrigation farmers are also least likely to be satisfied with the involvement of the tribal authorities in the scheme management, their understanding of scheme rules and their contribution to scheme rule enforcement and their cooperation with the irrigation farmers. This clearly points to the uniqueness of MFIS regarding the manner in which the irrigation farmers interact with the traditional authorities. MFIS and MRIS irrigation farmers are less satisfied with involvement of Department of Agriculture, Forestry and Fisheries and Department of Rural Development and Land Reform compared to the other two schemes. TFIS had recently been rehabilitated, while MFIS has strong support from most government departments. Farmers probably cannot differentiate between the two departments. Farmers are only generally marginally satisfied with Department of Water and Sanitation, with NIS being the least satisfied. This low level of satisfaction could be due to the fact that the departments generally work though other agencies, rather than dealing directly with the irrigation farmers. Farmer in TFIS are most satisfied with their own involvement in making rules at scheme level. MFIS farmers are the least satisfied. All schemes are generally satisfied with their executive committees, including its election process. The involvement of youths is considered least satisfying in MRIS compared to other irrigation schemes.

6.2.4.3 Proxies of governance and participation

Principal Component Analysis (PCA) was used for reducing the multiple dimensions of different measures of governance. Table 6.10 shows the summaries of the proxies obtained from the PCA. Traditional authorities are an integral part of the SIS, since they are located in the communal areas. This is particularly for Msinga-based irrigation schemes, which have been in existence for the longest. This seems to suggest that the influence of tribal authorities becomes important and

indeed contribute to better performance of irrigation schemes. However, there are significant differences in the index for effect of traditional authorities across the schemes. The greatest positive effect is in MRIS, followed by TFIS and is least in MFIS. MFIS has more prevalence of trusts, such that irrigation farmers might not strongly value the role of traditional authorities, despite that the trusts operate under their jurisdiction.

Table 6.10: Proxies of participation across irrigation schemes

Irrigation Scheme	Factor Level	TFIS	MFIS	NIS
Participation of traditional authorities				
MRIS	0.3883783	***	***	ns
TFIS	0.0799934		***	***
MFIS	-1.1409970			***
NIS	-0.1406659			
Contribution of government departments				
MRIS	-0.3926402	***	ns	***
TFIS	0.3047243		***	**
MFIS	-0.2720842			***
NIS	-0.7112409			
Poor functioning of local committees				
MRIS	0.1152102	ns	ns	*
TFIS	-0.0632884		ns	ns
MFIS	0.0052806			ns
NIS	-0.2514182			
Poor participation of youths				
MRIS	0.2239085	***	ns	ns
TFIS	-0.1691731		ns	ns
MFIS	-0.0365330			ns
NIS	-0.1001621			

**** = p <0.01; ** = p< 0.05; * = p< 0.1; ns = not statistically significant*

The positive contribution of government departments is evident in TFIS and NIS. NIS's index is statistically different from those of the other schemes. This is expected, as it is the most recently established scheme. Government has implemented programmes to improve production. MRIS

and MFIS have the lowest indices with respect to government support.

Generally, the irrigation schemes do not statistically significantly differ in their perceptions of participation of local committees in their governance. The index is low to negative, suggesting a poor effectiveness of local committees in ensuring functionality of irrigation schemes. A significant difference existed between MRIS and NIS. Local committees were considered less effective in MRIS than in NIS. This was expected as MRIS irrigation scheme water sharing mechanisms are generally poorly coordinated, resulting in water shortages in the lower blocks.

MFIS, NIS and TFIS did not differ in their perceptions of participation of youths in the governance of irrigation schemes. MRIS and TFIS differed significantly. MRIS irrigation farmers being of the opinion that youth participation is lower compared to TFIS.

6.2.4.4 Farmer participation in scheme governance

Tables 6.11-20 captures the level of farmer participation across schemes. The survey further assessed members' contributions to the management of their respective schemes. Seventy one percent of the irrigation farmers indicated unwillingness to participate in scheme management. MRIS irrigation farmers are more likely not to want to participate in scheme management. NIS has the highest percentage of irrigation farmers who would be willing to participate in scheme management, followed by MFIS. However, there are no statistically significant differences between the schemes in this regard. Table 6.11 shows that a similar picture emerges for willingness to contribute financially towards irrigation maintenance. Despite these differences, most members from the irrigation schemes are willing to always attend meetings (Table 6.12). More than 90% of the irrigation farmers across the schemes are willing to "sometimes" or "always" take part in scheme meetings.

Regarding participation in training, NIS and TFIS irrigation farmers are more receptive to training. MRIS and MFIS irrigation farmers are less receptive to training. Further enquiry is required to determine the local sensitivities that could be contributing to the differences in willingness to participate in training.

Table 6.11: Farmer Financial participation

Irrigation Scheme	**None (never involved) (%)**	**Sometimes (%)**	**Always (%)**	**n**	**Sig. Level**
Contributing finance towards irrigation pump maintenance					
MRIS	59.2	32.5	8.3	120	
TFIS	19.2	45.0	35.	120	
MFIS	27.3	15.9	56.8	44	***
NIS	2.9	0	97.1	34	
Contributing finance towards irrigation scheme maintenance					
MRIS	50.0	40.0	10.0	120	
TFIS	18.3	47.5	34.2	120	
MFIS	18.6	18.6	62.8	43	***
NIS	0	3.0	97.0	33	

*** = $p < 0.01$

Table 6.12: Farmer Participation in Decision-making

Irrigation Scheme	None (never involved)	Sometimes	Always	n	X^2 Sig. level
Attending irrigation meetings					
MRIS	1.7	35.0	63.3	120	
TFIS	1.7	22.5	75.8	120	
MFIS	2.3	25.6	72.1	43	*
NIS	8.8	29.4	61.8	34	
Attending water related training					
MRIS	23.3	34.2	42.5	120	
TFIS	18.3	18.3	63.3	120	
MFIS	11.4	50.0	38.6	44	
NIS	11.8	26.5	61.8	34	**
Engaging authorities regarding water issues in the area					
MRIS	34.2	40.0	25.8	120	
TFIS	12.5	49.2	38.3	120	
MFIS	29.5	54.5	15.9	44	
NIS	14.7	26.5	58.8	34	***
Distributing information about water issues (verbal or written)					
MRIS	15.8	36.7	47.5	120	

Irrigation Scheme	None (never involved)	Sometimes	Always	n	X^2 Sig. level
TFIS	6.7	30.0	63.3	120	
MFIS	16.7	45.2	38.1	42	***
NIS	5.9	20.6	73.5	34	
Helping other farmers to manage/conserve water					
MRIS	7.5	24.2	68.3	120	
TFIS	2.5	15.0	82.5	120	
MFIS	11.4	38.6	50.0	44	***
NIS	0.0	17.6	82.4	34	
In electing/removing committee members					
MRIS	8.3	27.5	64.2	120	
TFIS	10.0	35.0	55.0	120	***
MFIS	9.1	25.0	65.9	44	
NIS	8.8	11.8	79.4	34	
In formulating rules in the scheme					
MRIS	12.5	45.8	41.7	120	
TFIS	12.5	45.0	42.5	120	
MFIS	18.2	20.5	61.4	44	**
NIS	8.8	26.5	64.7	34	
In irrigation water scheduling					
MRIS	17.5	45.8	36.7	120	
TFIS	18.3	40.8	40.8	120	
MFIS	20.5	34.1	45.5	44	**
NIS	29.4%	8.8%	61.8	34	

**** = p <0.01; ** = p< 0.05; * = p< 0.1; ns = not statistically significant*

NIS and TFIS farmers are more willing to engage authorities about scheme water issues. Mooi and MFIS irrigation farmers are less willing to do so. A similar pattern emerges regarding willingness to distribute information about water issues. Farmers were asked whether they would be willing to assist others manage water. NIS and TFIS irrigation farmers were most ready to undertake this function. Least ready was MFIS, where only 50% indicated willingness to help always. NIS irrigation farmers are most willing to participate in electing committee members. TFIS irrigation farmers are least willing to participate in electing their committee representatives.

More sessions are required in TFIS to make them understand the importance of participating in electing local committees. However, there were no statistically significant differences in the distribution across the schemes. There is a general reluctance to participate in the formulation of rules among Mooi and TFIS irrigation farmers, compared to MFIS and NIS. It would appear that irrigation farmers in the old scheme feel that enough rules have been formulated already, yet those in the relatively newer schemes feel more obliged to participate in refining rules. Great effort is required in making irrigation farmers in older schemes understand the dynamism in rules and the need to update them regularly.

Generally, irrigation farmers are not willing to participate in determining water allocation schedules. Only NIS farmers are more willing to participate. One would expect that Mooi irrigation farmers, who experience perennial water shortages would be more willing to participate in scheduling. Further enquiry is required on this matter. It is also ironic that MRIS irrigation farmers were least ready to report leakages. This could be an indication of the impact of desperation, which in turn leads to despondency.

Table 6.13 shows that there were differences across the irrigation schemes with respect to their participation in regulating and controlling activities in the schemes.

6.2.4.5 Irrigation water law

Irrigation water is one of the most important resources that determines the potential of a farm. Since South Africa is a water stressed, it is important to regulate water by law (the National Water Law (NWA) no. 36 of 1998) to ensure that the nation's water is protected, conserved, managed and controlled to benefit everyone.

6.2.4.6 Water Rights

Water rights are basically the rights to use water for either domestic, agricultural or other industrial purposes. It entails the amount of water to use. The survey showed that 72%, 76%, 70% and 36% irrigation farmers from MRIS, TFIS, MFIS and NIS, respectively, indicated that they have water rights. Their water rights were attached to their land, i.e. they had access to irrigation water because they had plots within the irrigation scheme. However, responses to the question of secure water

access were not as strong as those on water rights, although the differences were statistically significant ($p<0.01$). This suggests that variations in perceptions of security of water rights across irrigation schemes. About 40% and 50% of irrigation farmers from MRIS and TFIS agreed, 47% irrigation farmers from in NIS strongly agreed, while 40.5% from MFIS disagreed that they had secure access to water (Table 6.14). It is not yet clear why MFIS irrigation farmers perceive their water rights as not being secure.

Table 6.13: Farmer Participation in Regulating and Control

Irrigation Scheme	None (never involved)	Sometimes	Always	n	X^2 Sig. level
Reporting unlawful behaviour					
MRIS	46.7	20.0	33.3	120	
TFIS	38.3	31.7	30.0	120	
MFIS	23.3	14.0	62.8	43	***
NIS	6.5	25.8	67.7	31	
Reporting leakages along the canal for repairs					
MRIS	18.3	37.5	44.2	120	
TFIS	7.5	31.7	60.8	120	***
MFIS	9.3	16.3	74.4	43	
NIS	0	20.0	80.0	30	

**** = p <0.01*

6.2.4.7 Water payment

With regards to payment for water, about 52%, 91% and 94% irrigation farmers from TFIS, MFIS and NIS indicated paying an average of R39.46, R3 147.93 and R2 856.26 monthly for water, respectively. Irrigation farmers from MRIS were not paying for irrigation water. The implication for statistically different variations in water payment were due to different complexity of technologies used for irrigation and the institutional setting in the provision of water. NIS and some blocks in MRIS require some pumping and hence have to pay. TFIS also has some blocks that receive pumped water, however, its members possibly differentiated payment for water as opposed to payment for energy to pump the water, have reported not paying for water.

Table 6.14: Farmer perception of security of access to water across irrigation schemes

Farmer perception	Irrigation Scheme				X^2 Sig. level
	MRIS (%)	TFIS (%)	MFIS (%)	NIS (%)	
Strongly disagree	3.3	3.3	4.8	2.9	***
Disagree	25.0	5.0	40.5	2.9	
Neutral	21.7	19.2	21.4	11.8	
Agree	40.0	50.0	31.0	35.3	
Strongly agree	10.0	22.5	2.4	47.1	

*** = $p < 0.01$

6.2.4.8 Water conflicts

Irrigation water is commonly the primary source of conflicts in areas where water supply is not available in sufficient quantities. Mostly in irrigation schemes, water conflicts emanate from failure to adhere to irrigation water schedules. Where irrigation farmers are not satisfied with irrigation schedule, water conflicts are inevitable. About 39%, 12%, 16%, and 12% irrigation farmers from MRIS, TFIS, MFIS and NIS indicated they had experienced water conflicts between farmers. Again, 35%, 1%, 2% and 6% irrigation farmers from MRIS, TFIS, MFIS and NIS indicated they had witnessed water conflicts between blocks. While, about 5% and 6% irrigation farmers from MFIS and NIS indicated they had water conflicts between cooperatives. Relatively few irrigation farmers across these irrigation schemes experience water conflicts between farmers, blocks or conflicts. This is also supported by the responses by irrigation farmers on the level of satisfaction with the irrigation schedule. About 30.0%, 53.5%, 46.5% and 63.6% irrigation farmers from MRIS, TFIS, MFIS and NIS indicated that they were satisfied with irrigation schedule in their irrigation schemes. While, 31.7%, 5.0%, 23.3% and 3.0% indicated that they were not satisfied with the irrigation schedule (Table 6.15).

Table 6.15: Level of satisfaction with irrigation schedule across irrigation schemes

Satisfaction	Irrigation Scheme				X^2 Sig. level
	MRIS **(%)**	TFIS **(%)**	MFIS **(%)**	NIS **(%)**	
Strongly disagree	20.8	2.5	4.7	0.0	
Disagree	31.7	5.0	23.3	3.0	
Neutral	10.8	5.0	25.6	15.2	***
Agree	30.0	53.5	46.5	63.6	
Strongly agree	6.7	34.2	0.0	18.2	

*** = $p < 0.01$

6.2.4.9 Farmer organisations

Farmer organisations were found as the most convenient ways to distribute new information and for farmers to learn new agricultural and water policies and laws. Irrigation farmers were asked to indicate their membership in Water User Association (WUA). Almost all irrigation farmers from the four irrigation schemes indicated that they were not members of WUA and most did not know any WUAs (Table 6.16).

Table 6.16: Membership in farmer organisation across irrigation scheme

Variable	Irrigation Scheme				X^2 Sig. level
	MRIS **(%)**	**TFIS (%)**	**MFIS (%)**	NIS **(%)**	
Member of WUAs	0	0	0	3	***
Knowledge of any WUAs	7	1	5	7	**

*** = $p < 0.01$; ** = $p < 0.05$

Table 6.17: Distribution of farmer perception about the effectiveness of irrigation water law

Variable		Irrigation Scheme				X^2
		MRIS (%)	TFIS (%)	MFIS (%)	NIS (%)	Sig. level
Irrigation water laws are effective in the management of water resources	Strongly Disagree	4	3	0	0	*
	Disagree	13	13	20	12	
	Neutral	25	18	27	15	
	Agree	46	42	48	67	
	Strongly Agree	13	23	5	6	
Irrigation water laws influence decisions on resource allocation	Strongly Disagree	4	3	2	3	*
	Disagree	12	17	11	18	
	Neutral	24	14	27	15	
	Agree	43	38	45	61	
	Strongly Agree	18	28	14	3	
Irrigation water laws influence economic performance	Strongly Disagree	3	3	2	3	***
	Disagree	11	24	20	24	
	Neutral	21	5	32	12	
	Agree	47	26	34	58	
	Strongly Agree	19	42	11	3	
Irrigation water laws influence cropping pattern	Strongly Disagree	1	7	0	0	***
	Disagree	16	21	11	27	
	Neutral	14	10	30	18	
	Agree	45	26	50	55	
	Strongly Agree	24	37	9	0	

**** statistically significant at 1% level; * statistically significant at 10% level*

6.2.4.10 Effectiveness of irrigation water laws

The management of water is important for protecting and conserving limited supply of water resources for sustainable use. Applying the right amount of water required at a given crop growth stage is one way to ensure sustainability in water use. Table 6.17 displays the distribution of irrigation farmer perceptions with respect to the effectiveness of irrigation water law. Survey results yielded statistically significant variations in the responses provided by irrigation farmers across the irrigation schemes. As shown in Table 6.17, 46%, 42%, 48% and 67% irrigation farmers from MRIS, TFIS, MFIS and NIS, respectively agreed that irrigation water laws were effective in the management of water resources; 43%, 38%, 45% and 61% irrigation farmers across these

irrigation schemes agreed that irrigation water laws influenced decisions on resource allocation; again, only 47%, 26%, 34% and 58% irrigation farmers from MRIS, TFIS, MFIS and NIS, respectively, agreed that irrigation water laws had an influence on their economic performance; while 45%, 26%, 50% and 55% from these irrigation schemes indicated that irrigation water laws did influence their cropping pattern. Further variations on irrigation farmers perceptions with the effectiveness and influence of irrigation water laws. These results indicate heterogeneity that exist between irrigation farmers, with NIS irrigation farmers being more positive about the effectiveness of water laws in resource management. This may be due to the fact that NIS relies on pumped water only and local laws are very pivotal to the equitable access by irrigation farmers.

6.2.4.11 Farmer performance and wellbeing

This study works on the premise that the governance regime on the scheme translates into the confidence (or lack thereof), of irrigation farmers to derive a living from the scheme. Table 6.18 summarizes irrigation farmers' responses about their confidence in the scheme.

Table 6.18: Farmers Perceptions about the performance of their irrigation schemes

Variable[1]	MRIS (n=120)	TFIS (n=120)	MFIS (n=44)	NIS (n=34)	X^2 Sig. Level
Satisfied with the performance of the scheme	2.54	2.09	2.32	1.47	***
Level of confidence in farming as a means of sustainable livelihood	2.10	2.03	1.73	1.26	***
Level of confidence as farmers	1.99	1.98	1.48	1.24	***

*** = $p < 0.01$

[1]Measured on a likert scale of 0-5, where 5 is strongly agree, 3 is neutral and o is strongly disagree

There are statistically significant differences in the opinion of irrigation farmers about their satisfaction with the performance of the irrigation schemes. NIS irrigation farmers are most satisfied, while MRIS irrigation farmers are least satisfied. Despite the availability of water at MFIS, the irrigation farmers are only marginally satisfied with the performance of the scheme. This suggest that availability of water is not the only criteria farmers factor in in assessing irrigation

performance. Irrigation farmers also look at reliability of supply and the conditions under which the water is provided.

NIS irrigation farmers are most confident that farming is a means of achieving sustainable livelihoods. Least confident are MRIS irrigation farmers. Nevertheless, irrigation farmers across all irrigation schemes are confident of the ability of farming to sustain their livelihoods. In addition, the same trend emerges in terms of the levels of confidence that the irrigation farmers have. All farmers are generally optimistic about the future of farming in their locality. NIS and TFIS are most optimistic while MRIS are least.

6.2.4.12 Income and Expenditure

Across the four irrigation schemes, income is derived from irrigation farming, non-irrigation farming (dryland farming and livestock production), off-farm sources (remittances, permanent and temporal employment) and welfare grants (pension, child support, disability and foster care grant. Irrigation farm income was the dominant income source across the schemes, followed by welfare grants and/ or non-irrigation income (Table 6.19).

Table 6.19: Average income (Rand) from various sources across irrigation schemes

Income Source	MRIS	TFIS	MFIS	NIS	Sig. Level
Amount spent on food per month	1517.92	1662.50	1290.91	2421.88	***
Amount spent on non-food items	274.50	256.58	705.91	1268.18	***
Remittances	307.08	251.67	127.27	264.71	ns
Irrigation farming	5684.17	3940.00	12075.00	92970.59	***
Dryland farming	279.17	3.33	0.00	0.00	ns
Livestock production	25.29	66.67	162.79	588.24	ns
Permanent employment	800.00	308.33	20.45	1073.53	ns
Temporary employment	483.08	568.33	63.64	264.71	ns
Disability grant	106.67	46.33	111.77	141.18	ns
Child support grant	623.83	691.83	630.55	435.88	ns
Pension grant	1081.50	1072.83	870.48	564.71	*
Foster care grant	7.67	0.00	0.00	352.94	***
Total household income	9398.46	6949.33	14055.70	96656.47	***

**** = p <0.01; ** = p< 0.05; * = p< 0.1; ns = not statistically significant*

Irrigation farmers from NIS made the highest irrigation farm income followed by MFIS irrigation farmers. All irrigation farmers across the schemes received relatively less income from off-farm sources. However, the overall analysis on the discrepancies of household income received from these various sources across the schemes only indicated statistically significant variations on the income received from irrigation farming ($p<0.01$), income received from pension grant ($p< 0.10$) and income received from foster care grant ($p<0.01$). A further analysis (multiple comparisons) was done to determine where exactly the significant differences within these irrigation schemes were. Table 6:20 presents the significant differences in household income among the four irrigation schemes.

Table 6.20: The distribution of household income (Rand) and income sources across irrigation schemes

Source of income	(I) Irrigation Scheme	(J) Irrigation Scheme	Mean Difference (I-J)	Std. Error	Sig. level
Irrigation farming income	MRIS	NIS	-87,286.42	7,984.34	***
	TFIS	NIS	-89,030.59	7,984.34	***
	MFIS	NIS	-80,895.59	9,384.05	***
Dryland farming income	MRIS	TFIS	275.83	152.14	*
Livestock production income	MRIS	NIS	-562.94	246.61	**
	TFIS	NIS	-521.57	246.61	**
Permanent employment income	MFIS	NIS	-1053.08	613.22	*
Child support grant income	TFIS	NIS	255.95	147.81	*
Temporal employment income	MRIS	MFIS	419.45	220.56	*
	TFIS	MFIS	504.70	220.56	**
Pension grant income	MRIS	NIS	516.79	203.93	**
	TFIS	NIS	508.13	203.93	**
Foster care grant income	MRIS	NIS	-345.28	96.11	***
	TFIS	NIS	-352.94	96.20	***
	MFIS	NIS	-352.94	112.96	***

**** = p <0.01; ** = p< 0.05; * = p< 0.1; ns = not statistically significant*

Income received from agricultural activities showed more significant difference across irrigation

schemes relative to the other income sources. Irrigation farming income received by MRIS S, TFIS and MFIS irrigation farmers was significantly different from what NIS irrigation farmers receive. The survey showed that NIS irrigation farmers received more income from irrigation farming relative to the other irrigation schemes. Moreover, all these differences were statistically significant at 1% level (Table 6:20), this indicates the discrepancies in farmer potential, productive resource accessibility as well as the extent to which irrigation farmers access output market and sell their produce. On the other hand, dryland farming income was only significantly different (at 10%) between MRIS and TFIS irrigation farmers. While livestock farming income was significantly different (at 5%) between MRIS, TFIS and NIS. This implies that irrigation farmers from NIS, TFIS and MRIS do dryland and livestock farming as supplementary income sources.

Regarding off-farm income, there were no statistically significant differences in remittances across the irrigation schemes. Income from permanent employment was only significantly different (at 10%) between MFIS and NIS, implying that NIS irrigation farmers were more economically active and still participating in the labour force or some of their household members were permanently employed. Income that irrigation farmers received from temporary employment on the other hand was significantly different between MRIS and MFIS (at 10% level); TFIS and MFIS (at 5%) (Table 6:20). This suggests that TFIS and MRIS irrigation farmers were more involved in temporary employment as an alternative strategy to increase household income compared to MFIS.

Welfare grants, especially pension and child support, are important income sources for rural people in South Africa. Child support grant was significantly different at 10% level between TFIS and NIS irrigation farmers, with TFIS households receiving more. This significance variation could be attributed to differences in the number of household children that were applicable for receiving this grant. NIS households tend to be younger, meaning that they have less children. Income from pension grant that MRIS and TFIS irrigation farmers received was significantly different from what NIS irrigation farmers received. Income from foster care grant showed highly statistically significant differences ($p<0.01$) between the three irrigation schemes and NIS.

Irrigation farmers indicated their main expenditures as being purchasing of inputs and on household expenditure. The study revealed that irrigation farmers spend relatively less income on

household expenses (Table 6:21). NIS irrigation farmers spent considerably more on both food and non-food items compared to the other three schemes. In line with Mafuru and Marsh (2003), this was expected since NIS farmers also realise the highest level of income.

The study revealed statistically significant differences (p = 0.001) in the amount of money that irrigation farmers spend on food items across the four irrigation schemes. Further analysis indicated the sources of the differences in the amount spent on food items. Table 6.21 presents the statistically significant mean variations.

Table 6.21: Distribution of monthly expenditure (Rand) on food items across irrigation schemes

(I) Irrigation Scheme	(J) Irrigation Scheme	Mean Difference (I-J)	Std. Error	Significance
MRIS	NIS	-903.958*	156.939	***
TFIS	MFIS	371.591*	139.021	***
	NIS	-759.375*	156.939	***
MFIS	NIS	-1130.966*	183.266	***

**** = p <0.01; ** = p< 0.05; * = p< 0.1; ns = not statistically significant*

Monthly expenditure on food items in MRIS was significantly different from that in NIS; TFIS was significantly different from that in MFIS and NIS irrigation farmers; while the monthly expenditure on food items in NIS was significantly different from the expenditures indicated by all the other three irrigation schemes. This implies differences in the affordability of food basket and food security across these irrigation schemes

The analysis that was done on household monthly expenditure on non-food items also revealed an overall statistically significant differences across the four irrigation schemes (p=0.001). In-depth analysis revealed that irrigation farmers across the four irrigation schemes spent the very small amount on non-food items especially the MRIS and TFIS irrigation farmers who spend below R1000 monthly, on average. This is because medical services, schools are free and income is usually spent on burial insurance, debt repayments, stokvels, toiletries, and electricity.

Table 6:22 displays the statistically significant mean differences in monthly expenditure on non-

food items across the four irrigation schemes. The study revealed that the amount spent on non-food items in MRIS and TFIS were both statistically different from that spent in MFIS and NIS, This suggests differences in the quality of life that these irrigation farmers live in Msinga and Jozini.

Table 6.22: Distribution of monthly expenditure on food and non-food expenditure across irrigation schemes

(I) Irrigation Scheme	(J) Irrigation Scheme	Mean Difference (I-J)	Std. Error	Significance
MRIS	MFIS	-431.409*	109.882	***
	NIS	-993.682*	122.551	***
TFIS	MFIS	-449.326*	109.882	***
	NIS	-1011.598*	122.551	***
MFIS	NIS	-562.273*	143.576	***

*** = $p < 0.01$

6.3 Summary

Sustainable water resource management requires solid institutional arrangements, stakeholder participation and collective efforts. Stakeholders should be aware of policies, strategies, rules and regulations that affect them in irrigation schemes. The discussions with the farmers showed that irrigation farmers are generally not aware of water and land policies in South Africa. Although some have an idea of what the governments expects and plans for them. They operate in the scheme under locally set rules. However, some farmers do not comply. Conflict management in the schemes is relatively good and farmers that break the rules usually pay their dues. “Ubuntu”, which is a practice of mutually respective each other, plays a significant role in the harmony and cordial resolution of conflicts among irrigation farmers. Unfortunately, the same “Ubuntu” spirit prohibits irrigation farmers from taking objective and principled stances when dealing with delinquent members. The stakeholders involved in the schemes are the DARD, the DRDLR, LIMA, Technoserve and the traditional authorities (represented by trusts in Jozini). The common challenge faced in the schemes is the lack of output markets. All stakeholders that the project team consulted agreed to take part and assist wherever they can during the implementation of this research.

The critical role of governance, incorporating rules, regulations, policies on various aspects of SISs. Governance affects the irrigation resources such as infrastructure, water access and security, which in turn affects productivity and production. The net outcome manifests itself on how the welfare of the irrigation farmers and their household turn out.

Operation and maintenance, which are functions of the infrastructure should reflect the dynamic societal needs. As such, procedures and strategies involved should focus on identifying sensitive points along the water conveyance system to allow water managers to avoid water shortages. The adoption of IMT has been fraught with challenges regarding maintenance of irrigation infrastructure and ensuring reliable access to water for irrigation farmers. Worldwide, irrigated agriculture has been recognized as a strategy for improving agricultural production, improving irrigation farmers incomes, as well as for improving food security. However, irrigation schemes often face challenges with the allocation and distribution of land and water resources since there is unclear legal status regarding the ownership of the irrigation hardware. Literature notes that the co-existence of different legal regimes (formal and informal) regarding land allocations is problematic. Women and youths are disadvantaged when customary legal systems dominate land allocation. Since ownership of plots translates into right to water, it means that women and youth are disadvantaged.

Governance of irrigation scheme affects the all other processed on the scheme as well as the performance of the irrigation farmers. SIS's in South Africa were meant to enhance agricultural productivity in rural areas, and their effective governance has the potential to improve irrigation farmers' wellbeing and economic performance. Several policies, strategies, rules and regulations, and institutional reforms are applied in irrigation schemes. Literature has shown that the successful implementation of programmes and the proper management of water resources improves water access and enables farmers to use water more productively, as such increasing their production. Agricultural productivity translates into better economic performance as well as improved household welfare, food security and even nutrition. As such, it is important to evaluate the effectiveness of governance in the schemes, to ensure that farmers in irrigation schemes are water-use secure.

Results show discrepancies in the understanding of governance issues across schemes. This indicates that the effects of scheme governances cannot be generalized. It also emerges that many factors determine the effectiveness of governance across schemes. Factors such as age of the scheme, age composition of the scheme members influence understanding and participation in scheme governance. Older schemes seem less informed about governance that the more recent schemes, suggesting the need for greater effort to raise awareness about governance and its role in such old schemes.

The existence of multiple tenure regimes (in MFIS) seems to significantly impact the perception of governance, including the interaction with the traditional authorities. Irrigation farmers in such schemes tended to consider governance in adverse terms, compared to other schemes with singular tenure regimes. Nevertheless, it was evident that land tenure, including the role of traditional authorities in this aspect, is not a serious issue affecting scheme governance. Therefore, more focus interventions on water security and related aspect are needed.

Farmers' summative assessment of governance reflects the effect of various factors on their performance and level of confidence in the irrigation farming. NIS stands out in giving hope to farmers. When governance mechanisms are working in harmony (accompanied with the right level of resources), farmers also perform better. This is due to the better governance systems they have set up and their better understanding of governance. MRISs is on the other end of the scale.

The study suggest the need to make irrigation farmers understand the multi-faceted nature of scheme governance, and its effects on their performance. Irrigation farmers should be assisted to understand that the schemes are shared resources and everyone should participate for the common good. A deeper enquiry for the reluctance of some irrigation farmer from participating in scheme governance is required.

CHAPTER 7: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Background

The human population is expected to increase to 8.2 billion by 2050 and a billion of this increase is expected to be in Africa. This increase in population will mean higher demand for food. The South African government has invested considerably to the rehabilitation and revitalisation of SISs. Nevertheless, the performance of SISs remains below expectations despite the hope placed on them to uplift the productivity in communal areas. The government has come up with various policies to bring SISs into mainstream economy, e.g. the Integrated Food Security and Nutrition Programme and the National Development Plan. The policies put a high priority on smallholder agriculture.

On the other hand, there are increasing demands for higher water productivity. In the past, only technical solutions were sought, but more recently institutional aspects of land and water management are considered as possible opportunities for enhancing irrigation performance requiring legal and institutional arrangements. Strengthening the institutional capacities requires participation of a cross section of stakeholders. Legally, Acts such as National Water Act (NWA) determine the manner in which water rights are allocated and managed. On the other hand, customs and traditional practices also exist and affect land and water rights in SISs. Therefore, both formal and informal institutional settings affect irrigation performance.

Land tenure also impacts on SISs, where insecure tenure can limit farmer incentives to make long-term development investments. Gender also interact with land tenure since females do most of the farming yet usually have the weakest land tenure security. The need for effective support services in SISs cannot be over emphasized.

This problem confronting SISs, i.e. failure to fully perform despite of concerted government investments and policy changes, was studied through a research whose aim was to assess the effectiveness of policies and strategies, rules and regulations and governance of programmes that provide support to smallholder farmers on irrigation schemes. The research was conducted across four irrigation schemes in KwaZulu-Natal Province, namely, TFIS, MRIS, MFIS Flats, and NIS.

The schemes were selected on the basis of their unique and contrasting characteristics, which allow for a comparative study of the effects of the policies, strategies, rules and regulations.

The research was conducted through a mixed-methods approach, where both formal and informal data collection methods were used. First, extensive literature review was undertaken to ground the understanding of the subject on previous studies. Thereafter, interactions with farmers were interspaced with formal, sample-based surveys where a structured questionnaire was used. Data were subjected to statistical analyses for drawing inferences. Periodic consultations with irrigation farmers were done to ensure that the findings resonated with their understandings.

7.2 Summary of Findings

The study revealed the coexistence of formal and informal rules and regulations in the respective irrigation schemes. The formal acts, policies, rules, and regulations instituted in South, namely; Irrigation Strategy (2015), National Water Resources Strategy (2013), Water Allocation Reform (2006), the National Water Act (1998), which incorporates stipulations on Catchment Management Agency and Water Users Association, are discussed. On the other hand, are informal rules and regulations, that are area specific. They emanate from the traditional authorities under whose jurisdiction the irrigation schemes operate. The irrigation schemes also have their committees that are not necessarily aligned to the formal structures, such as WUA, yet some government departments recognize such structures, while others may not.

The lack of awareness among irrigation farmers of the formal policies reflects their inconsequential role in SISs. Survey results showed that only 4% of the irrigation farmers had knowledge about WUAs, of which only 0.3% claimed to be WUA members. The farmers across the irrigation schemes, apart from NIS, do not know NWA, NWRS, or government-stated aims for SISs and WUAs. Irrigation farmers devise their own rules, and regulations stipulated in the scheme constitutions, but there are not linked to the objectives of national policies. Government policies are actualized through direct implementation, e.g. through infrastructure improvement as part of the revitalisation programme, rather than through facilitated processes.

Both formal and informal water institutions are important in determining the water management at the scheme level. However, informal institutional arrangements (customary institutions) and

local institutions tend to be more visible, valuable, influential and powerful at the scheme level. On the other hand, formal institutions have low diffusion among irrigation farmers. In general, irrigation farmers across the four irrigation schemes expressed satisfaction with land and water allocation despite that they function through locally crafted institutions. Nevertheless, irrigation farmers' perceptions of the effectiveness of traditional rules are not uniform and differ on the basis of the commercial orientation of the scheme. The irrigation farmers in more food security-oriented irrigation schemes feel that the rules are more effective compared to their counterparts in commercially-oriented schemes. Irrigation farmers in irrigation schemes operating close to the subsistence level, namely, MRIS and TFIS, were satisfied with land allocation through traditional authorities. On the other hand, irrigation farmers in more commercially-oriented schemes (NIS and MFIS) considered the lack of title deeds to be a hindrance to their investment decisions.

Irrigation farmers believe that local scheme rules are fair, easy to enforce and with most members generally complying with them. However, discontent may exist in specific localities of irrigation schemes where water is not readily available. The general picture of satisfaction with water allocation masks the spatial differences across irrigation farmers located at different locations in the irrigation schemes. This is particularly the case in MRIS where water is generally scarce and irrigation blocks at the tail end of the scheme receive limited quantities of water, which has led some of them to abandon their plots. Farmers in MRIS are least satisfied with the water schedules and they attributed this to non-compliance to schedules among farmers in the upper blocks.

Irrigation farmers are satisfied with land allocation, which falls under the realm of traditional authorities and local trusts. However, despite the satisfaction, gender inequity was evident regarding land ownership, with 55.4% of males having land registered in their names while only 44.1% of women had land registered in their names. While both gender types are represented in scheme leadership, the secondary committees comprise more men than women.

Although women are considered as primary users of land and water resources and the major food producers, they remain highly dependent on men for land and other productive resources since men have more control over resources. Traditional norms often disregard the potential of women as farmers and decision-makers and thus prevent them from participating in public organisations and in decision-making processes. Moreover, men in rural areas are regarded as leaders, hence, it

is important to educate them.

The study shows that the co-existence of formal and informal institutional settings at irrigation schemes, where their roles overlap, partly causes dysfunction in the implementation of strategies, rules, and regulations. This dysfunction can be attributed to the contrast in the nature of the two systems. Government-instituted policies, rules, and regulations tend to be dynamic as they are changed from time-to-time, as the need arises. In some cases, one policy or rule is replaced by a totally different one. Such dynamic policies and rules are to interact with traditional institutions and rules that are largely static across generations. In view of rural dynamics, the transmission of the government rules or programmes takes time and at times are not fully implemented during the set life-span. For example, the government-instituted programmes such as IMT, PIM, and WUAs have not become fully operationalized across irrigation schemes. Instead, locally formulated governance settings prevail, i.e. rules, regulations, and institutions. One of the sources of this dysfunction is that the approach has been that the formal approach needs to replace the informal one. The attempt to completely replace the informal with the formal usually leads to the former being ignored whereas it is clear that there are some essential components of the formal system that are necessary, for instance the Water Acts. Therefore, since it is known that the informal will persist, it is essential to find out if it is possible to strike a balance between the two that does not compromise productivity improvements.

The fact that different government departments use different approaches to interact with irrigation schemes leads to further ineffectiveness of formal policies, rules, and regulations. Field work showed that the national and provincial departments of agriculture (DAFF and DARD) work through cooperatives that they have facilitated to establish. On the other hand, the DWA has adopted the WUAs as the vehicle through which it conducts its work. As a result, there are different policies, rules, regulations, training from within government, resulting in different levels of understanding of rules among irrigation farmers.

In general, despite that the same rules and regulations are applicable across irrigation schemes, different approaches to provision of support exists. In the case of agricultural extension, the government only services the food security-oriented schemes, while the private sector and the

NGOs are mostly in the commercial-oriented ones.

The dysfunction of irrigation schemes has serious consequences for the irrigation farmers. In MRIS, the dysfunctionality means that the infrastructure is badly dilapidated and requiring maintenance. Most canals were critically damaged needing immediate repair. Some components of the sluice gates and the regulators had exceeded their service life. Distribution canals in TFIS exhibited signs of deterioration, i.e. the components of the infrastructure were due for maintenance. The in-field watering hosepipes were damaged and needed to be replaced. The cracks in the hosepipes resulted in water leakages. Stakeholders (extension workers and irrigation designers) potentially exacerbated the deterioration of infrastructure as the irrigation schemes had no operation and maintenance programme. In addition, the lack of cooperation among irrigation farmers, and irrigation farmers' unwillingness to contribute financially towards the scheme infrastructure exacerbated the situation. The extension workers failed to articulate policy, as a result, the schemes had no WUAs. Farmers in MRIS did not know where to approach to get water released to the scheme from the supply dam, nor did they understand their water rights, in contrast to those of the commercial farmers across the river.

7.3 Level of understanding of formal policies among irrigation farmers

Most irrigation farmers across the four irrigation schemes had no formal training on irrigation and water management. Such a scenario means that they lacked comprehension of the need for IMT, let alone how it is implemented in SISs. There is a need for a concerted effort to train farmers about the specific tenets of government policies and strategies. This can allow farmers to react accordingly, rather than expecting the status quo. In the face of IMT, even though the initial design was for the government to first rehabilitate and capacitate the farmers, this never happened. Nevertheless, the government proceeded to withdraw its support as though IMT had been fully implemented. A re-engineered IMT needs to be developed and farmers made aware of the new arrangements. The current situation where farmers expect the traditional type of support, including bailiffs, is hindering the effectiveness of local institutions as they cannot develop the confidence to make decisions.

7.4 Factors that Affect the Effectiveness of Policies, Strategies, Rules and Regulations on Smallholder Irrigation Schemes

The study identified factors that affect the effectiveness of irrigation schemes. Gender, land ownership, level of education emerged as key determinants. Other factors were fairness in water distribution in the scheme and availability of water rights (permits), availability and reliability of irrigation water provision are similar attributes effectiveness the effectiveness of irrigation schemes.

Evidently, the performance of smallholder irrigation depends on a variety of factors. While the availability of water and land are critical, it is now clear that challenges also emanate from policies, strategies, rules and regulations and governance of programmes that provide support to smallholder farmers on irrigation schemes. Indeed, no single interventions whether of policy, strategy, rules etc. on its own can determine irrigation performance. As such a holistic approach is required when looking at how such interventions can be employed to improve irrigation schemes.

The level at which farmers participate in irrigation management is critical in determining how well the scheme functions. Awareness of the national water policies affects the willingness and ability to pay for water by irrigation farmers. Other factors are whether farmers belong to cooperatives, have received training on irrigation, receive extension support, and are members of irrigation committees. The identified factors indicate that policy changes should be accompanied by other interventions that have a bearing on the performance of irrigation schemes. The study also showed that the various factors do not operate in isolation as the contribution of one factor is linked to the performance of other factors. The relationship between rules and regulations in governance and the factors determining their effectiveness is not linear but cyclical and complex system.

7.5 Recommendations for Policy Changes

The following recommendations are made based on the research findings.

- Informal and formal rules and regulations need to be harmonized. The scheme members need clarity as to which rule or policy will be applicable to them at a particular time and instance. The study observed the existence of plural institutional systems at irrigation schemes due to the overlap between informal and formal systems. In some cases, the

informal and formal institutions in irrigation schemes conflict with each other. Examples of contradictions exist in payment versus non-payment for irrigation water, penalties for breaking rules, provision of bailiffs vs collective policing.

- Effort to achieve gender equity should be prioritized. Efforts should be broadened to all livelihood spheres than only looking at the irrigation scheme level. Despite that irrigation farmers generally do not see gender-based disparities, study findings show that females are less represented in various structures that define governance in irrigation schemes. Their limited participation emanates from their gender responsibilities at the household level.
- A participatory way of developing such policies, rules and regulations is needed. Irrigation farmers are largely unaware of government initiatives, including rules and regulations. The current top-down approach means that the instituted policies, rules and regulations are not understood, let alone being followed, resulting in poor performance of irrigation schemes. Policies, rules, and regulations developed in a participatory manner would be compatible with local rules and would accommodate the multiple factors that have a bearing on scheme effectiveness. The need to use a participatory approach in developing policies, rules and regulations could be a medium to a long-term goal. The immediate recommendation is that training programmes should be undertaken to increase irrigation farmers' awareness of different government initiatives and existing policies, rules and regulations. The training should be cognizant of the low literacy levels among SIS irrigation farmers.
- Training needs to be conducted urgently on irrigation and water management. Irrigation farmers that had water management training were more likely to perceive water to be adequate, i.e. they understood the value of water and did not expect to receive it in excessive quantities. In contrast, those without training would over-irrigate and generally felt that they did not receiving adequate quantities of water, resulting in them being despondent and not contributing to improve the functioning of the irrigations schemes. Across all irrigation schemes, lack of training resulted in farmers not following the irrigation schedule as they felt that the soil should always look wet. In MRIS, this resulted in some blocks not accessing water as expected. In other irrigation schemes, this resulted in conflicts of access to water and also impassibility of some areas due to waterlogging from over-application of irrigation water. Training in water management will allow farmers

to understand water availability at the catchment level and how that translates to water availability in the scheme. Farmers and their institutions will become more aware of intra-scheme water availability and access (upstream vs downstream blocks), and possibly make them more responsible in their water application.

- Stakeholders who interact with smallholder irrigation schemes need to be sensitized and made fully aware of government initiatives and existing policies, rules and regulations, and the need for coordinated execution of interventions. Many stakeholders cause confusion in irrigation schemes as they intervene without taking cognizance of existing institutional settings, including formal and informal ones.
- Land should be made equally available for both genders, with young girls having the possibility of inheriting land, especially those interested in agriculture.
- The IMT needs to be re-configured to make it functional across all smallholder irrigation schemes. To date, the irrigation farmers are not conversant with the IMT. In any event, the government did not do a complete rehabilitation of the irrigation before handing over to irrigation farmers. The training required for capacitating farmers to operate the irrigation schemes was not provided. A more thorough study is required on what elements of the IMT to retain and how to roll them out. IMT should be re-engineered in a participatory manner, i.e. in consultation with the farmers. Prior to its implementation, farmers at large should be made aware of the new arrangements and the course to be followed.
- Irrigation farmers perceive informal institutions as more relevant to their needs and thus tend to attract greater compliance than formal institutions. Therefore, informal institutions on water resource management should be recognized and should be appropriately incorporated into water governance. Informal institutions which are functional and complementary to the re-engineered IMT initiative should be strengthened.
- Farmers' institutions should be granted greater autonomy so that they are able to deal with scheme matters on their own without government support. Farmer awareness of water policies, government aims, and programmes implemented for effective management of water resources should be improved in order to increase their compliance with formal institutions.

- The configuration or appropriateness of WUA should be reconsidered. Farmers are not aware of WUAs nor are they members. However, some government departments expects WUAs to be the link between farmers and Catchment Management Agencies.
- A holistic approach is required in the implementation of irrigation policies or rolling out of programmes. Emphasis should be balanced across the different components identified as affecting irrigation performance. The relationship between rules and regulations in governance and the factors determining their effectiveness is not linear but cyclical and complex system.
- Government departments should synchronize their messages and approaches before taking them to the SIS level. This will ensure that their efforts are not counterproductive, but synergistic.
- Government needs to act a guarantor for finance that is meant for land development to counteract the insecure tenure regime which limits farmer's access to finance.

7.6 Areas for Future Research

- A study on what elements of the IMT to retain and how to roll them out is required. Lessons should to be drawn from areas where schemes have been subjected to the classical IMT roll-out. The research should identify what to let go of and what to retain in the IMT, for effectiveness of scheme operation?
- There is need to study whether an appropriate level of co-existence of formal and informal institutions, rules, and regulations can be established without compromising on improving performance of SIS. This study looked at informal regulations and institutions and how they function and have a bearing on SISs. It established that they are the institutions keeping the food-security oriented schemes operational, e.g. in MRIS and TFIS. While the government may find it desirable to introduce formally constituted rules and regulations, it may be more cost-effective and sustainable to incorporate relevant aspect of informal regulations and institutions in the emerging IMT framework.
- There is need to establish the relationship between the level of commercialisation among smallholder irrigation farmers and informal institutions, rules, and regulations. This study

pointed to the fact that a negative relationship exists between the level of commercialisation and the desirability of informal rules and regulations. A determination of this question would allow policymakers to fine-tune policies informed by the level of commercialisation achieved in an irrigation scheme. The current "one-size-fits-all" approach being used does not produce the most ideal results across the board.

- The possibility of customary laws to give men and women, youth and elderly equal privileges and opportunities especially with regards to land accessibility and control over resources needs to be considered.

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APPENDIX A: QUESTIONNAIRE USED IN THE FORMAL SURVEY

UNIVERSITY OF KWAZULU-NATAL

SCHOOL OF AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

EVALUATION OF INTEGRATION, FARMER PARTICIPATION AND PERFORMANCE IN SMALLHOLDER IRRIGATION SCHEMES IN KWAZULU-NATAL, SOUTH AFRICA.

QUESTIONNAIRE

All the information provided in this interview will be treated as STRICTLY CONFIDENTIAL.

Household name	Municipality	District	Date
Are you an irrigation scheme member?	Irrigation scheme	Interviewer's name	Name of Respondent

**Municipality*: 1= Jozini Local, 2= Msinga Local
**District*: 1= Umzinyathi, 2= Umkhanyakude
**Irrigation scheme*: 1=Mooi River, 2= Tugela Ferry, 3=Makhathini, 4= Ndumo
**Irrigation scheme member*: 1= Yes, 0= No

A: HOUSEHOLD DEMOGRAPHICS (INFORMATION ABOUT THE IRRIGATION FARMER TO BE ENTERED BELOW) (circle the appropriate)

A2.Age Gender: M / F Marital status: 1=Single 2=Married 3=Divorced 4=Widowed
A3. Education 1=No formal 2=Primary 3=High School 4= Tertiary
A4. Main occupation 1=Full time 2=Regular salaried job 3=Temporary job 4=Unemployed 5=Self-employed 6=Student 7=Retired 8=Other (Specify)

A8.Total number of household members	
A9. How many of the household members are adults/children?	
A10. How many of the adult household members are unable to work due to illness or old age?	
A11. How many of the household members work on the farm?	
A12. Do you hire labour to work on the farm? 1= Yes, 2= No	

** Household head refers to the household head that stays in the household for 4 or more days per week*
*** Please include only those who stay in the household for 3 or more days per week*

B: SKILLS AND TRAINING

B1. Has the irrigation farmer been trained in the following?

Skills	Have you been trained (1=Yes;0=No)	Who provided training
General crop production		
Land Preparation		
Fertilizer application		
Herbicide application		
General irrigation practices		
Water management		
Commodity marketing		
Packaging		
Processing		
Pricing of products and negotiation		
Business planning		
Bookkeeping		
Other (specify)		

B2. If No above do you need training? 1=Yes; 0=No

B4. Which training did you find most useful on the farm?.....

C. ASSET OWNERSHIP

C1.Household asset: Indicate agricultural production assets that you have access to:

Asset	Quantity/ Number of items owned	Do you consider the production assets you have to be adequate for your Agricultural Activities*: 1= Yes ; 0=No*
Hand Hoes		
Ox-drawn plough		
Wheelbarrow		
Trailer		

Tractor		
Tractor-drawn plough		
Vehicle		
Cattle		
Goats		
Other		

C2. Are there any production assets supplied by the government? 1= Yes, 2= No

If yes which ones:

C3. Should government supply production assets? 1= Yes, 2= No

D. LAND OWNERSHIP AND UTILISATION

Land type	Ownership	Area utilized	Area not utilized
Homestead garden			
Dry-land fields			
Irrigation plots inside the scheme			
Irrigation plots outside the scheme			

* *ownership*:1=Traditional allocation; 2=Rented; 3=State supplied/owned; 4=Inherited 5=Owned 6= Other

If 5 above is it in your name? 1= Yes; 2= No

D1.How do you feel about your land size? 1=Too small 2=Just right 3=Too large	
D2.Rate the quality of your land for crop production 0=Poor 1=Average 2=Good	
Water holding capacity	
Drainage capacity	
Resilience to degradation and unfavourable conditions	
Low weed pressure	
Sufficient nutrient supply	
D3.Are you satisfied with the tenure security of your land? Yes=1 No=0	

D4.Are you permitted to sell or rent your irrigated piece of land? Yes=1 No=0	
• D4.1. If No in D4, should people be allowed to sell or rent their land to others? Yes=1 No=0 • D4.2 Does the tenure security of your land influence your land use decision? 1= Yes; 2= No Explain	
D6.How far is your homestead from the irrigation scheme?	
D7. Do you pay for land (if leased)? Yes=1 No=0 (Rands)	
D8. Are you satisfied with the fees you pay for land? Yes=1; No=0	

E. SCHEME GOVERNANCE

E1. Please answer the following questions regarding the governance of SIS's

1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree

I am aware of the National Water Act of South Africa	
I am aware or have heard of the Natural Water Resource Strategy of SA	
I know what the government aims to achieve in SIS	
I know that I have to have a water licence to use irrigation water	
I am satisfied with how the land is allocated in SIS	
The terms of land allocation should change to suit farmer needs	
The rules regarding water allocation in the scheme are fair	
The rules set within the irrigation scheme are fair	
The rules in the scheme are hard to enforce	
Penalties for failure to comply with the rules are fair	
I am satisfied with the cooperation between blocks and farmers in the irrigation scheme	
Water users are always willing to contribute to the maintenance of infrastructure and equipment in the scheme	
I am satisfied with how water conflicts are managed in the scheme	
I am satisfied with the involvement of the Tribal Authority in the irrigation scheme	
I am satisfied with the involvement of the DAFF in the scheme	
I am satisfied with the involvement of the DRDLR in the scheme	

I am satisfied with the involvement of the DWAS in the scheme	
I am satisfied with the involvement of the government departments in the scheme	
I am satisfied with the involvement of NGOs in the scheme	
I am satisfied with the involvement of Farmers in making the rules	
I am satisfied with the current executive committee	
The election process of the executive committee is fair	
I am satisfied with the contribution of the traditional council in irrigation management	
I am satisfied with the traditional council's level of understanding of the rule in the irrigations scheme	
I am satisfied with the level of contribution of the traditional council in t rule enforcement	
I am satisfied with the youth's involvement in irrigation scheme management	
I am satisfied with the youths level of understanding of the schemes rules	
I am satisfied with the way that the farmers and traditional authorities work in the scheme	

E3. IRRIGATION WATER LAW	
Questions	**Response**
1. Do you have water rights? *1= Yes 2= No 3= I do not know*	
2. If Yes, in what form? *1= Licence/ Permits; 2= Other, Specify……..*	
3. If No to **1,** please specify the constraints for accessing the irrigation water rights …..……	
4. My right to water is secure *1= Strongly agree; 2= Agree; 3= Neutral; 4=Disagree; 5= Strongly disagree*	
5. Have you experienced water conflicts in the past 12 months? *1= Yes 2= No*	
5.1. Between farmers	
5.2. Between blocks	
5.3. Between cooperatives	
6. If yes above, what were the causes?	

6. If water conflicts arise, how are they resolved? …….. ……	
7. Do you belong to Water Users Associations (WUAs)? 1= Yes 2= No	
8. Do you know any Water Users Associations (WUAs)? *1= Yes 2= No*	
1= Strongly agree; 2= Agree; 3= Neutral; 4=Disagree; 5= Strongly disagree	
9. If Yes in 7, the WUAs has improved water access in your irrigation scheme	
10. Government participation in irrigation water management increases your feeling of responsibility to manage water.	
11. Private sector and NGO's participation in irrigation water management increase your feeling of responsibility to manage water	
12. Irrigation water laws are effective in the management of water resources	
13. Irrigation laws influence your decisions on resource allocation.	
14. Irrigation water laws influence your economic performance	
15. Irrigation water laws influence your cropping patterns.	
E4. INFORMAL WATER MANAGEMENT INSTITUTIONS	
1= *Strongly agree; 2= Agree; 3= Neutral; 4=Disagree; 5= Strongly disagree*	**Response**
16. Are there Appropriate rules exist on irrigation water management	
17. Mechanisms e.g. constitutions, to assist irrigation water management at scheme level exist	
18. The constitution is effective in the management of water resources	
19. Irrigation water policies are effective in the management of water resources.	
20. Informal water institutions are effective in the management of water resources.	
21. Informal water institutions affect your daily operation in the scheme.	
22. Informal water institutions influence your economic performance.	
23. You comply to the rules of the scheme	
24. The existing committee is effective in ensuring compliance to regulation on water uses	
25. Other water users understand the consequences of their actions in the irrigation scheme	

F. FARMER PARTICIPATION

Question	Response
F1. What are you in the scheme? *1= ordinary member, 2= committee member, 3= chairperson of the committee, 4=Other; Specify……..*	
F2. If not participating: are you willing to participate? *1=Yes; 0=No*	
F3.If not participating, give your reasons? ……	
F4.Do you pay for use of water? *Yes=1; No=0*. How much?	R
F5. If not paying, would you be willing to pay for water in the irrigation scheme? *1=Yes; 2=No*	
F6.If so much how much per month?	R
F7. If No why?.....	
F8. Who do you feel has the responsibility to ensure water availability	
F9. Why?.....	

F10.What has been your level of involvement in the following activities for the past year (June 2016-June 2017): *0=None (never involved); 1=Sometimes; 2=Always*

Activities	Rank
1. Labour based participation	
Canal cleaning (removing debris, overgrown grass, etc.)	
Repairing broken canals	
Financial based participation	
Contributing finance towards irrigation pump maintenance	
Contributing finance towards irrigation maintenance (buying material, paying the maintenance people, etc.)	
Contributing finances towards the Water Users' Association (WUA)	
2. Participation in decision making processes	
Attending irrigation meetings	
Attending irrigation/water related training	

Engaging authorities regarding water issues in the area	
Distributing information about water issues (written or verbal)	
Helping other farmers to manage/conserve water	
Other(specify)	
In electing/removing committee members	
In formulating rules in the scheme	
In irrigation water scheduling	
3. Participation in regulation and control	
Reporting unlawful behaviour (unauthorised handling, etc.)	
Reporting leakages along the canal for repairs	
How often do you attend water related meetings (e.g. weekly, monthly, none, etc.):	

F11. Participation in irrigation water management improves access to government support (*0=Strongly disagree; 1=Disagree; 2=Neutral; 3=Agree; 4=Strongly agree)*

……

F12. If irrigation farmer participates in management, Why do you participate in the management and maintenance of the irrigation scheme? (Please rank your response according to the options below (1 being the main cause; 6 being the last possible cause).

Condition	Ranking	Amount (Rands)
1. Possibility of access to water at all times		
2. Guaranteed access to water when it's your turn?		
3. In order to gain governmental support		

F15. Your participation in irrigation management increase your feeling of responsibility to manage water? (*0=Strongly disagree; 1=Disagree; 2=Neutral; 3=Agree; 4=Strongly agree)*

F16. Your participation in water related meetings help to lobby for local organisations to solve irrigation? (*0=Strongly disagree; 1=Disagree; 2=Neutral 3=Agree 4=Strongly agree)*

G. CROPPING AND MARKETING SYSTEM

G1.Please indicate the crops you planted in the past summer season, the area you planted, the output you produced and the costs you incurred

Crop name	Area Planted	Quantity harvested (kgs)	Quantity sold	Price per unit	Output Market	Inputs used	Quantity purchased	Cost per unit

Key

Crops	Market Outlet	Inputs used
1=Maize; 2=Tomatoes 3=Potatoes; 4=Sugarcane	1=Local shop 2=Neighbours 3=Contractor; 4=Hawkers	1=Fertilizers; 2=Herbicides 3=Labour; 4=Transport

5= Spinach; 6=Cabbage 7=Beans; 8=Onions 9=Butternut; 10=Other (specify)	5=Shops in town 6=Other (specify)	5=Marketing; 6=Seeds 7=Pesticides; 8=Tillage 9=Packaging; 10=Other (Specify)

G2.How often do you fail to sell your farm produce? *(Never=0 Sometimes=1 Always=2)*

……..

G3. How much do you make from your crops? R…….G4. What cropping method do you use in your plot 1=Mono-cropping; 2= Inter-cropping; 3= Crop rotation; 5= Other

H. WATER AVAILABILITY AND IRRIGATION

H1.How many times per week do you have access to water in your plot(s)?	days
• H1.1.It is adequate? Yes=1; No=0	

H8.Please rate the extent to which you agree with the following statements pertaining to water access to your irrigation plot(s). (*Strongly disagree=1 Disagree=2 Neutral=3 Agree=4 Strongly agree=5)*

Water is reliable	
I always get water in my plot(s)	
Water is sufficient for my cropping requirements	
I have the ability to pay for water and water-related services	
Water distribution/sharing at farm level is fair	

H9.Rate the amount of water you have received over the past 12 months. (1=less; 2=same; 3=more)

I. HOUSEHOLD FOOD SECURITY

No.	Question	Response(0=No 1=Yes)	How often did this happen?**
1	In the past four weeks, did you worry that your household would not have enough food?		
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?		
3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?		
4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of		

	resources to obtain other types of food?		
5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?		
6	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?		
7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?		
8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?		
9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?		

***How often did this happen?* 1 = Rarely (once or twice in the past four weeks); 2 = Sometimes (three to ten times in the past four weeks); 3 = Often (more than ten times in the past four weeks)

J: HOUSEHOLD INCOME AND EXPENDITURE INFORMATION

J1. Please indicate the amount spent per month on:

i. Food items R……. ii.

ii. Non-food items (School-fees, medical bills, utility bills etc.) R…….

J2.What were the sources of your household income in the last 12 months? (Indicate approximately how much each source contributed and how often).

Household Income Source		Total amount (Rands)	Frequency (how often?)
Remittances			
Agri activities	Irrigation Farming		
	Dry land farming		
	Livestock production		
Permanent Employment			
Temporary Employment			
Welfare grants	Disability grant		
	Child grant		

	Pensioners grant		
Other (Specify)			

J4.Please answer the following questions

Questions	Response
Do you have access to credit? *1=Yes 2=No*	
Have you taken credit or used any loan facility in the past 12 months? *1=Yes 2=No*	
If Yes, what was the main source of credit? *1= Relative/ friend; 2= Money lender; 3= Stokvel; 4= Input supplier; 5= Output buyer; 6= Financial institution (specify name)*	
If No to 4, please specify the reason(s). *1= Loan not required; 2= Interest rate is high; 3= I couldn't secure the collateral; 4= I have got my own sufficient capital; 5= It is not easily accessible; 6= I am risk averse*	
If you took credit, were you able to pay back? *1=Yes 2=No*	
If No, please specify the reason	

K.PSYCHOLOGICAL CAPITAL

K1. What is your main reason for farming? (*1=Income 2=Extra food 3=Employment 4=Other*) …….

K2. You consider farming as a business and can be managed as such**? (***1= Strongly agree 2= Agree 3= Neutral 4=Disagree 5= Strongly disagree)* ……

K3a**.**You are interested in expanding your farming operations (including increasing plots). (*1= Strongly agree 2= Agree 3= Neutral 4=Disagree 5 = Strongly disagree)*…….

K3b**.Why**?_____

_____

K4**.**Do you see yourself as a potential commercial farmer one day? 1=Yes 0=No ……..

K5. You feel confident to contribute to discussions about the irrigation scheme strategy. *(1= Strongly agree 2= Agree 3= Neutral 4=Disagree 5 = Strongly disagree)*

K6**.** How satisfied are you with the performance of the scheme? (*1=Very satisfied 2=Satisfied 3= Neutral 4= Dissatisfied 5= Very Dissatisfied) ……*

K7**.** How interested are you in being a scheme committee member? (*1= Very interested 2= Interested 3=Neutral 4= Slightly disinterested 5= Not interested at all) ……..*

K8. How interested are you in taking part in training in collective management of irrigation scheme? (*1= Very interested 2= Interested 3=Neutral 4= Slightly disinterested 5= Not interested at all*)

When working in a group securing a sustainable use of resources for the future is important? (Yes=1; No=0).

K9. How high is your confidence in farming as a means to a sustainable livelihood? (*1 =Very high 2= High 3= Neutral 4= Low 5= Very low*) **……**

K10**.** How high is your confidence in yourself as a farmer? *(1 =Very high 2= High 3= Average 4= Low 5= Very low) ……..*

K11**.** In your opinion, who should pay for water services? *(1= No one, government only 2= Everyone participating in irrigation schemes 3= Only those irrigating a lot 4= Only those that are making more money) ……..*

K12**.** Please indicate the extent to which you agree with following statements

(1=Strongly disagree=1 Disagree=2 Neutral=3 Agree=4 Strongly agree=5)

The government is not doing enough for the wellbeing of farmers	
I am optimistic about the future of farming in my are	
I am able to cope with natural shocks such as drought	
I am willing to go find a market if there aren't any available in my area	
I enjoy new challenges and opportunities	
I do not give up easily	
I am willing to take business risks	
I am willing to invest in farming and make a loss in the short-run in order to benefit in the long-run	
I have the power to affect the outcome of my farming	
I hope the quality of life will be better	
I trust other farmers	
I would not be farming If I had a better source of income	

L. SOCIAL CAPITAL

L1.Are you a member of any of the following groups

Group	Membership (Yes=1; No=0)	Function
Cooperative		
Social group (church, stokvel, burial society)		
Other (specify)		

L2.Please rank the following information sources of information relevant to your farming activities based

on how you have used them in the past year (*e.g. market prices, when to grow, where to sell). 1=Unimportant 2=Neutral 3= Important*

Extension Officers		NGO's	
Media		Private organisations	
Internet		Academic institutions	
Fellow Farmer		Others (specify)	
Community meetings		Cooperative	
Irrigation committees		Traditional Leaders	

M.CHALLENGES IN SIS

(1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree)

There are not enough plots available in the scheme	
Irrigation scheme is too far from the homestead	
People use water illegally in the scheme	
There is a lack of market access for farm produce	
Farmers are not willing to pay for water use	
People benefit from irrigation water but do not participate in the scheme	
Infrastructure is in poor condition	

In your opinion, what causes infrastructure damage?

.....

THANK YOU/SIYABONGA

APPENDIX B: REPORTS OF THE FEEDBACKS TO FARMERS

Feedback report for the household survey in Tugela Ferry Irrigation Scheme

Introduction

On the 27th of April 2018, the project team had a meeting with Tugela Ferry irrigation scheme irrigation farmers to deliver feedback on the major findings from the household survey conducted in August 2017. Only women attended the meeting. The feedback workshops focused on five issues, that is, the knowledge of laws, governance, land allocation, training, and challenges.

Methods

Preceding focus group discussions, key informant interviews and a household survey conducted in 2017, irrigation farmers were given feedback on the findings obtained from all these interviews. Findings on these issues were presented to irrigation farmer, giving them an opportunity to voice their perceptions about the authenticity of the presented findings.

Findings

Knowledge of laws

Irrigation farmers who attended had no knowledge of NWA. They operated under informal rules created by scheme irrigation farmers themselves and the traditional rules learnt from the elder irrigation farmers. They are not willing to pay for water resources, they believe that water (Tugela River) is natural and belongs to no one. No one from the department especially DWAS ever came to inform them about NWA.

Governance

Most irrigation farmer lack willingness to participate in scheme leadership due to various reasons. While elderly complained about illnesses and no formal education, others were very satisfied with the current scheme committee and believe that having many members of the scheme committee will result in conflicts.

During the discussion, it was evident that irrigation farmers are aware of the irrigation management transfer. They understand that it is now their responsibility to manage and maintain the scheme

and irrigation infrastructure. However, they are still expecting most of the things to be done by government especially the maintaining/ rehabilitating irrigation infrastructure. The only assistance they are now receiving is from the Department of Agriculture and Rural Development (DARD) with inputs.

Irrigation farmers also mentioned that the scheme committee communicates with stakeholders (DARD) but the communication is not effective.

Land Allocation

Irrigation farmers are happy with the manner in which land is allocated. The acquire land from the chief and perceive land allocations by the chief very effective and better controllable. They don't believe it should be changed to other alternatives of land acquisitions, such as acquiring land from rental markets. The land is often registered under the husband's name and transferred to the wife's name when the husband dies. Likewise in the death of both parents, the land is passed on to children. They pointed out that land is the family legacy that is transferred among generations within the household.

Training

Irrigation farmers pointed out that they do not need training related to irrigation methods and water management techniques because at the end they will be required to pay for those services. Some women also pointed out that the only training they believe is important for them is agricultural training, new cropping methods since they are still using traditional methods.

Challenges

Irrigation farmers affirmed that limited produce market access and poor irrigation infrastructure were the central challenges they were facing. Water supply is adequate but stressed on having their own *isizalo (weir)* since irrigation farmers closer to the *isizalo* sometimes block water for them to access it.

Conclusion

In summary, the main points that came out from the discussion were that irrigation farmers had no knowledge about NWA as they have never been informed about it, they were satisfied with land allocations and did not think other forms of land allocations were necessary, were not willing to participate in scheme leadership, they indicated the need for agricultural training, assistance with access to output markets. The main challenges faced in Tugela Ferry irrigation schemes were limited produce market access, poor irrigation infrastructure, and insufficient water supply to the plots due to *isizalo* that is far away from the plots (Block 5).

Feedback report for the household survey in Mooi River Irrigation Scheme

Introduction

On the 3rd of April 2018, the project team had a meeting with Mooi River irrigation scheme irrigation farmers to deliver feedback on the major findings from the household survey conducted in August 2017. Approximately 20 irrigation farmers attended the meeting with the majority being women. The major areas for the feedback meeting focused on the following five issues: knowledge of laws, scheme governance, land allocation, training received as well as challenges faced by scheme irrigation farmers.

Methods

The feedback to irrigation farmers was delivered in a form of discussion where the project team presented findings and allowed irrigation farmers to comment on the findings and base their comments on the causes, effects, and strategies that irrigation farmers have tried to overcome/ deal with the possible causes for those issues.

Findings

Knowledge of laws

Irrigation farmers in the meeting did not have knowledge on NWA and no one from the departments came to capacitate them with laws implemented at national level. They only operated under informal (scheme) rules created by irrigation farmers themselves.

Governance

Findings from the survey indicated unwillingness of irrigation farmers in scheme leadership. In the feedback meeting indicated several reasons for this unwillingness to participate which included the following:

- It is not easy to lead people since they have different personalities,

- Being a member of the scheme committee is time-consuming and end up neglecting your crops, sometimes do not even get water on your irrigation day,
- Self-doubt, not educated and not used to meetings,
- It is costly, you use your own money for transport and phone calls, and time away from plots

Scheme leaders in Mooi River irrigation scheme value communication with other committees and stakeholders (extension officers from the department) and believe it is important and benefits them. If there is a problem in one area, they interact with each other to help solve the problem.

The central problem in Mooi River irrigation scheme is the issue of unequal access to irrigation water. Irrigation farmers from the upper blocks do not follow irrigation schedule and irrigate even if it is not their turn to irrigate. In the past, the government used to hire water wardens (*iphoyisa*) to organize daily water schedule after irrigation farmers indicated their needs; cleaning of canal and furrows; helps resolve conflicts over irrigation water. The solution to this problem suggested by irrigation farmers was to hire *iphoyisa* but sources of limitations to this could be the lack of funds from the other blocks, corruption-irrigation farmers who are well-off in terms of money can bribe *iphoyisa* to let them irrigate even if it is not their turn.

Despite the challenges that irrigation farmers face with the accessibility of adequate irrigation water, they are still not willing to pay for irrigation water. They believe that more water is used in the suburbs. They do not understand how water can be controlled in their irrigation scheme since there is no meter to control water usage. Usually, irrigation farmers clean and fix canals themselves. The contractors that have been hired by the government/ the department to rehabilitate the canal never finished instead they caused more damages. The last one caused damages not only to the canal but also to the community, they cleaned the canal and the dam but left open without fencing. Children played there and one of them died.

Land allocation

Land in Mooi River irrigation scheme is mainly allocated by the chief (Mchunu) and irrigation farmers are satisfied with how the Chief allocated land. Women are also satisfied with land allocations and consider land as a family legacy. Although men are custodians of land in Msinga,

the land is transferred to the wife in the death of a husband and also transferred to the children when both parents die. The land is only taken away if is not cultivated.

Training

Findings from the survey indicated low levels of training in Msinga. Irrigation farmers indicated that they only receive training from extension officers although no formal training has been provided on irrigation and water management. Irrigation farmers showed willingness to learn about these laws if someone can come to teach them how to manage water resources and if that will benefit them in the long run. Areas of training that farmers seek training in were market since they lack output market to sell their output produce and training on diseases affecting their crop because extension officers did not know about these diseases.

Challenges faced in the irrigation scheme

Among challenges that irrigation farmers often face in smallholder irrigation schemes, Mooi River irrigation farmers highlighted inadequate water supply, poor infrastructure and lack of access to output market as the major challenges faced.

Conclusion

In summary, the main points that came out from the discussion were that irrigation farmers had no knowledge about NWA as they have never been informed about it, they were satisfied with land allocations and did not think other forms of land allocations were necessary, were not willing to participate in scheme leadership, were good with agricultural practices and only felt they needed training of water management techniques, markets and pests and crop diseases. The main issues faced in Mooi river irrigation schemes were inadequate water supply, poor infrastructure and limited access to output market.

Feedback Report for the Household Survey in Makhathini and Ndumo Irrigation Schemes

Introduction

On the 25th and 26th of April 2018, the project team had a meeting with Makhathini and Ndumo irrigation scheme irrigation farmers respectively to deliver feedback on the major findings from the household survey conducted in August 2017. About 12 irrigation farmers attended the meeting at Makhathini with females only in attendance and about 32 irrigation farmers in Ndumo irrigation scheme (A and B), with the majority being men. The major areas for the feedback meeting focused on the following five issues: knowledge of laws, scheme governance, land allocation, training received as well as challenges faced by scheme irrigation farmers.

Methods

The feedback was delivered to the irrigation farmers in a form of discussions where the project team members presented findings and allowed irrigation farmers to comment on the findings and base their comments on the causes, effects, and strategies that irrigation farmers have employed in trying to deal with the possible causes for those issues. Farmers were asked to engage in the discussion, and respond to the findings, whether they are true or not.

Findings

Knowledge of laws

According to the study, Makhatini, Tugela-Ferry and Mooi-River farmers are not aware of the NWA, while Ndumo farmers are aware of the act. Mjindi is responsible for communicating such information with them, farmers are required to pay for water in order to have access, but the NWA has never been communicated.

Makhathini farmers were asked if they think it was important or useful for them to know about where these laws/policies come from and who implements them, and they responded that they would like to know. Farmers complained that they pay water fees every month even if they only use the water for two weeks and not the whole month, they have to pay the full fixed cost. They feel they need to see the bigger picture as to why they pay the water fees.

Ndumo farmers know and are aware of the act. They have been introduced to the act by the Department of Sanitation, where they were told about water rights but do not comply with the rules and laws that come with the act. They feel that they still need to be educated about the NWA. They only operated under informal scheme rules created by irrigation farmers themselves.

Governance

Findings from the survey indicated that irrigation farmers were not willing to take part in scheme leadership. In the feedback meeting, irrigation farmers indicated several reasons for this unwillingness to participate which included the following:

- Being a member of the scheme committee is time-consuming and end up neglecting your crops, sometimes do not even get water on your irrigation day,
- Young farmers find it difficult to lead older people,
- Farmers said being part of the committee means you spend more time focusing on committee issues rather than focusing on your farm which is their source of income
- There are no incentives in being part of the committee, they end up using their own money for transport to attend meetings and for phone call,

Female farmers from Ndumo indicated that they would like to participate in scheme leaderships, and the youth fell that the government has failed to provide them with agricultural education and training to encourage them inti getting inti Agribusiness. Ndumo farmers do not pay for water use, they pay for electricity usage. They recently experience theft of their electric cables, and were

working on replacing the cables among themselves. They say waiting for help from the government takes longer hence when they solve problems among themselves its quicker and more efficient.

Farmers were asked if they value the presence of cooperatives and committees, and they said they do. They would be willing to be part of committees if they were to get paid for their services. Farmers were asked if they would be willing to make monthly contributions to pay members of the committee, they responded that they are strongly willing and that they would have to have a meeting to determine how much they should contribute towards this suggestion. Farmers concluded this topic by saying they are not ready to work independently as they lack the power and resources. When asked if they satisfied with the work that the current committee does, they responded with a no. They feel their complaints do not get to the higher power in time, because the committee members are also busy focusing on their farming plots and sometimes don't get around to submitting their complaints.

Land allocation

Makhathini farmers are not satisfied by the way in which they are allocated land, a new system which began in 2018 is used, and they now get land through Trusts. They are allocated 2ha of land of which is smaller compared to the 5ha they were previously allocated by Land affairs. Farmers previously had their 5ha and 41ha shared land for farming, with the trust in place the shared land was taken from the irrigation scheme members. With the new land allocations in place, farmers have insecure rights to land as they have to renew their lease contracts every year. Farmers want bigger plots with longer term contracts.

Ndumo farmers are not happy that the plots they farm in belong to the chief, although they invest so much in the land, they do not have tittle deeds. This is a challenge as they are not able to acquire credit since they do not have tittle deeds. They fear that in the long-run the land may be taken from their children and the next generation. There are uncertainties and insecurities regarding land ownership among the irrigation farmers.

Skills and training

Makhathini and Ndumo farmers have received agricultural training but both schemes have not receive much training on irrigation and water conservation. Both schemes highlighted that water conservation and irrigation training is much needed, as some farmers irrigate with more water than they should. Although most of the farmers received training, some have not. Members of the schemes who received training do share with other members but it's not as effective. Farmers pointed out that they need more training on financial management, soil sampling for lab testing.

Market and Infrastructure

Makhathini irrigation farmers have do not have a stable access to market for selling their produce, they try to sell their produce on their own to the locals, at times they get approached by individuals who offer to find a market and sell their produce but end up not getting their money afterwards. Ndumo farmers also do not have a stable marked but they are better compared to all the other irrigation schemes, they manage to sell bulk of their produce to different people and locals.

Challenges faced in the irrigation schemes

Among challenges that irrigation farmers often face in smallholder irrigation schemes, Makhathini irrigation farmers highlighted inadequate water supply, poor infrastructure and lack of access to output market as the major challenges faced. Their main water pipes (underground) burst regularly which affects distribution. Ndumo farmers faces challenges of water engines, they are old and underperforming, and they buy and replace their own resources without help from the government.

Conclusion

In summary, the main points that came out from the discussion were that Makhathini irrigation farmers had no knowledge about NWA as they have never been informed about it, and both irrigation schemes were not satisfied with land allocations and did think other forms of land

allocations were necessary, were not willing to participate in scheme leadership, were good with agricultural practices and only felt they needed training of water management techniques, financial management, markets and land allocation. The main issues faced in Makhathini irrigation schemes were inadequate water supply, poor infrastructure and limited access to output market. The main issues faced by Ndumo irrigation scheme were limited access to market, poor infrastructure and lack financial management.

MINUTES OF THE FEEDBACK MEETING TO JOZINI FARMERS

on the project

ASSESSMENT OF POLICIES AND STRATEGIES FOR THE GOVERNANCE OF SMALLHOLDER IRRIGATION FARMING IN KWAZULU-NATAL PROVINCE, SOUTH AFRICA

Date: 22 August 2019

Time: 10: 00 am

Venue: Mjindi Hall

1. Attendance

Some 35 farmers attended the meeting. Also attending were Prof Mudhara and Dr A. Senzanje (UKZN academics), S. Ngcongo (UKZN master's student) and two Agricultural Extension Officers from the provincial Department of Agriculture. See attendance register.

1.1 Call to order

Prof Mudhara (University of KwaZulu-Natal (UKZN), chairperson of the Water Research Feedback Meeting called the meeting to order at 10:00 am. The meeting opened with a prayer from one of the farmers.

1.2 Welcome

Prof M. Mudhara welcomed all to the meeting. He said he was happy to see majority of those attending were farmers, not only committee members. He said this indicated that they were hungry for success. Prof Mudhara added that he expected everyone to actively and freely participate in the discussion. Mr Ngcongo was appointed as the translator, translating from English to IsiZulu to ensure that farmers understand since the majority did not understand English perfectly.

1.3 Purpose of the meeting

The purpose of the meeting was indicated as to give feedback to farmers in Jozini on research

studies conducted to assess the effectiveness of government policies, rules and strategies and implementation thereof to assist smallholder irrigation farming with a focus on KwaZulu-Natal.

2. Main Points of the Feedback Presentation

Below are some of the main points in the feedback presentation to the farmers.

a) The research: The research was premised on acknowledging that water management is key to agricultural production. Realising this, the government of South Africa had invested in the revitalisation of smallholder irrigation in the country, including KwaZulu-Natal.
b) Research objectives: The main objective of the research project was to assess the effectiveness of policies and strategies, including rules and regulations, in the governance of smallholder irrigation farming in KwaZulu-Natal.
c) Research sites: the research was undertaken at four smallholder irrigation (SHI) schemes, namely Tugela Ferry Irrigation Scheme (TFIS), Mooi River Irrigation Scheme (MRIS), Ndumo Irrigation Scheme (NIS) and Makhathini Flats Irrigation Scheme MFIS). The case study schemes offered a variety of characteristics that enriched the study and these included; land holding size, irrigation infrastructure, management structures in place, production focus, support services in place, and so on.
d) Data collection: In total, data was collected from some 340 farmers broken down as 120 respondents in MRIS, 120 in TFIS, 60 MFIS and 40 in NIS.
e) General findings of the study:
    - There exists formal and informal institutions in SHI and these have overlapping functions which makes systems dysfunctional.
    - There seems to be dynamic government rules and regulations, and static informal rules and practices.
    - Some of the government programmes in SHI are not taken on seriously by farmers, for example, Irrigation Management Transfer (IMT), Participatory Irrigation Management (PIM), establishing Water Users Associations (WUA) and/or Irrigation Management Committees (IMC).

- Different government departments use different approaches when dealing with SHI farmers. As an example, Department of Agriculture Forestry and Fisheries (DAFF) uses WUAs whereas Department of Agriculture, Land and Rural Development (DALRD) tends to deal with cooperatives.
- Farmers were given different types of support by government, private sector and non-governmental organisations (NGOs), depending on the production orientation – commercial oriented or food security oriented. Some of the support includes fertilisers, agro-chemicals, seeds and tractors, as well as SHI scheme infrastructure revitalisation and general annual infrastructure maintenance.
- Perceptions by farmers differ over traditional rules depending on the level of commercialisation. The more commercial the level of production the less traditional rules are observed.
- Regarding land tenure, for subsistence level operations, the farmers are happy with traditional authorities, whereas those following commercial production favour having title deeds to the land they cultivate.
- Effectiveness of SHI governance manifests through water management, water security, farmer participation in scheme activities and infrastructure management.
- The relationship or linkages among rules and regulations in SHI governance are cyclical and complex and are driven by a number of factors.
- A number of factors are key drivers to the effectiveness of SHI governance and these can be categorised under the following; socio-economic factors, equitable access to water, awareness of policies, rules and regulations, and participatory governance.

f) Recommendations: The following were the recommendations from the research across the SHI in KZN:

- There is a need to harmonise formal and informal institutions.
- Gender equity must be prioritised, noting that equity is different from equality.
- SHI farmers need to be trained so that there are sensitised to government policies, rules, and regulations.

- Farmers need be trained in irrigation water management as well as irrigated agricultural production.
- SHI and other stakeholder need to be sensitised to government initiatives so that they become receptive to these and can benefit.
- Any policy changes by government must take into cognisance local institutions and incorporate these in water governance issues.
- Government and SHI farmers need to work together to reconfigure the WUA.
- IMT seems not to be widely understood or accepted, so it needs to revisited and identify what features to retain, what to modify and what to discard.

3. Questions and Discussion

After the presentation, the floor was opened for discussion as well as questions from all participants. The following were some of the issues raised:

a) IMT – farmers and extension workers wanted to get an understanding of IMT and how it actually functions.
b) Tenders – farmers indicated that they believed that tenders for SHI service provision were given to incompetent companies or individuals and in the process farmers suffered.
c) Infrastructure maintenance – it was not clear to farmers as to who does what maintenance of irrigation infrastructure and up to what point from source to field level.
d) Water management problems – farmers highlighted the problem relating to timely water availability and its impact on crop performance and hence farm income.
e) Mjindi contract – it was highlighted that the Mjindi contract was ending and most of their responsibilities would be taken over by the farmers.
f) IMT – government needed to review irrigation management transfer and make it workable.
g) Revitalisation – government needed to revitalise some of the infrastructure as it was old.

4. Conclusion

The meeting concluded with the chairman thanking all the attendees and their enthusiastic participation. The research team encouraged farmers to attend such meetings as it allows them to flag their concerns. The meeting was closed with a prayer from one of the farmers.

The meeting ended at 13:00 hours.

MINUTES OF THE FEEDBACK MEETING TO MSINGA FARMERS

ON THE PROJECT

ASSESSMENT OF POLICIES AND STRATEGIES FOR THE GOVERNANCE OF SMALLHOLDER IRRIGATION FARMING IN KWAZULU-NATAL PROVINCE, SOUTH AFRICA

Held on 23 July 2019 at Msinga Library starting at 10am.

Chairperson: Prof M.M Mudhara

Scriber: Ms. Z.D Tibane

1. The meeting was opened with a prayer.

2. Prof Mudhara's presentation touched on the following issues:

Project background

- The main aim of the project was to look at all the factors that were hindering the irrigation schemes from performing at optimal levels and to look at the stakeholders that are involved (all Departments) and the policies, strategies, regulations and rules that make up the governance of the schemes.
- The research sites were: Tugela-Ferry, Mooi-River, Makhathini Flats and Ndumo irrigation schemes. They were chosen on the basis that they all had unique characteristics for contrasting and comparison purposes, such as, size ranging from 0.1 ha/farmer (for food security) to 10 ha/farmer (for commercial purposes).
- The research methodology used in the project comprised meetings with the farmers in the form of focus group discussions and farmer interviews through structured questionnaires.

Conclusions from the study

- The study found a co-existence of both formal and informal institutions at the schemes, which is causing some conflict and a dysfunction in the implementation of strategies, rules and regulations.
- The study showed that government policies, rules and regulation were dynamic, i.e. always change subject to whether they are useful or not, yet the local institutions are static.
- IMT, WUA's and PIM have not become fully operationalized, instead concocted governance settings prevail.
- Government departments use different approaches to interact with farmers in the different irrigation schemes (DWA vs DAFF/DARD; WUAs and Cooperatives), which leads to different levels of understating of rules and regulations.
- In the case of the project Mooi and Tugela-Ferry irrigation schemes can be classified as food security centered and Makhathini Flats and Ndumo can be classified as commercial.
- Farmers perceptions of traditional rules differ with the level of commercialisation in the schemes. Traditional rules are not as effective in the commercialized schemes.
- Land tenure: Mooi-River and Tugela-Ferry irrigation schemes are satisfied with traditional authority land allocation.
- The commercialized schemes find lack of tittle deeds hinder their investment decisions in the farms.
- Effectiveness of governance expressed itself through various aspects:
    i. Water management;
    ii. Water security;
    iii. Farmer and stakeholder participation;
    iv. Infrastructure management.
- Non-linear relationship between rules and regulations in governance and factors determining its effectiveness (is cyclical and complex).

The study identified factors contributing to effectiveness of policy, rules and regulations and there

were:

- Socio-economic factors
    - Gender
    - Availability of water rights
    - Land tenure/ownership
- Awareness of NWP equitable access to water
    - Access and sharing of water
    - Distribution of water
    - Availability of water
    - Reliability of water
- Awareness of policies rules and regulations
    - Irrigation training and education
- Irrigation governance
    - Farmer participation in management.
    - Irrigation committee membership
    - Ability and willingness to pay

Recommendations

- Where formal and informal institutions are in conflict, there is a need for them to be harmonized.
- Gender equity should be prioritized.
- Trainings programmes for farmers should increase irrigators' awareness of different government initiatives, policies, rules and strategies.
- Water management and irrigation training should be a priority.
- Stakeholders should be sensitized and be made fully aware of government initiatives.

Inputs from Irrigators

The floor was opened for questions and inputs from the irrigators and different stakeholders that were present:

- A question was raised as to the way forward. Irrigators wanted to know the next for things to happen on the ground. Prof Mudhara responded that after the Msinga feedback, there were going to be another feedback to stakeholders in Makhathini Flats and then DARD and others. After that it was going to be up to government to decide the next step since they partly funded the research in the quest for answers.
- A question was also raised as to whether the team had come to Msinga to learn or teach or hear the farmers' queries. The response was that this was a feedback session on the findings from the research, and then also to DAFF via WRC in Pretoria.
- Mr Mtungwa (an irrigator) highlighted that the biggest issue they faced was securing a formal market for their produce. He was aware of the programs such as AGRIPARK and RASET, which is a market for fresh produce.
- The extension officers from DARD pointed out that the Revitalisation program did not include road infrastructure, which meant that the conditions within the irrigation schemes did not allow for easy access to markets. He requested that roads leading to the irrigation schemes be fixed as it hinders buyers and extension officers from accessing the schemes.
- The farmers also highlighted the need for each scheme to have its own tractors for tillage. Nevertheless, they expect the government to provide.
- The extension officers also suggested that irrigators should look into venturing to agro-processing and participate in a wider breath of the value chain.
- Farmers raised the point that water distribution among blocks is an issue of great concern. Farmers requested that water be distributed fairly, by rotation, as it was done before with the presence of a bailiff (iphoyisa or ihanesi). They emphasized that there was no water at all reaching Blocks 14 and 15, hence there was need for a solution to be found.
- Irrigators indicated that they do not get water in the winter season and requested that the government buy engines, water storage tanks and pumps for their use.

- Prof Mudhara highlighted the importance of irrigators to be aware of regulations and issues of water rights.

The meeting was adjourned at 13h00 with a prayer.

APPENDIX C: ABSTRACTS OF DISSERTATIONS PRODUCED DURING THE STUDY

Engineering and Water Governance Interactions in Smallholder Irrigation Schemes for Improved Water Management

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ABSTRACT

Smallholder irrigation schemes (SISs) in South Africa have reported below expectation performance, despite massive investments. A diagnosis of the SISs poor performance indicates prevalence of infrastructural deficiencies, as well as poor institutional setup. The government's irrigation management transfer (IMT) initiative compounds the problem. IMT placed irrigation farmers in self-governance, which advertently made irrigation farmers carry the burden of scheme O&M costs. This study sought to establish potential synergies between water governance and water control infrastructure in relation to scheme performance in KwaZulu-Natal. The study hypothesized that the existing current water control infrastructure does not match up to the water governance frameworks in the selected study sites. The study was carried out in Tugela Ferry Irrigation Scheme (TFIS) and Mooi-River Irrigation Scheme (MRIS). An infrastructure condition assessment was carried out followed by a root cause analysis. Questionnaires were then administered to relevant stakeholders to rate the degree of identified causal factors. Key informants ranked how water governance and infrastructure aspects are related. The data was processed using fuzzy theory. Finally, structured questionnaires were administered to irrigation farmers to establish how water governance impacted on water adequacy for crop production. A binary logit regression model was employed to process the data. Assessments revealed the poor condition of infrastructure such as deep cracks in canals and missing latches on hydrants. The study revealed that TFIS had a strong institutional setups according to the Closeness Coefficients($CC_i = 0.18$), and clearly defined goals and objectives for the scheme operation. However, other governance aspects such as procedures ($CC_{TFIS} = 0.17, CC_{MRIS} = 0.16$) were not strong. MRIS ($CC_{MRIS} = 0.20$) had a good standing on rules and regulations as compared to TFIS ($CC_{TFIS} = 0.14$). The binary logit regression model identified five explanatory variables that

statistically significantly influenced water adequacy. The five variables were irrigation scheme($p = 0.000$), location of plot within the scheme($p = 0.001$), training in water management($p = 0.022$), satisfaction with irrigation schedule ($p = 0.000$) and water conflicts between block($p = 0.081$). A descriptive analysis showed that 24% and 86% of the farmers in MRIS and TFIS respectively, had adequate water. The study concluded that the SISs lacked an O&M plan and the farmers were not willing to opt for collective action and cooperate in Water Users Association (WUAs) and Irrigation Management Committees (IMCs). Some of the water governance aspects were discordant with infrastructure characteristics and requirements, consequently, impacting on the water adequacy for the irrigation farmers. Overall, the study approved the hypothesis that the water control infrastructure does not match up with the water governance frameworks. This study recommends that the stakeholders involved in SISs, i.e. government, extension workers NGOs, should aid the irrigation farmers in policy articulation. In addition, the WUA and IMCs should provide incentives to motivate farmers to actively participate in scheme O&M.

Effects of interactions between governance, intergenerational and gender dimensions on smallholder irrigation scheme in KwaZulu-Natal, South Africa

Senamile Fortunate Dlangalala

ABSTRACT

Smallholder irrigation schemes (SISs) face several challenges hindering them from performing at satisfactory levels. In South Africa, the government made considerable financial investments in developing SISs and revitalising them to improve their performance. However, poor performance persisted, indicating that the key root of poor performance could lie elsewhere, e.g. weak institutional arrangements, an aspect which is often overlooked, and in an inequitable distribution of land and other productive resources across intergenerational and gender dimensions. Researchers have argued that the absence of effective management regimes was underpinning the poor performance of SISs.

This study sought to assess the effects of the interaction between governance, on one hand, and intergenerational and gender dimensions, on the other, on the performance of SISs in KwaZulu-

Natal, South Africa. The specific objectives were to describe the institutional arrangements for water management in SISs, to identify the determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in SISs, and to investigate the effects of governance on cropland allocation across gender and intergenerational dimensions in SISs. The study was conducted in Mooi River, Tugela Ferry Irrigation Schemes located in Msinga Local Municipality and Ndumo Irrigation Scheme located in Jozini Local Municipality. Primary data were collected through focus group discussions, key informant interviews and a structured household questionnaire administered by Zulu-speaking enumerators. Stratified and systematic random sampling techniques were employed to select survey respondents.

Empirical models used were the Descriptive Statistical technique, Principal Component Analysis, Ordinary Least Squares technique and Fractional Regression Generalized Linear model. The results indicated that the studied irrigation schemes had functional institutional arrangements, and all schemes had scheme committees, i.e. the leaders responsible for ensuring that all the scheme rules and policies are obeyed. Furthermore, the study revealed that formal water institutions were unknown and non-existence at the local level which led to a high reliance on informal institutional arrangements for water resource management. The statistically significant determinants of farmer awareness of water governance dimensions were along the gender, level of education, water management training, scheme location, membership in water users association, stakeholder participation, farmer's involvement in scheme decision-making processes, and source of information. Age of an irrigation farmer, size of a plot, type of land ownership, access to credit, revenue (farm income), and irrigation water sufficiency were found to have a significant influence on cropland allocation decisions. Through the application of Fractional Logit Generalised Linear Model, the study concludes that gender of an irrigation farmer, farmer perceptions with scheme water governance and irrigation water schedule do not influence farmer decisions on cropland allocation in Mooi River, Tugela Ferry and Ndumo irrigation schemes.

There is a need to raise irrigation farmers' awareness about formal water institutions, their intentions and the importance of knowing them. In addition, irrigation farmers need to be capacitated on best management practices and in making informed production decisions. Therefore, improvements in communication between irrigation farmers and external stakeholders

are critical. Moreover, government and policymakers must incorporate customary laws when formulating national laws to increase compliance by smallholder irrigation farmers with formal water institutions.

APPENDIX D: ABSTRACT OF PAPERS PRODUCED DURING THE SYUDY

Dirwai, T.L., Senzanje, A. and Mudhara, M. (2019). Assessing the Functional and Operational Relationships between the Water Control Infrastructure and Water Governance: A case of Tugela Ferry Irrigation Scheme and Mooi River Irrigation Scheme. *Physics and Chemistry of the Earth* 112: 12-20

Assessing the Functional and Operational Relationships between the Water Control Infrastructure and Water Governance: A case of Tugela Ferry Irrigation Scheme and Mooi River Irrigation Scheme

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Abstract

Water governance is a multi-level and multi-actor decision-making process. The multi-actors are grouped under formal and informal institutions, and they collectively determine how irrigation scheme infrastructure is operated or managed. Infrastructure and governance interactions are precursors to a fully functional irrigation scheme, consequently enhancing agricultural productivity, which subsequently boosts rural economies. Water control infrastructure is a critical component that determines management of canal operation and use, and therefore, has to be built within a water governance framework that considers multisector and multilevel actors. This paper sought to establish an operational and functional relationship between water control infrastructure and the existing water governance in Mooi River Irrigation Scheme (MRIS) and Tugela Ferry Irrigation Scheme (TFIS). The technology adopted was imposed rather than being setup in a participatory manner and only considered engineering and hydraulics and not human and institutional aspects. This study uses a fuzzy model to establish a link between water control infrastructure, i.e. its characteristics, operational requirements, on one hand, and the existing water governance frameworks in the respective irrigation schemes, on the other. The approach was based on Fuzzy Analytical Hierarchy Process (FAHP) and Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (FTOPSIS). The FAHP techniques was used to determine the fuzzy weight of the water control infrastructure aspects and the FTOPSIS was used to rank the water governance aspects, i.e. institutions, processes, procedures, rules and regulations, with respect to the infrastructure weights. Due to the high uncertainty and vagueness, the linguistic variable were expressed, as triangular fuzzy numbers. Questionnaires were administered to five irrigation experts from each scheme. The Closeness Coefficient (CC_i) was used for ranking. The study revealed that TFIS had strong institutional setups ($CC_{TFIS} = 0.18$), as compared to MRIS ($CC_{MRIS} = 0.13$). However, TFIS showed a low ranking on rules and regulation

($CC_{TFIS} = 0.14$). Farmers unwillingness to pay water tariffs and contribute funds for operation and maintenance is illuminated under the rules and regulations governance pillar. A collective and participatory approach is required to improve on the water governance shortcomings. In consequent, this will improve the scheme performance.

Keywords: Fuzzy Analytical Hierarchy Process (FAHP), Fuzzy Technique for Order of Preference by Similarity to ideal Solution (FTOPSIS), MCDM, Linguistic Variables.

Dirwai, T.L., Senzanje, A. and **Mudhara**, M. (2019). Water governance impacts on water adequacy in smallholder irrigation schemes in KwaZulu-Natal Province, South Africa. *Water Policy* 21 127-146

Water Governance Impacts on Water Adequacy in Smallholder Irrigation Schemes in KwaZulu-Natal Province, South Africa

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Abstract

Water adequacy is central to maximized agricultural production in irrigation schemes. Smallholder irrigation schemes (SISs) are designed to distribute water efficiently, adequately and equitably. Water governance, defined as the institutions, processes, procedures, rules and regulations involved in water management, plays an important role in water allocation and subsequently water adequacy. The intersectoral institutions involved in water governance in SISs, i.e. government, water users associations (WUAs), irrigation management committees (IMCs) and traditional authorities, interact to formulate and design policies for running SISs. However, multilevel interaction amongst the active stakeholders at multiple levels shapes policy and underlies SISs performance. This research aimed at investigating the impacts water governance had on adequacy of water in irrigation schemes and it was premised on the hypothesis that governance had no effect on water adequacy. Water adequacy describes water supply relative to demand. Adequacy indicates whether the water delivery system supplies the required amount to a section in the irrigation scheme over a period of time (daily, monthly or seasonally). Two irrigation schemes, Mooi River (MRIS) and Tugela Ferry Irrigation Schemes (TFIS) were used as case studies. A descriptive analysis showed that 86% of the farmers in TFIS had adequate water, whereas 24% in MRIS

had water adequacy. A Binary Logit model was employed to investigate the factors that influence water adequacy among irrigation farmers. The regression model identified eight statistically significant factors that influenced water adequacy, and these were irrigation scheme, location of plot within the scheme, training in water management, training in irrigation, irrigation farmers' knowledge about the government's aims in SIS, availability of water licenses, payment of water fees and satisfaction with irrigation schedule. The study concluded that governance factors had influence on water adequacy in the selected SISs. The implication is that stakeholders should make irrigation farmers aware of government irrigation management transfer (IMT) policy and strategies. The study recommended that the schemes put rules, procedures and protocols to support irrigation farmers to enhance scheme governance and lead to realisation of government policies.
Keywords: Binary Logit, Governance, IMT, Regression, Water adequacy

Dirwai, T.L., Senzanje, A. and Mudhara, M. (2019). An Investigation and Condition Assessment of the Existing Water Control Infrastructure in Selected Smallholder Irrigation Schemes: Case of Tugela Ferry Irrigation Scheme and Mooi River Irrigation Scheme, South Africa. *Irrigation and Drainage* 68: 657-668.

AN INVESTIGATION AND CONDITION ASSESSMENT OF THE EXISTING WATER CONTROL INFRASTRUCTURE IN SELECTED SMALLHOLDER IRRIGATION SCHEMES

CASE OF TUGELA FERRY IRRIGATION SCHEME AND MOOI RIVER IRRIGATION SCHEME, SOUTH AFRICA

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ABSTRACT

Note: please reduce the abstract to not more than about 200 words

This study investigated and evaluated the condition of the existing water conveyancing, storage and control infrastructure at the Mooi River Irrigation Scheme (MRIS) and the Tugela Ferry Irrigation Scheme (TFIS), in KwaZulu-Natal, South Africa. An Infrastructure Condition Assessment (ICA) was undertaken based on inspections and condition scoring or grading. In addition, technical experts were consulted to determine weights of the structural evaluation criteria using the Analytical Hierarchy Process (AHP). Furthermore, the Fishbone 'Ishikawa' diagram and the Relative Causal Index (RCI) method were used to carry out the root cause analysis (RCA). For RCI, questionnaires were administered to stakeholders to capture their perception on the causal factors. According to the study, the Fishbone 'Ishikawa' diagram characterized and identified 23 probable causal factors that led to infrastructure dilapidation. The RCI quantified the causal factors and revealed the converging points between technical experts (te) and the extension workers (ex) regarding causal factors. The converging causal factors were

maintenance ($RCI_{te} = 0.8, RCI_{ex} = 0.7$), people ($RCI_{te} = 0.7, RCI_{ex} = 0.7$), institutional ($RCI_{te} = 0.7, RCI_{ex} = 0.6$) and environmental ($RCI_{te} = 0.8, RCI_{ex} = 0.7$) related. The study further revealed that, the stakeholders involved had points of divergence on causes of infrastructure decay. Follow-up questionnaires were again administered to capture the reasons of diverging thoughts. The study recommends participatory engagement in process and procedure design for enhanced infrastructure condition.

KEY WORDS: infrastructural condition assessment; root cause analysis; relative causal index water infrastructure; smallholder irrigation.