

**CONDITIONS CHARACTERIZING THE SUSTAINABILITY OF SMALLHOLDER  
IRRIGATION SCHEMES: THE CASE OF BIKITA DISTRICT ZIMBABWE**

By

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A dissertation submitted in fulfilment of the requirements for a

Philosophiae Doctor in Geography

in the

Faculty of Natural and Agricultural Sciences

at the

University of the Free State

Qwaqwa

May 2016

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## **DECLARATION**

I declare that this thesis, submitted in fulfilment of the degree Philosophiae Doctor in Geography at the University of the Free State, is my own independent work, which I have not previously submitted for a qualification at another university or faculty.

I furthermore cede copyright of the dissertation in favour of the University of the Free State.

Qwaqwa, 2016

## ACKNOWLEDGEMENTS

I wish to express my sincere gratitude and appreciation to The Good Lord for life and health, and for all the opportunities and blessings that have made it possible for me to produce this work. May His name be glorified forever! Amen.

I also wish to express my gratitude towards

- My supervisor, Dr G. Mukwada, for his advice, guidance, encouragement and constructive criticism throughout the compilation the thesis. I am highly indebted to him for his responsible, meticulous and dedicated supervision of this work, and for all he has done for me.
- The University of the Free State, for its assistance in the form of a postgraduate workshop presentation, which gave me the opportunity to interact and share ideas with renowned scholars, who assisted in shaping my thesis.
- The Ministry of Agriculture, Masvingo Provincial Director, District AGRITEX Officer, Mr Mugari, and all irrigation-based AGRITEX officers who gave me permission to carry out the research at their schemes.
- Mr Chivhenge and Mr Museba, thanks for resounding support in moulding the thesis.
- My dear wife Julian, and children, Samantha and Samuel deserve a special word of thanks. I am indeed proud of her, for her encouragement, and for her social, emotional and financial support during the time of my fieldwork.
- Lastly, all the many researchers whose works and ideas I used to augment my thoughts and opinions in this study.

## **DEDICATION**

This work is dedicated to my beloved wife Julian, my daughter Samantha, and my only son Samuel, as well as to my late parents, Chazovachii Zvavarungu Patrick and Sosana Harungwarwi Makwamure, Rutete. I cherish the values and ethos I learnt from my late parents. Father and Mother, you have always been my fortress, my heroes and my pillars of strength. Thank you for always encouraging me to work.

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## **LIST OF ACRONYMS**

ADA:	Agriculture Development Association
AGRITEX:	Department of Agricultural Research and Extension
ARDA:	Agricultural and Rural Development Authority
ARDA:	Agriculture and Rural Development Association
CBNRM:	Community Based Natural Resources Management
CCMD:	Capacity Continuum – Multiple Drivers Model
CPR:	Common Pool Resources
CSO:	Central Statistical Office
DFID:	Department of International Development
DoI:	Department of Irrigation
EIA:	Environmental Impact Assessment
FAO:	Food and Agricultural Organization
FTLRP:	Fast Track Land Reform Programme
GDP:	Gross Domestic Product
GMB:	Grain Marketing Board
GoZ:	Government of Zimbabwe
GTZ:	Gesellschaft für Technische Zusammenarbeit
IFAD:	International Fund for Agricultural Development
IMC:	Irrigation Management Committee
IMT:	Irrigation Management Transfers program
IWRM:	Integrated Water Resources Management
JICA:	Japan International Cooperation Agency
LDC:	Least Developed Countries
MAIM:	Ministry of Agriculture, Irrigation and Mechanization
MDGs:	Millennium Development Goals
MWRD:	Ministry of Water Resources and Development
NFIF:	National Farm Irrigation Fund
NGO:	Non-Governmental Organizations
NORAD:	Norwegian Development Corporation
SIA:	Social Impact Assessment

SIDA:	Swedish International Development Cooperation
SLF:	Sustainable Livelihood Framework
ST:	Sustainability Theory
SPSS:	Statistical Package for Social Scientists
TILCOR:	Tribal Trust Land Development Cooperation
UDI:	Unilateral Declaration of Independence
UN:	United Nations
VSBT:	Viability System Based Theory
WUAs:	Water Users Associations
WWF:	World Wildlife Fund
ZAPF:	Zimbabwe Agricultural Policy Framework
ZFU:	Zimbabwe Farmers' Union
ZINWA:	Zimbabwe National Water Authority

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## **ABSTRACT**

This thesis examines conditions characterizing viability and sustainability of smallholder irrigation agriculture based on four smallholder irrigation schemes in Bikita District, Masvingo Province of Zimbabwe, namely Chinyamatumwa, Mashoko, Rozva and Shereni. Climate change and variability has necessitated investment in smallholder irrigation agriculture, a sector that has been bypassed by the green revolution, leaving the resource-poor and small landholders food insecure. Smallholder irrigation schemes in Zimbabwe are unsustainable beyond external assistance. These outcomes leave plot holders worse off, due to their failure to achieve viability and sustainability. Application of Irrigation Management Transfer at country and irrigation scheme levels has lacked consideration of local conditions and specific characteristics of local scheme management. The Zimbabwean economic downturn that started in 1999 worsened the condition due to the withdrawal of government and donor support from irrigation development. This left smallholder irrigation schemes exposed to organisational and management problems, creating differences and confusion amongst institutions and irrigation project supervisors, regarding their duties and responsibilities. Hitherto, conditions characterizing the viability and sustainability of smallholder irrigation agriculture have received no direct research attention nor has the nexus of the two phenomena been theorized in Zimbabwe. This study is the first study to apply the Viability-Sustainability Model in the assessment of challenges facing smallholder irrigation agriculture in the country. The Sustainable Livelihood Approach augmented by the Viability System Based Theory was employed in the assessment of the aforementioned four smallholder irrigation schemes.

The methodology of the study was informed by both the positivist and constructivist paradigms. This mixed-methods research allowed the opportunity to compensate for inherent methodological weaknesses, capitalize on inherent method strengths and offset inevitable methodological biases. A sequential exploratory design was employed where collection and analysis of qualitative data was followed by a collection and analysis of quantitative data or vice-versa. Data-collection tools included questionnaires, interviews, focus group discussions, observations (using photographic equipment) and document analysis, all of which were used for triangulation purposes. Purposive sampling was used to select key informants who were interviewed while computer generated random number tables were used to select the irrigators

who were included in the questionnaire survey and FGDs. SPSS, Version 16.0, was used to perform descriptive statistics, ANOVA, during quantitative data analysis. The thematic process of data-analysis (a model of content analysis), complemented by the constant comparative method, was used in qualitative analysis. In all the smallholder irrigation schemes, viability was considered to be a function of governance and social cohesion, financial management capability and technical and water resources management capability as well as a variety of capitals all of which are interconnected into a single system. However, social dissonance and poor financial management system were prevalent in all the schemes as compared to other factors. The study concludes that for smallholder irrigation schemes to develop as farming organizations, farmer empowerment is the order of the day. The study also concludes that farming organizations such as irrigation schemes are under the influence of both internal and external forces, which should be carefully managed in order to attain viability and sustainability. The ability of farmers to organize themselves or their operations depends on internal factors like competency of the IMC, WUA, systems in place, training, and financial systems. Similarly, the ability of the farmers to relate to external stakeholders such as donors, credit institutions, government policy, farmers' cooperatives, markets and competitors is also critical for mapping the viability and sustainability of the schemes.

**KEY WORDS:** smallholder irrigation agriculture, viability, sustainability, food security, sustainable development, indicators, livelihoods, effectiveness, Bikita, Zimbabwe

# CHAPTER 1 INTRODUCTION

## 1.0 INTRODUCTION

Smallholder irrigation schemes in most developing countries, including Zimbabwe, have proved to be unsustainable beyond external assistance (Mutambara and Munodawafa, 2015). Smallholder irrigation schemes are those schemes that are designed by the government for smallholder farmers to complement their livelihoods. The plots in these schemes are at least one ha in size. The farmers who were allocated plots in these schemes are those who hold Master's Farmer Certificates or those whose plots were incorporated in the schemes when the schemes were founded (Gomo, 2010). The history of smallholder irrigation schemes in Zimbabwe indicates that they have suffered considerable neglect and a mixture of success and failure has been witnessed in the post-independence era. Sishuta (2005) proves that the Irrigation Management Transfer (IMT), a process of transferring authority and responsibility from government agencies managing irrigation systems to private sector entities or irrigation users, is a complex and delicate process, to the extent that beneficiaries in smallholder irrigation schemes are faced with formidable viability challenges. The viability and sustainability of smallholder irrigation schemes demand a comprehensive package of interventions that address governance, social coherence, financial, technical capacity and water resource management. This raises concerns about the possibility of independent agricultural production as well as sustainable rural livelihoods. Irrigation agriculture is regarded as the most viable means of reducing crop failure, hunger and malnutrition in Africa (Mutambara et al., 2015), and an effective means of improving rural livelihoods.

In order to meet food requirements by 2020, FAO (2000) estimated that food production from areas under irrigation will increase from 35% in 1995 to 45% of agricultural output in 2020. Unfortunately, despite efforts by government, NGO and the private sector, in Africa as a whole, there are hardly any cases of successful and sustainable farmer-managed smallholder irrigation schemes (Mutambara et al., 2015). The results have been low levels of production and rapid deterioration of the irrigation infrastructure, requiring recurrent investment in rehabilitation, thus consequently failing to generate returns commensurate with expectations and minimal direct contribution to the national economy (Nhundu and Mushunje, 2010). Several researches have

been carried out on smallholder irrigation schemes but none of them wholesomely focused on the conditions characterizing viability and sustainability in schemes. The thrust of the researches has been mainly on issues such as economic and financial viability of different crops, socio-economic impacts of schemes, institutional sustainability of water users associations, productivity challenges and sustainability of smallholder irrigation system as separate processes (Makadho, 2000; Kamara et al., 2001; Wichelm et al., 2012, Mutambara et al., 2015). However, in Zimbabwe, little has been done so far to assess these issues holistically, especially during the past 20 years of the country's economic downturn. In this context, this study therefore seeks to assess the conditions that characterize the viability and sustainability of smallholder irrigation agriculture in Zimbabwe, using the case study of Bikita District.

‘Viability in this study included the ability of the scheme to generate sufficient outputs to satisfy the household income expectations of the irrigators and to cover the basic operational and maintenance cost of the irrigation infrastructure, while not undermining the natural resources (water and soil). It also considers the ability to manage risks and shocks associated with small-scale farming and the cost of sustainable self-management and reliance of farmers on irrigation’ (Kamara et al., 2001).

Viability largely depends on the capacity of farmers to organise themselves into water users associations, as well as to manage the organization, make and force resource use rules and regulations and resolve emerging conflicts. Sustainability, according to Astier et al. (2012), captures productivity, stability, reliability, resilience, adaptability, equity and self-reliance of the irrigation scheme. Mupaso et al. (2014:190) indicate that “for a scheme to be sustainable, all the technical, socio-economic, health and environmental information should be analysed, socially acceptable and environmentally sound”. In addressing viability and sustainability of smallholder irrigation agriculture, the thrust has been on

- governance and viability of smallholder irrigation schemes
- social coherence and performance of schemes
- financial management and viability of schemes
- technical capacity and water resource management in schemes

Scholars agree that reaching the Millennium Development Goals (MDG) of halving poverty and hunger by 2015 in Sub-Saharan Africa requires high prioritization of smallholder irrigation (Tshuma, 2012; Sinyolo, Madhara and Wale, 2014). Small-scale irrigation remains a feasible strategy for achieving improved agricultural production, household food security and rural poverty reduction in the developing world (Barcla et al., 2011; Sinyolo, 2014). Despite the fact that irrigation development comes with a cost and negative environmental and health consequences associated with it, such as increased water logging, salinization and water-borne diseases, it is one of the most important options in increasing crop productivity and improving overall agricultural performance. Access to irrigation increases the area under cultivation and crop intensity and decreases crop losses (Sinyolo et al., 2014). Moreover, reduced poverty is achieved by expanding opportunities for higher and more stable incomes and by increasing prospects for multiple cropping and crop diversification.

Ozerol (2013) opines that the heavy interventionist stance in schemes by the Irrigation Management Committee and other block committees has ripple effects on people's potential to produce in the farming activities. In the case of Zimbabwe, the involvement of Agriculture and Technical Extension (AGRITEX) officers as experts in providing advice about crops that should be grown rather than allowing farmers to choose what to grow on their own has negatively affected production in a number of irrigation schemes in Zimbabwe. It therefore means that farmer participation in such projects ceases to be voluntary and this dampens farmers' quest for participation in the farming project and has a knock-on effect of punching irrigation agriculture into an arena of conflicts and struggles. It is against this background that this study seeks to unveil the conditions characterizing the viability and sustainability of smallholder irrigation schemes in the country.

## **1.1 BACKGROUND TO THE STUDY**

The Integrated Panel on Climate Change (IPCC) identified Africa as one of the continents that are most vulnerable to climate variability and change because of the range of projected impacts, multiple stressors and low adaptive capacity (Woltersdorf et al., 2015:1402). Climate change affects both society and the environment. It affects water availability and agriculture, especially subsistence farming which the majority of smallholder farmers depend on for livelihood. With a land area of 30.2 million km<sup>2</sup> and a population approaching one billion, Africa has a vast

potential for agricultural and economic development. Its population has been increasing rapidly since the beginning of the 20th century. The population was 120 million in 1900, 221 million in 1950, 796 million in 2000, 867 million in 2010 and is projected to be 1,081 billion in 2020, 1,804 billion in 2050 and 2,550 billion in 2100 (Rattan, 2015).

Thus, “food security has been a major concern since the 1970s, and the green revolution bypassed the resource-poor and smallholder farmers of the continent of which Zimbabwe is one of the Sub-Saharan Africa (SSA) countries affected. There were 240 million food-insecure people in Africa in 2012, 223 million in Sub-Saharan Africa in 2013 and the number is projected to increase by an additional 17 million by 2020” (Rattan, 2015:2).

“SSA is a vulnerable region, subject to the vagaries of projected climate change. Some even project that as much as 65% of the global total increase in climate-related hunger would occur especially in Zimbabwe where farming seasons are shortened and a shift of rainfall pattern is rampant” (Rattan, 2015:3). Dambo cultivation has been done as an attempt to avert climate change but currently it is degrading.

“Due to infrastructural and institutional challenges, persistent food shortages occurred resulting in state and non-state agencies delivering food handouts to cushion food insecurity but this proved unsustainable. Worsening the situation, the majority of smallholder farmers in Zimbabwe are located in semi-arid areas where rainfall is low, erratic and unreliable” (Nyamadzawo et al., 2015:23).

Climate change and variability has increased the incidence and extent of mid-season dry spells and late start and abrupt end of the rainy season (Rattan, 2015). Because of erratic rains, both colonial and post-colonial governments invested in irrigation development, which included dam building and installing irrigation infrastructure (Mupaso et al., 2014). It enabled increased crop production and diversification. The role of irrigation on communal land has however, been less straightforward. Mupaso et al., (2014) contended that the benefits are more socio-political than economic. This has raised questions about how to balance the socio-political imperatives and the financial and economic realities. The donor-driven expansion of smallholder irrigation schemes has not performed according to expectation due to a combination of physical, technical and socio-economic

factors. Donor-sponsored irrigation development favoured large-scale projects than small ones. This massive investment did not borne fruits. Food production target were not met, high development costs, technical and management problems remained unsolved.

“Although achieving food security in SSA is a multifaceted effort, evidence from across scales from household to watershed to continent suggests that more reliable access to water, especially in the form of smallholder irrigation, has great potential to reduce hunger, raise incomes, and improve development prospects in the region” (Burney et al., 2013:31). Burney et al (2013) further state that projects supporting farmer-managed irrigation schemes have lower unit costs and better performance outcomes than those managed solely by government agencies.

In rural areas, livelihoods are defined by the way households access assets as well as how household capabilities are mediated by institutions in society (Scoones, 2010). Smallholder irrigation farming has been taken as a livelihood strategy in achieving positive rural livelihood outcomes such as reduced vulnerability and food security. Realizing the persistence of drought and spread of desert like conditions in SSA in the 1980s, Shar et al. (2002) are of the view that small-scale irrigation and water control could be instrumental in increasing agricultural output and food security. Irrigation is a rural livelihood resilient strategy to reduce persistent poverty in rural regions and secure food security in southern Africa. In Zimbabwe, there are three broad types of smallholder irrigation schemes, including government managed, farmer managed and jointly managed schemes (Rukuni, 2006; Nhundu and Mushunje, 2010). Government-managed schemes were developed and maintained by the Department of Agriculture and Extension Services. With time, there tended to be a shift away from the government managed towards farmer-managed projects. Farmer-managed schemes were developed by the government but owned and managed by the farmers and administered by Irrigation Management Committees (IMCs). There is minimal government intervention in terms of management. For jointly managed schemes, the farmers and the government share the financial responsibility of operating and maintaining the schemes. However, government is usually responsible for the headworks while farmers provide field infrastructure (FAO, 2000). In Zimbabwe, since 1980, there have been reforms on irrigation management from government to beneficiaries or other Non-Governmental Organisation (NGO) agencies, combined with the withdrawal of government’s role in operation and maintenance with the intention to reduce government expenditure. However, since the

majority of the schemes had been established with the backing of international donors, the introduction of neo-liberal economic policies into the country led to a gradual shift of the management of smallholder irrigation system to local communities. This transfer was conceived as the best approach for ensuring the effective use and sustainability of the small-scale irrigation schemes (Akudugu, 2013). Njok (2011) advocates this as a means of ensuring community participation, but more importantly as a means of ensuring the sustainability of these schemes.

It has been assumed that with increasing productivity levels of irrigation agriculture, the beneficiaries would meet the operation and maintenance costs of their scheme but this has proved to be a failure. However, with time it has been shown that the sustainability of these schemes cannot be easily be guaranteed by merely transferring their management to local communities (Akudugu, 2013). Regarding the Sahel zone, Shar (2002:12) wrote in a World Bank Report that “most successful irrigation schemes in Africa were owned by private individuals”.

Since smallholder irrigation systems have become critical economic assets, their viable and sustainable management has become a matter of concern. While beneficiaries were happy to have access to irrigation facilities for dry season farming, the use of these facilities and their general management raises issues regarding their sustainability (Akudugu, 2013). As a matter of concern on irrigation, in many developing countries, new policies and laws have been promoted as institutional measures to ‘increase efficiency of water allocation’ and management.

‘In Zimbabwe, over 80% of the rural population lives in natural region III, IV and V where rainfall is erratic and unreliable, making dry land cultivation a risky venture. Rainfall reliability decreases from north to south and also from east to west. Only 37% of the country receives rainfall considered adequate for agriculture. This makes irrigation development a pre-requisite in these areas’ (Chazovachii, 2013).

Climate change has affected the reliability and sustainability of agriculture especially in the developing world, which calls for the artificial supply of water to cushion the challenge. Irrigation agriculture has become important since the rainfall is low and there is need to increase crop yields. Therefore, smallholder irrigation schemes were established to help rural communities to meet their food requirements and provide self-employment to these

communities. The irrigation sector has played a vital role in food production and developing rural economies. The estimated irrigable area in Zimbabwe is 550 000 ha, of which 200 000 ha has been developed (Chazovachii, 2013). The developed area includes functional and non-functional irrigation system as well as informal irrigation schemes (Nhundu, 2010). Considering the relief brought by irrigation schemes, a lot has been done to cope with the growing population.

Studies by Nhundu et al. (2010) recommend that national governments in southern Africa should formulate and hold sound irrigation development strategies and encourage partnerships between public and private institutions in defining and implementing comprehensive strategies for sustainable irrigation development. Fanadzo (2012) has identified weak institutional and organisational arrangements, as well as lack of technical skills by farmers as the major factors leading to underperformance of most smallholder-irrigation projects.

The problem came with the implementation of Irrigation Management Transfers (IMT) schemes, which required farmers to bear the costs, without secure rights to water from the systems (Meinzen-Dick, 2014). As part of these reforms, irrigation management transfers programs aimed at transferring the administration of large-scale irrigation schemes from state agencies to irrigation users. Worldwide, IMT schemes were seen as an important measure for developing the irrigation sector. The famous “tragedy of the commons” has been used as an argument for supporting institutional reforms under this approach. Applied to irrigation, such a ‘tragedy’ meant that a rapid deterioration of infrastructure and management tasks would occur as a consequence of private strategies adopted by each irrigator, followed by a vicious circle of less incentives or refusal to pay for services and this results in deterioration of infrastructure such as pumps or canals in smallholder irrigation schemes (Nhundu, 2010). This outcome left everybody worse-off because farmers were failing to realize conditions required for the viability and sustainability of smallholder irrigation agriculture. Therefore, it is against this background that the research seeks to assess the conditions characterising the viability and sustainability of smallholder irrigation schemes in Bikita.

## **1.2 STATEMENT OF THE PROBLEM**

Irrigation Management Transfers programs aimed at transferring the administration of irrigation schemes from state agencies to irrigation users were implemented worldwide as an important

measure in the irrigation sector (Meinzen-Dick, 2014). However, the application of reforms at country and irrigation scheme levels has been widely questioned by many in relation to the lack of consideration for local conditions and specific characteristics of local water management and the top-down structures in which they were generally applied (Nhundu, 2010).

Coupled with that, the economic downturn in Zimbabwe since 2008 resulted in the withdrawal of government and donor support from irrigation development, which left smallholder irrigation schemes exposed to organisational and management problems, creating conflict and confusion within irrigation schemes (Nhundu, 2010). Regardless of their experience in smallholder irrigation agriculture, irrigators have not realized the conditions required to influence smallholder irrigation viability and sustainability. Thus, this study focuses on these two conditions at three levels (individual, organisations and the system) in smallholder irrigation schemes. Viability and sustainability in smallholder irrigation schemes in Zimbabwe can only be tested by checking the performance of AGRITEX officials, schemes farmers, Irrigation Management Committee, organisations and the irrigation system just to mention a few. This helps to determine the variability of the indicators reflecting viability and sustainability in the schemes. In Bikita, there are four smallholder irrigation schemes that were commissioned by the government, including Mashoko, Rozva, Shereni and Chinyamatumwa (AGRITEX Bikita, 2013). The responsibility of managing these schemes was recently transferred to the farmers. It is in this context that the study characterizes the viability and sustainability of smallholder irrigation agriculture in Bikita.

### **1.3 RESEARCH AIM**

- To assess the conditions characterizing the viability and sustainability of smallholder irrigation agriculture in Bikita in Zimbabwe

#### **1.3.1 Objectives**

- To identify the key indicators that can be used to characterize the viability and sustainability of smallholder irrigation schemes in Bikita
- To assess the viability and sustainability of smallholder irrigation schemes in Bikita
- To determine the critical factors that influence the performance and viability of smallholder irrigation schemes in Bikita

- To draw up recommendations that can guide the planning of smallholder irrigation schemes in Bikita

## **1.4 RESEARCH QUESTIONS**

This research seeks to answer the following questions:

- What are the indicators that characterize viability and sustainability in smallholder irrigation schemes?
- How viable are smallholder irrigation schemes in Bikita?
- How sustainable are smallholder irrigation schemes in Bikita?
- What are the factors influencing the performance and viability of smallholder irrigation schemes?
- What recommendations could be made to guide the plans and policies for increasing the viability and sustainability of smallholder irrigation schemes in Bikita?

## **1.5 JUSTIFICATION OF THE STUDY**

“About 70 percent of the rural Zimbabwean population lives in poverty and depend mostly on smallholder agriculture for their livelihoods” (Nhundu, 2013). Irrigation agriculture is an important source of income and livelihood for many rural livelihoods in developing countries. However, the Zimbabwe Vulnerability Assessment Committee (ZimVAC) report (2014:65) states that, “of the wards with irrigation schemes, 44% has functional, 13% has partly functional while 43% had non-functional schemes. Compared to 2013, there is an increase in the proportion of non-functional irrigation schemes and a decrease in the proportion of partially functional which calls for concern”. This research assesses the viability and sustainability of smallholder irrigation schemes, in an environment where resource-poor subsistence farmers have been bypassed by the green revolution (Rattan, 2015). Following government and donor withdrawal of support from irrigation schemes there is need to determine the level of viability and sustainability of schemes and assess the extent to which the farmers are self-sufficient. The application of Irrigation Management Transfer (IMT) reforms at country and irrigation scheme levels has been

widely questioned due to their lack of consideration for local conditions and specific characteristics of local schemes and compromises the livelihoods of local communities. In Zimbabwe, the viability and sustainability of smallholder irrigation schemes has not received direct research attention in the past, neither has the nexus between the two phenomena been theorized. Due to the current economic recession, the government has scaled down technical and institutional support that it previously extended to smallholder irrigation schemes. “The cumulative effect of economic decline and recurrence of drought has created multiple stressors that have made the livelihoods of most Zimbabweans vulnerable” (Mukwada 2012:105). This has created a situation where farmers’ organizations and irrigation systems in smallholder irrigation schemes have to depend on their own capacity to operate and maintain the scheme they depend on for livelihood. The study examines the dynamics characterizing the viability and sustainability bottlenecks associated with smallholder irrigation schemes, using four categories of criteria, namely

- governance and viability of smallholder irrigation schemes,
- social cohesion and performance of the schemes,
- financial management and viability of the schemes and
- technical and water resource management in the schemes

## 1.6 DEFINITIONS OF TERMS

- **Viability:** entails the ability of the scheme to generate sufficient income to satisfy the household income expectations of the irrigators and to cover the basic operational and maintenance cost of the irrigation infrastructure, while not undermining the natural resources (water and soil). It also considered ability to manage risks and shocks associated with small-scale farming and cost of sustainable self-management and reliance of farmers on irrigation (Kamara et al., 2001).
- **Sustainability:** is “the capacity to conserve natural resources involved in economic activities over time for the benefit of future generations. In the context of sustainability of smallholder irrigation agriculture, it relates two key issues of global attention, namely continuity in food supply and access to water” (Callejo and Cossio 2009: 41).

- **Rural livelihoods:** Refers to smallholder irrigation activities done by resource poor, subsistence and small-scale farmers to earn a living in drought prone areas that relied much on rain-fed agriculture before the establishment of irrigation scheme.
- **Smallholder Farmers:** Resource-poor, subsistence farmers. They are also defined as those farmers owning small-based plots of land on which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour.
- **Irrigation Management Committee (IMC):** this is a supervisory body introduced in smallholder irrigation schemes to improve coordination between irrigations and water management. The stakeholders include AGRITEX officials, councillors, farmers and irrigation officials (Nhundu, 2013).
- **Smallholder Irrigation:** Smallholder irrigation schemes are those schemes that are designed by the government for smallholder farmers to complement their livelihoods. The plots in these schemes are at least one ha in size. The farmers who were allocated plots in these schemes are those who hold Master's Farmer Certificates or those whose plots were incorporated in the schemes when the schemes were founded (Gomo, 2010).
- **Irrigation Performance:** is defined as the level at which resources such as water, land and labour are efficiently and effectively utilised for the production of food (Gomo, 2010:5).
- **Institutions:** “are the rules of the game in a society or, more formally, are the human devised constraints that shape human interaction” (North, 2000:3).
- **Organizations:** “are groups of individuals bound by some common purpose to achieve objectives. They include social bodies, family farms etc” (North, 2000:5).
- **Indicators:** these are determinants used to measure the viability and sustainability of irrigation schemes. Therefore, suitability, familiarization of scheme stakeholders with the indicators would result in viability and sustainability in smallholder irrigation agriculture.

- **Effectiveness:** The degree to which objectives are achieved and the extent to which targeted problems are solved. In contrast to efficiency, effectiveness is determined without reference to costs and, whereas efficiency means "doing the thing right," effectiveness means "doing the right thing."

<http://www.businessdictionary.com/definition/effectiveness.html#ixzz3PTIOcP7u>

## **1.7 LIMITATIONS OF THE STUDY**

Financial resources have negatively affected the researcher's efforts to undertake a sound and comprehensive research. Budgetary constraints limited the study to only one district of Zimbabwe. The selection of the four schemes was purposefully done to ensure that the findings are authentic. Contact with the key informants was bureaucratic in nature though a necessary evil. The researcher was affected by the intra-party political instability within ruling ZANU-PF and his visits to the study area were closely monitored and often interrupted by local party officials. To overcome this disorder, the researcher and his assistants were given approval letters and this eased the atmosphere of the study. Since the research is self-funded, a pilot survey was done to pre-test the questionnaire. Because of low remuneration in government, the AGRITEX officers in most schemes were not motivated to work hard. Generally, they have a negative attitude towards academic research work. The uncooperative behavior of some AGRITEX officers and irrigators towards academic research may have influenced the quality of the responses which were obtained. As a result methodological triangulation was necessary for validation of data. Respondents were assured that the purpose of the study is educational and that any norms, values, beliefs and responses within the instruments were to be kept confidential.

## **1.8 ORGANISATION OF THE THESIS**

This thesis comprises six chapters, which are organized as follows:

**Chapter One:** presents the introduction and background of the study. It gives a general overview of smallholder irrigation and viability and sustainability concepts. The chapter outlines the statement of the problem, aim, objectives, research questions and justification of the study. It also provides an overview of the limitations of the study and presents the definitions of the terms of the study.

**Chapter Two** covers the literature that was reviewed in the study, mainly based on previous studies conducted elsewhere regarding the viability and sustainability in smallholder irrigation agriculture. A review of case studies globally, regionally and locally was done to identify the research gaps. The Viability System-Based Theory (VSB) complemented by Oslo’s “zooming in and out model” and the Sustainable Livelihood Framework (SLF) have been used to guide the study. The concept of indicators and their utility was also reviewed. Factors affecting viability and sustainability of smallholder irrigation schemes were discussed alongside challenges that affect these conditions.

**Chapter Three:** presents the description and major characteristics of the study area. It also presents the methodology of the study from the design, population, sampling techniques and procedures, ethical considerations, data collection tools, presentation and analysis and validity and reliability of the approaches used. In this case, a mixed approach was employed biased towards the interpretive approach, use of viability-sustainability model, the statistical methods used (descriptive statistics and Analysis of Variance), thematic analysis and constant comparative methods.

**Chapter Four** presents the results of the study, focussing on

- governance and viability of smallholder irrigation schemes,
- social cohesion and performance of schemes,
- financial management and viability of schemes and technical and water resource management in schemes.

**Chapter Five** has discussions and interpretation of results checking on how the obtained results relate to other research findings. The discussion of results is based on:

- governance and viability of smallholder irrigation schemes
- social cohesion and performance of schemes
- financial management and viability of schemes
- technical and water resource management in schemes

**Chapter Six** presents the conclusion and summary of findings, as well as the recommendations of the study. A smallholder irrigation-sustainability model is spelt out as the way forward, while areas requiring further research are noted in this chapter.

## **1.9 CHAPTER SUMMARY**

In this chapter, the introduction to the conditions characterizing the viability and sustainability of smallholder irrigation agriculture, the background to the viability and dimension of sustainable development to the study, the aims of the research, the research methods, the limitations, and the demarcation of the study were outlined. Overall, the chapter presents the approach to the whole research design, data collection methods employed and the unit of analysis. There is also a discussion of the limitations of the study and the remedial measures that were proposed for the study. The next chapter focuses on the related literature, including theoretical framework guiding the study.

## **CHAPTER 2 LITERATURE REVIEW**

### **2.0 INTRODUCTION**

Halving poverty and hunger by 2015 in Sub-Saharan Africa, as proposed by the second Millennium Development Goal (MDG) is partly made possible by continuous assessment of the viability and sustainability of smallholder irrigation schemes (Gomo, 2010). Smallholder irrigation agriculture has remained a feasible strategy for enhancing agricultural production and household food security. Governments in Sub-Saharan Africa took smallholder irrigation development as an important means of coping against drought in communal lands, especially in drier parts of their countries. Agriculture, through smallholder irrigation has been a significant livelihood and income-generating project for a number of rural households in the developing world. For example, Gomo (2010) has examined the performance of irrigation in South Africa incorporating and analysing farmers' perception about the scheme performance as an opportunity for deriving best management practice. Similarly, Banele et al. (2013) have shown the sustainability of irrigation development projects in the Maplotni irrigation scheme in Swaziland, while Chibisa (2008) focuses on smallholder irrigation agriculture as one of the poverty alleviation strategies in Nyanga North in South Africa. Rukuni et al. (1994) note that the first smallholder irrigation schemes in Zimbabwe were established by missionaries between 1912 and 1927 to resettle blacks who were displaced by white farmers. Recently, Sinyolo et al. (2014) assess the impact of smallholder irrigation on household welfare, to capture the importance of smallholder irrigation agriculture, while Nhodo et al. (2014) have analysed the socio-cultural dynamics in smallholder irrigation schemes, especially the opportunities and constraints. Due to the prevalence of the "tragedy of the commons" in smallholder irrigation schemes, as reiterated by Nhodo (2014), the importance of institutions (rules and regulations) in the governance of smallholder irrigation schemes becomes evident. Rules and regulations are formal and informal conventions that shape the political, economic and social behaviour of the members of irrigation schemes (Ochieno, 2012). Ozerol (2013) writes about institutions of farmers' participation and environmental sustainability in Turkey and their role in the improvement of interaction and creation of a common meaning for actions and outcomes. Nhundu (2013) further assessed irrigation water management institutions in Zimbabwe using a new institutional economic

theory, while Wichelns et al. (2012) look at institutional sustainability of smallholder water systems for productive use; a case of water users' associations. Oslo (2000) has developed general assessment indicators without specific applications to any sector, while Wichelns (2012) discussed the dimensions in institutional sustainability and assessed them on Water Users' Associations in Ethiopia, specifically on smallholder water-user associations that produce irrigated vegetables for sale on the market. Although the Ethiopian study focused on institutional sustainability, the gap left by the study is the component of viability of the small water users associations.

Ozerol (2013), Wim van Averbeké et al. (2006) and Zuku (2010) have determined the factors affecting the performance of smallholder irrigation schemes without looking at sustainability and viability aspects of the irrigation schemes. From the aforementioned studies, it is evident that the conditions characterizing the relationship between viability and sustainability are overlooked and under researched; hence, this research strives to fill the stated knowledge gap by examining irrigation schemes as a supra-system, capturing the comparative analysis of the conditions characterizing the schemes.

In Sub-Saharan Africa, the conditions characterizing viability and sustainability in irrigation schemes have not been adequately researched, thus resilience in rural livelihoods is poorly understood and difficult to achieve. The result is that poverty remains persistent and overwhelming in this region. The literature reviewed in this study focuses on a global perspective of smallholder irrigation farming, the evolution of smallholder irrigation farming in Zimbabwe, the importance of irrigation to smallholder farming in the developing world and the legal and institutional framework governing irrigation projects in Zimbabwe. Viability and sustainability as concepts, Viability System Based Theory (VSBT) and Sustainable Livelihood Framework (SLF), dimensions of sustainability are assessed in this study using case studies from Sub-Saharan Africa. The concept of indicators for assessing the viability and sustainability of smallholder irrigation schemes is also addressed. To understand the factors influencing institutional sustainability, institutional scale and institutional alignment, conventional theory of a firm, the farming style theory and the social capital theory have been applied at a global level and in sub-Saharan Africa

## **2.1 UNDERSTANDING THE ROLE OF SMALLHOLDER IRRIGATION FARMERS IN AGRICULTURE**

### **2.1.1 Smallholder irrigation farmers**

Machethe et al. (2004:4) define “smallholder farmers as previously disadvantaged individuals or groups with access to land that can only support agricultural production at small- or medium-scale enterprise”. Smallholder farmers consist of small-scale farmers, depressed farmers, emerging farmers and those who benefit from the land reform (Gomo, 2010). These classification criteria are determined by size of land and the farmers’ purpose of production.

### **2.1.2 Smallholder irrigation agriculture: A global perspective**

Around the world, smallholder irrigation is faced with numerous challenges because it is too small to have economies of scale, hence falling into the trap of low levels of technology (Gomo, 2010). Smallholder irrigation is exposed to improper institutions and organisational approaches, as well as a lack of the capacity to provide the necessary assistance to smallholder farmers (Mudau, 2010). In some instances, “the situation has been fuelled by uneconomically designed irrigation systems and such schemes experience high production costs with little chance of cost recovery” (Mudau, 2010:5). However, Mudau (2010) observed that, by making use of village-level irrigation and institutional management by village government officials, some countries like Thailand, Indonesia and Philippines have managed to sustain small-scale irrigation schemes for many years.

### **2.1.3 Smallholder irrigation agriculture in Sub-Saharan Africa**

Rainfall is a limiting factor in crop and livestock production in Africa. Mudau (2010:6) “estimated that the African continent has a total of 12.4 million hectares of irrigated land and the performance of smallholder irrigation systems has failed to meet expectations, providing low economic and financial returns and discouraging investment in irrigation”. Akudugu (2013) observed that most smallholder irrigation schemes in the African region have performed dismally in terms of production and management and have failed to attain the predicted production levels.

Mudau (2010) further states that the path for a sustainable institutional transformation in farmer-managed irrigation schemes in an African context needs to consider their differences and alternative approaches in line with the scheme's special challenges.

## **2.2 VALUE OF SMALLHOLDER IRRIGATION AGRICULTURE IN THE DEVELOPING WORLD**

“Irrigation agriculture has an important role in the developing countries' economies in terms of the size of the economic sector and strategic development” (Sarker et al., 2014:8). It contributes about a 30-60% share of the GDP, employs about 40-95% of the workforce and provides food, subsistence and income to the majority of developing countries' population (FAO, 2001; Sarkar et al., 2014:8). Since the agricultural sector creates both forward and backward linkages within the economy, any disturbance in agriculture has an impact on the economy as a whole. Despite the agricultural sector's importance in developing nations, its productivity is falling. “The per capita food production decreased by 0.8 percent in 1980 and 0.1 percent in the 1990s” (FAO, 2001, Sarkar et al., 2014:8). In the context of the Millennium Development Goal One (MDG1) of halving hunger and starvation by 2015, it would have been critical to increase the benefit in the irrigation agriculture sector, as enough evidence is there that agricultural productivity increase is the pillar to the reduction of poverty.

Continuous growth in agriculture is not an option but a pre-requisite for less developed nations (Sarkers et al., 2014). Instead of jeopardising the natural resource base, agricultural growth must be attained sustainably (Hagos, 2003, Sarker et al., 2014). Gallup et al. (1997, in Sarkers et al., 2014:9) have “found that for every 1% increase in per capita agricultural output there was a 1.61% increase in the incomes of the poorest 20% of the population”. Sarkers et al. (2014:10) resolve that, “on average, every 1% increase in agriculture yields reduced the number of people living on less than US \$1 a day by 0.83%. Hence, development of the agriculture sector is defined in terms of increased production with decreased average cost and it becomes a prerequisite for the overall development of a developing economy”. The 2007 World Bank Report revealed that if the world had wanted to half poverty by 2015, agriculture development should have been at the centre stage.

Smallholder irrigation agriculture has been prioritized in particular, as it is critical in generating employment, improving the welfare of human beings, peace and tranquillity in southern Africa (Delgado and Machethe, 2004). Smallholder irrigation agriculture stabilises rural exodus, generate growth linkages and broaden the demand for industrial produce (Ericher and Rukuni, 1996; Machethe, 2004) it is taken as both a prominent cause and potential solution for reduction of hunger and starvation and growth in economy (Jazairy et al., 1992, DFID, 2002). To maximise the contribution of smallholder irrigation agriculture to poverty reduction, agricultural productivity must be raised and sustained through irrigation agriculture.

Irrigation systems have long been used as an important case for studying collective action in the empirical common pool resource literature (Wang et al., 2014). Therefore, irrigation schemes are established to help rural people meet their food requirements and provide self-employment to their communities. The irrigation sector has played a vital role in food production and rural economies. The estimated total area for irrigation in Zimbabwe is 550 000 ha and out of this total, 200 000 ha have been upgraded, encompassing both operational and non-operational irrigation systems and capturing informal irrigation schemes as well (Nhundu, 2010). In Zimbabwe, the majority (80%) of the population lives in rural areas in Natural Region III, IV and V where rainfall is inadequate, making dry land farming inappropriate. “Rainfall reliability decreases from north to south and also from east to west. “Only 37% % of the country receives rainfall considered adequate for agriculture. For the rest of the country the rainfall pattern is inadequate, erratic and unreliable making supplementary or full-time irrigation a requirement for successful agriculture” (Chazovachii, 2013:2).

An investment in smallholder irrigation is one of the most effective ways to develop smallholder agriculture and reduce poverty. The role of smallholder irrigation in poverty alleviation has been demonstrated in Bangladesh where canal and tube-well irrigation has played a major role in the development and implementation of efficient and effective smallholder irrigation schemes (Nhodo, 2014). Irrigation development benefited the rural poor in reducing food prices resulting from increased production. Increase in on-farm and off-farm employment leads to income generation for the poor in rural areas; hence, irrigation would contribute to improved household income. One significant increase in water productivity may come from improved water management and improved plant varieties or agronomic practices. In most smallholder schemes,

the unreliability of water supplies has significantly contributed to the poor performance of smallholder irrigation schemes. Nhodo et al. (2014) maintain that irrigation has been appreciated the world over for increasing agriculture production all year round.

Several authors agree that achieving the first MDG in Sub-Saharan Africa requires high prioritisation of smallholder irrigators (Tshuma, 2012; Sinyolo, 2014). Small-scale irrigation continues to be a plausible approach for achieving high agricultural production, food security among households and reduction in rural poverty in less developed countries (Barcla et al., 2011; Singolo, 2014). Despite the fact that the erection of irrigation schemes comes with costs and unfavourable environmental and health impacts such as water logging, soil salinity and the spread of aquatic diseases, it is one of the critically significant components required for increasing overall performance in agriculture. The area under cultivation and crop intensity is increased through irrigation (Sinyolo et al., 2014). Moreover, irrigation increases prospects for multiple cropping and crop diversification, thus reducing poverty by expanding farmers' income opportunities. The South African government prioritizes irrigation development due to its potential in poverty reduction and food (Wim van Averbeke et al., 2011; Sinyolo, 2014). Of the total land under irrigation in South Africa, smallholder irrigation agriculture accounts for about 0.1 million ha (Sinyolo, 2014). Though small in proportion, smallholder irrigation agriculture has attracted national public interest in recent years. In South Africa, the significance of irrigation farming is underscored by the 80% irrigated land, which contributes 30% to the total agricultural production. The importance of irrigation schemes arises from the fact that the schemes are located in the economically depressed regions with high levels of poverty and food insecurity. However, this claim of failure has not been based on in-depth and systematic impact evaluations" (Sinyolo et al., 2014:153).

### **2.3 EVOLUTION OF SMALLHOLDER IRRIGATION AGRICULTURE IN ZIMBABWE (PRE-INDEPENDENCE TO PRESENT)**

In Zimbabwe, "the historical evolution of smallholder irrigation policy is understood in the context of changing provision of services to irrigation schemes" (Rukuni, 1988:200). The history of smallholder irrigation in Zimbabwe is "scrutinized in the broader context of the colonial power developing an agrarian structure meant to control the destiny of the majority of the people

who are black smallholder farmers” (Rukuni et al., 1994:128). Table 2.1 shows the historical development of smallholder irrigation policy in the country.

**Table 2.1: Zimbabwe: Evolution of the smallholder irrigation policy: 1912-1991**

<b>Period</b>	<b>Policy objectives</b>
<b>1912-27</b>	Missionaries introduce irrigation to smallholder agriculture
<b>1928-34</b>	Government provides services and helps farmers develop irrigation schemes but farmers retain control of schemes.
<b>1935-45</b>	Government takes over management of communal irrigation schemes.
<b>1946-56</b>	Land apportionment act of 1930 is amended and blacks are moved to native reserves. New irrigation schemes were created to resettle black farmers.
<b>1957-65</b>	Government curtails development of new schemes because they are not cost effective.
<b>1966-80</b>	Government policy of separate development for blacks and whites and introduction of strategy of rural growth points mostly based on irrigation.
<b>1981-90</b>	Government policy emphasises reduction of irrigation subsidies and greater farmer participation in the design, financing and management schemes.

(Source: Adopted from Rukuni et al., 1994:130)

Smallholder irrigation agriculture was introduced in an attempt to improve agricultural productivity within the black communities who were residing in drought stricken areas. The black communities were crowded in places that were not conducive for human settlement. “Voluntary smallholder irrigation schemes in Zimbabwe were launched in 1913 as a means of relieving famine and to resettle black farmers displaced by white commercial farmers” (Rukuni, 1988:200). The government introduced controls and subsidies to maintain irrigation schemes in the then communal lands and from 1912 to 1927 smallholder farmers constructed and operated their own irrigation project (Roder, 1965; Rukuni et al., 1994:128). The first involvement of the colonial government in irrigation followed the appointment of Emery Alvord as an “agriculturalist for the instruction of natives” in 1927. The 1912 to 1927 period was described as

a time of “incorporation of irrigation into indigenous agriculture” (Rukuni, 1988:200). Missionaries promoted irrigation development in eastern Zimbabwe by helping the farmers develop small, irrigated plots of about one hectare or less while they continued to rely heavily on rain-fed farming for the bulk of their family food supply (Manzungu, 1995). Alvord assisted missionary-established schemes with the focus on surveying and site layouts. Famine relief was the justification for government support in smallholder irrigation. For a number of decades the supported irrigation-scheme development areas experienced food insecurity due to inadequate rainfall. Irrigation was an insurance against bad harvests, source of funds for paying poll taxes. In return for human capital, farmers were given land (Rukuni, 1988).

After the return of Alvord from studies “on Indian reservations in the USA in 1935, the irrigation policy in Rhodesia changed. Farmers were required to give up rain-fed crops production and other non-irrigation activities.” (Rukuni, 1994:129) Farmers organised themselves in the maintenance of schemes during their slack time. The construction of new schemes was taken over by the state with minimum participation by farmers in all the stages of the new irrigation scheme development. Most eastern highlands schemes of Zimbabwe were under the control of the government and there was pressure on farmers to produce cash crops.

Cropping patterns were designed by agronomists based on wheat, beans and legumes. After the amendment of the Land Apportionment Act of 1930, all black farmers were in designated areas within a short period. The development of irrigation projects came to a halt between 1957 and 1965 due to rising construction and maintenance costs, which resulted in the review of native agriculture by the department. An economist was engaged into the system to examine the viability of schemes in 1957 and findings revealed that schemes were uneconomic (Hunter, 1958; Rukuni, 1994:130). A new commitment to irrigation development was brought about by the Unilateral Declaration of Independence (UDI) in 1965 as part of promoting the concept of separate development of blacks and whites by establishing growth centres for the African races. Tribal Trust Land Development Corporation (TILCOR) developed irrigation-based growth points were set up in the communal lands, referred to as African reserves at that time.

By 1928, the colonial government had started interventions in smallholder irrigation development by providing support to already established smallholder schemes and assistance in

coming up with new ones. This process culminated in the exclusion of farmers participating in the planning, implementation and funding of smallholder irrigation schemes as they were exposed to heavy subsidies. The government availed loans to groups based on financial viability though the funds were not accessed by the majority of smallholders. After 1980,

“Zimbabwe inherited a dual agrarian structure composed of roughly 5 000 commercial, large-scale farms producing cotton, wheat and soya bean and between 700 000 and 800 000 smallholder farmers scattered over the communal areas. Smallholders were engaged in the production of their staple foods like maize and sorghum” (Rukuni, 1988:200).

The post-colonial government that followed supported the idea that irrigation is an important means of coping with drought in communal lands in drier parts of the country. “The 1982-84 devastating drought was met by a concerted government policy of reducing the dependency on rain-fed agriculture” (Rukuni, 1998:200).

Although the policy emphasised smallholder farmer participation in all stages of irrigation development and management, there were challenges that impeded the development of smallholder irrigation (Manzungu, 1995). Unavailability of irrigable soils limited the potential use of available water. Development costs of small-scale irrigable schemes were rising in Zimbabwe; hence, limiting the potential for expansion. FAO (2000) maintained that irrigated areas were remote from water sources. For example, in Manicaland, most irrigated soils consist of sand of high infiltration rate and communal lands are generally far from major water supply centres. Lynch et al. (1987:35) argue, “whilst it is costly to construct schemes in communal lands, consideration is given to the disposal of produce, which is crucial to projects’ profitability”.

### **2.3.1 Smallholder irrigation development in Zimbabwe**

In 1985,

“the development of Agricultural and Technical Extension (AGRITEX) took over from TILCOR on the smallholder irrigation schemes management in communal lands. At the end 1991, 4 775 ha of irrigation land were farmed on 70 schemes by

7 900 families in communal land although 82 irrigation schemes had been developed” (Rukuni, 1994:130).

In 1981, two parastatals, the Tribal Trust Land Development Cooperation (TILCO) and the Save-Limpopo Authority (SLA) were merged to form the Agricultural and Rural Development Authority (ARDA), which was renamed the Agricultural Development Authority (ADA). It managed the nine state-owned smallholder irrigation schemes that had been established in the communal lands, which incorporated 529 smallholders. “A settlement officer was appointed to manage smallholder settlers. The core estate provided land-preparatory services, credits, extension support, accounting used and a ‘stop order’ system to recover commodities” (Lynch et al., 1987:35).

Since independence, what emerged as a type of water users’ association, are now called Irrigation Management Committees (IMC) on both Department of Agricultural and Technical Extension Service and Agricultural Development Authority irrigation schemes. Members of the IMC were normally elected by plot holders. Its role was to manage irrigation schemes. This development is consistent with the policy of the government that smallholder farmers will finally take over the administration of their irrigation schemes (Nhundu et al., 2010). The government prioritised the rehabilitation and expansion of established irrigation schemes before constructing new ones. Apart from that, the government policy of 1983 was to promote communally managed schemes. This was reinforced by the 1984 prime minister’s directive of decentralisation and development. However, though a number of irrigation schemes were established throughout the country, little attention in some of the researches has been done in the efficient and effective management of smallholder irrigation in Zimbabwe since independence. The government pronounced financial viability as critical and the majority of the proposed schemes failed to meet the prerequisites for lending.

“In 1983, the government subsidised about 89% of operation and maintenance cost of the 72 smallholder irrigation schemes.” (Rukuni, 1994:131) They were justified due to social desirability of the majority of schemes on their increase in food security for rural households (Rukuni and Eicher, 1987; Rukuni et al., 1994).

### **2.3.2 The potential for expanding irrigation development in Zimbabwe**

On surface water potentials, Zimbabwe’s climate is such that the wet season is short, causing extreme variability in river flow (Rukuni, 1998). However, there is little information on Zimbabwe’s groundwater potential, although known large aquifers exist in the Save Valley and northern Matabeleland regions. About 400 000 hectares were the maximum area feasible for irrigation if all surface-water and ground water were used for irrigation.

“In 1985, the National Farm Irrigation Fund (NFIF) was established but none of the smallholder irrigation tapped that and it was only used by large-scale commercial farmers. Under the NFIF, farmers were expected to pay in field and running costs yet farmers on existing schemes enjoyed subsidies. This was the policy dilemma in the development of irrigation schemes in Zimbabwe” (Rukuni et al., 1994:137).

**Table 2.2: Status of irrigation development in Zimbabwe**

<b>SECTOR</b>	<b>AREA UNDER IRRIGATION (HA)</b>	<b>AS (%) OF TOTAL AREA UNDER IRRIGATION</b>
<b>Large scale</b>	98 400	82
<b>State farms</b>	8 400	7
<b>Out-grower schemes</b>	2 200	2
<b>Smallholder</b>	11 000	9
<b>Total</b>	120 000	100

(Source: FAO, 2000:20)

Irrigation development has been followed by studies in the last two decades that assist policy makers in formulating sound policies for the future. Though studies do exist, more is needed at regular intervals, since policy formulation changes with time (FAO, 2000).

Recent studies have contributed to a pronounced appreciation of small-scale irrigation that gave them lessons from previous experiences for future planning of projects. The use of rivers, reservoirs and boreholes has led to the construction of 187 smallholder schemes, covering tracks of land relatively little compared to the total 120 000 ha. About 2 200 ha were developed on

small-scale purchased land and ultimately giving a total of 13 200 ha of smallholder irrigation. In terms of scheme numbers, half are farmer managed, while 32% and 18% are government managed and jointly managed, respectively. Irrigation technologies in use include surface irrigation for 68% of the schemes and sprinkler irrigation for 32% of the schemes (AGRITEX, 1999). However, considering the status of the schemes in Zimbabwe, their sustainability has not been sufficiently studied.

## **2.4 INSTITUTIONAL WEAKNESSES IN SMALLHOLDER IRRIGATION SCHEMES**

Public resources are open to abuse and unsustainable exploitation. Smallholder irrigation schemes are public property, with beneficiaries coming from different socio-economic backgrounds. Canals, irrigation water and other forms of irrigation infrastructure are public or community-based resources that need collective planning and management. Nhundu (2013) has observed that public goods are no man's resource, to the extent that there is no responsibility, accountability and ownership spirit among beneficiaries. The reciprocal altruism theory states that individuals are only willing to participate in co-management if they perceive return benefits (Mukwada, 2012). As recently demonstrated in lessons gained from Community Based Natural Resource Management (CBNRM), reciprocity encourages people to cooperate with others when fostering the stewardship of community-based resources. Reciprocity is considered as the basis for symbiosis between individuals. As noted by Mukwada (2012) in the Capacity Continuum-Multiple Drivers Model (CCMD), collective responsibility varies through space and time to create different opportunities for CBNRM.

“Individual utility and social utility are opposite sides of the same coin. Individuals are self-interested people who put themselves first and others second, yet social utility thrives on social capital, i.e. relationships, networks and integration among members” (Mukwada, 2012:72). Therefore, cooperation occurs only when social utility exceeds individual utility. “Individuals within the community express different levels of collective responsibility that define their preparedness to contribute to CBNRM since the sense of ownership and willingness to participate varies with individuals and through time and space” (Mukwada, 2012:72).

When individual utility exceeds social utility, collective effort is diminished and chances of CBNRM succeeding are reduced while the opposite is true when social utility exceeds individual

utility. This is characterised by competition and cooperation, respectively. Schemes are weak if individual utility is greater than social utility. The driver component denotes the environmental conditions that regulate both the capacity continuum and demand for environmental resources. These conditions determine how resources are used and managed in an environment where supply is fixed. The notion of drivers is compatible with the Sustainable Livelihood Framework Approach, which maintains that communities depend on assets found in their environment to eke a living. “Some drivers induce cooperation and bind community members together, while others enhance social dissonance because they promote individual utility and competition, and sometimes lead to resource overuse, scarcity and depletion” (Mukwada, 2012:73). These weaknesses are common in most smallholder-irrigation schemes in developing nations.

## **2.5 LEGAL FRAMEWORK OF SMALLHOLDER IRRIGATION AGRICULTURE IN ZIMBABWE**

Weinrich (1975), cited in Nhudu, (2013) states that the spatial distribution of water resources in Zimbabwe is based on rainfall potentials, yielding six agro-ecological zones. It is onto this landscape of diverse variation in rainfall patterns and agricultural potential that deprivation of water to smallholder farmers not only created a skewed distribution of land, but also an inequitable access to water. “Based on this land alienation and inequitable distribution of water, African irrigation schemes were developed with the view to promoting productive uses of water in selected ‘native reserves’ ‘on small pockets of irrigable land partly with the objective to allow the resettlement of a larger population of people whose land had been ‘alienated’” (Nhundu, 2013:40-41).

The pre-independent state of Zimbabwe, established legislation that promulgated racial access and control of water in favour of the white community in European towns, large-scale commercial farms, mines and industries at the detriment of blacks in the native areas (Mtisi and Nicol, 2003). Since the inception of the pioneer column until 1927, the administration of water had a weakly administered legislative framework apportioning water to the above-mentioned sectors.

“Water for agriculture was apportioned and managed under the Water Ordinance of 1913, which was repealed by the 1927 Water Act, which was in turn, repealed

by the 1976 Water Act. To this end, the 1976 Water Act became the most comprehensive piece of water legislation that set the parameters of access, use and control of water from 1976 to 1997. Central to the water legislation was the denial of access to water for productive purposes to the majority of Africans” (Nhundu, 2013:42).

The Water Act (1976) was amended several times, and global trends ultimately forced a review of approaches to the management of water in Zimbabwe. This led to a total transformation of the Water Act (1976), which was replaced with the 1998 Water Act, in line with modern trends and addressing unjust colonial inequalities. Almost two decades after 1980, there was continuity in the governance of water resource by the 1976 Water Act. However, the colonial imbalances in the water sector called for water reforms (Matinenga, 1999; Manzungu et al., 1999). Continued racial biases on access to water favouring white farmers really gave rise to the need to review the water sector and to enact legislative measures that created more balanced accessibility to water by all citizens.

“Equitable access to water was viewed as providing a basis for rural people to gain access to water for productive uses, which would contribute to the improvement of their livelihoods derived from the use of water. Within this context, the 1976 Water Act was repealed by two pieces of legislation, namely the Water Act and the Zimbabwe National Water Authority (ZINWA) Act, both promulgated in 1998. The Water Act of 1998 set the parameters of access and use of water as well as providing for the establishment of Catchment and Sub-catchment areas based on hydrological boundaries. Catchment and sub-catchment areas formed the basis for water management. In this vein, seven catchment areas were established in Zimbabwe” (Nhundu, 2013:45).

In a short while, smallholder farmers got 10% of the water in state reservoirs. The new Water Act proclaimed water as an economic good and noted that users of water should pay for the resource. “ZINWA, a water authority in Zimbabwe operated as a profit making organisation. However, the state ensured that the depressed households would continue to have a fair access to water” (Nhundu.2013:47). A research based critique by Manzungu, (2001) and Mtisi, (2002)

assessed how rural livelihoods were affected by water reforms and they seem to have the consensus that these reforms did nothing in the development of smallholder irrigation hence rendering the water reforms palliative. The water pricing in smallholder irrigation aggravated the plight of the farmers. For example, plot holders in the Mushandike smallholder irrigation scheme in Zimbabwe withdrew their cooperation because of water pricing (Chazovachii, 2013).

### **2.5.1 The Zimbabwe National Water Authority (ZINWA) Act**

According to Nhundu (2013:49):

“the ZINWA Act of 1998, created the Zimbabwe National Water Authority (ZINWA), a ‘parastatal’ tasked with the responsibility for providing a coordinated framework for planning, development and management of water resources. Additionally, ZINWA took over the commercial functions associated with water provision, which were previously performed by the Department of Water Development. The functions of ZINWA vary depending on the level at which it is operating from”.

At national level, ZINWA advises the responsible Minister in the formulation of policies, pricing of water, development and management of water resources while at catchment level, it ensures the proficient discharge of functions by the catchment council in line with the Water Act, and assists councils in planning and coordinating development and management of water resources. It sells supplies and manages ‘agreement water’ (water behind dams that were previously owned by the state). Of significance is that the institutional structure of ZINWA is not controlled by the hydrological boundary but cuts across sub-catchments (Nhundu, 2013).

“The introduction of water permits for raw water, and agreement water contracts for ‘agreement water’, which, are not legally tied to land, has provided a basis for broad-based access to water. This represented a significant achievement of the water reform as it untied land and water, and devolved the responsibility for water application from the Water Court in Harare to local sub-offices”(Nhundu, 2013:48).

Despite the achievements as mentioned above, lack of coordination between the water institutions has affected water reforms, and management. This was worsened by the lack of coordination between ZINWA and the Catchment Councils in fulfilling their mandates. Apart from lack of coordination between these water management institutions, there are parallel lines of responsibility and accountability as ZINWA officials report direct and account to the Irrigation Officer at catchment level, and not the Catchment Council, which revealed signs of poor management of water at local level as suggested by the water policy (ZINWA ACT, 1998).

Nhundu (2013:138) points out that Zimbabwe's customary law states that

“water belongs to the land. All Zimbabwean citizens have the right to use water resources for domestic needs, irrigation, watering livestock, and in activities such as brick making. Use of Water is managed by water-point committees, however, chiefs, headmen, or village assemblies can do in their absence”.

“As Government reforms and interventions, the Water Act and the Zimbabwe National Water Authority Act are the culmination of Zimbabwe's overhaul of the legislative framework for the water sector.” (Nhundu, 2013:138) Nhundu (2013) further mention that since 1980, the government has registered commitment to support small to medium scale dam projects and irrigation schemes to support smallholder agriculture although there was much reliance on donor funding for their implementation.

According to Nhundu (2013:139),

‘The Zimbabwe's Agricultural Policy Framework (1995–2020) includes the following objectives:

- Growth in the irrigated area (particularly in the smallholder sector) with minimal negative impacts on the environment and human health;
- Equitable allocation and efficient use of scarce water resources;
- Establishment of a water-pricing structure that is consistent with cost and social efficiency;
- Establishment of an effective institutional structure; and

- Implementation of drought-mitigating strategies’.

The National Economic Recovery Programme (NERP) by the Zimbabwe government identified irrigation as the most significant strategy for agricultural development given the vulnerability of the country to unreliable rainfalls. The thrust was on poverty reduction by targeting disadvantaged farmers, enhancing food security at household level through farming all year round. The result would be the improvement of the nutritional status on households by the provision of a wide variety of crops in both wet and dry seasons, facilitating an enabling environment for private actors in irrigation development, promoting human capital in irrigation agriculture in the public and private sector, and creating business-minded smallholder farmers.

### **2.5.2 Institutional framework in smallholder irrigation agriculture**

Nhundu (2013) states that the Ministry of Water Resources and Development (MWRD) in Zimbabwe establishes water-resource development policies through several departments and parastatal agencies under the Ministry like the Department of Water Development, ZINWA, and the District Development Fund and these are responsible for water and irrigation management. The Zimbabwe National Water Authority advises the Minister for the Ministry of Environment Water and Climate “on the formulation of national water policies and standards and, in conjunction with Catchment Councils, which is responsible for the planning, coordination and management of national water resources and delivery” (Nhundu, 2013:143). Zimbabwe has seven Catchment Councils. Specifically the study area, the Bikita District, falls under the Save catchment area. Catchment councils and sub-councils are responsible for plans development and utilisation of the water resources, creation of inventories, and water-development proposals in line with the inventory of resources (Manzungu, 1999).

“The Ministry of Agriculture, Irrigation and Mechanization (MAIM), is responsible for agriculture and irrigation policy-development and implementation. Departments and parastatal agencies involved in irrigation in the control of MAIM include the Department of Agricultural Research and Extension (AGRITEX), the Agricultural and Rural Development Authority (ARDA), the Grain Marketing Board (GMB), and the Department of Irrigation (DoI). The Ministry of Local Government, Public Works and National Housing oversee smallholder irrigation

development, while the Ministry of Finance and Economic Development manages financial resources for irrigation development. Customary law provides that local bodies such as water-point committees and village councils, or traditional leaders such as chiefs and headmen, have authority to manage the community's water resources and community sanctions to ensure compliance with established rules. In many areas, the traditional bodies continue to govern issues of day-to-day water access and use, with water-point committees reporting in some cases to Catchment Councils or sub-councils" (Nhundu, 2013:149-158).

These institutions assist in smooth governance of water use, thereby promoting sustainability.

## **2.6 VIABILITY AND SUSTAINABILITY IN SMALLHOLDER IRRIGATION AGRICULTURE**

The term *viability* deals with the tactics and strategies to lengthen the life of business activities. Two important aspects of viability are the growth in business and its sustainability (Hayes, 2013). With reference to smallholder irrigation agriculture (Kamara, Van Koppen and Magingxa, 2001:18),

“viability includes the ability of the scheme to generate sufficient income to satisfy the household income expectations of the irrigators and to cover basic operational and maintenance costs of the irrigation infrastructure, while not undermining the natural resources especially (soil and water)”.

Viability is also considered as the “ability of the scheme to maintain cash flows and consistency of income generation overtime, and management of risks and shocks associated with small scale farming” (Kamara et al., 2001:18). Hayes (2013) uses solvency as the starting point in determining viability and sustainability. He alluded that organisations are viable, where, given normal service conditions, the organisation produces sufficient inflow of resources to at least balance all operating costs, strategic outflow and forecasted risks to achieve the strategic plans and expectations of stakeholders in the short to medium term period.

Assessment of viability involves the determination of the minimum point at which a balance between all operating costs, strategic outflow and forecasted risks is achievable. While other

studies focus on doing the process in a proper way, with favourable legal, institutional, technical aspects as important for viability. Shah et al. (2001, in Kamara, 2001) emphasise that viability after Irrigation Management Transfer (IMT) further depends on the costs of sustainable self-management and reliance of the farmer on irrigation. They further assert that for IMT to succeed, the following conditions must be satisfied (Kamara, 2001:3):

- “Holding out a promise of significant improvement in the life-situations of a significant proportion of the farmers involved in the process;
- Irrigation must be central to creating such improvement, i.e. a large proportion of the income of the farmers must come from irrigation. The cost of sustainable self-management must be acceptably a small proportion of the improved income; and that
- Transaction costs of the proposed organization must be relatively low”.

In irrigation schemes, viability largely depends on the ability to organize plot holders into effective water user associations, and the ability to manage the irrigation schemes, as well as capacity to develop and enforce resource use rules and regulation and address conflicts. “This capacity is hypothesized to be affected by heterogeneity within the scheme in terms of plot sizes, income sources and social capital variables that enhance meetings and forums for discussing issues related to self-management” (Kamara, 2001:4). The aforementioned variables affect the efficiency and effective operation of the scheme (Kamara, 2001). Viability is sustainable where continuity in planned balanced inflows and outflows are reasonably achievable in the longer term under changing conditions (Hayes, 2013). Viability and sustainability focus on assessing the ‘horse and cart’ in total. They are largely based on maintaining stakeholder-reasonable expectations, forecasts and confidence in the future. Viability in this study is based on individual farmers, as well as internal and external actors and institutions of the organisation. Sustainability encompasses fiscal, stakeholder, workforce and social sustainability (Baldwin, Stephens and Kelly, 2013). The most recognised framework for assessing organisational viability and sustainability is the integrated viability model. The model relates to the environment, organisational motivation and capacity as drivers of organisational performance. However, a new model characterising viability and sustainability is the Viability System Based Theory. As Bossel (2003) notes, the Viability Systems Based Theory refers to viability as the capability to be self-

reliant, develop and perform, implying the functions extended beyond mere viability requirements.

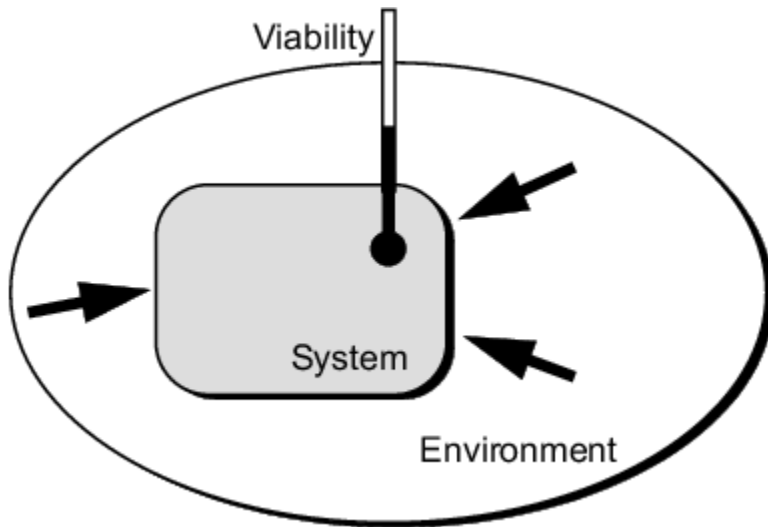
### **2.6.1 Viability System-Based Theory**

Viability is about maintaining stakeholders' reasonable expectations, forecast and confidence in the future. "At the level of the total system, the task is to find indicators that provide reliable information about its viability and performance" (Compbell et al., 2003:247). In the case of a nested system, what is required is a functional relationship between the elements of different sub-systems such that the systems functions as a complete whole.

"One set is required for determining subsystem viability and performance, where as a second set is needed to assess the contribution of the subsystem to the viability and performance of the system as a whole. This duality of indicators is repeated at every level of the system hierarchy" (Compbell et al., 2003:248).

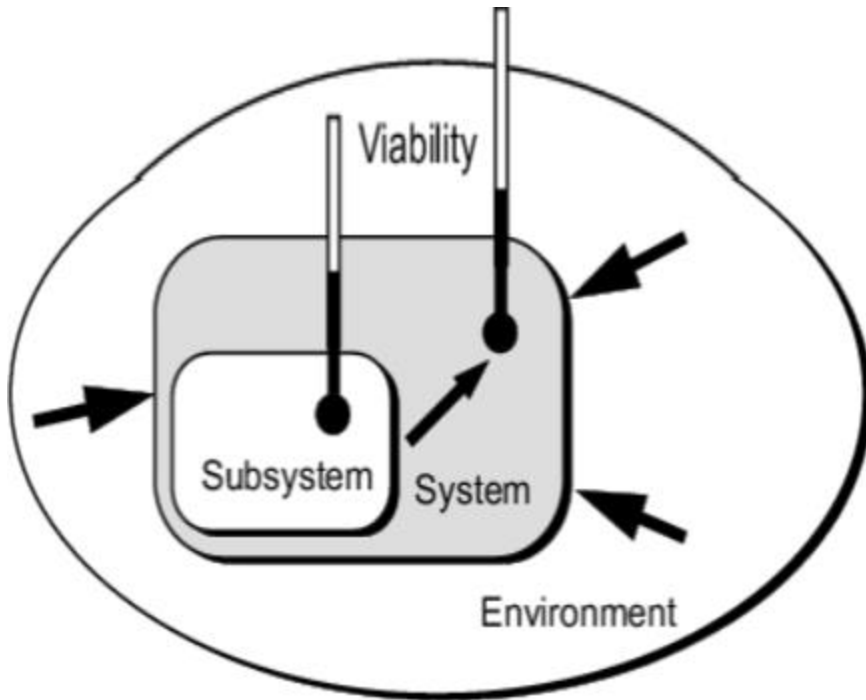
An important thing in these developments

"is the search for appropriate indicators of system performance to condense vital information into a compact set of reliable signals for management? The need for comprehensive indicators sets that assessing system viability, performance and sustainability is urgent in management for sustainable development at all levels from the global to the village level" (Compbell et al., 2003:248).



**Figure 2.1: How the environment influences system viability** (Adopted from Bossel, 2001:3).

“The performance indicators for a given system must reflect its viability and performance under the effects of its particular environment” (Bossel, 2001:3).



**Figure 2.2: Illustration of the contribution of subsystem viability to the viability of the overall system (Bossel, 2001:3)**

Generally, “the viability and performance of a system depend on the viability and performance of its subsystems. Subsystem indicators must reflect, first, the viability and performance of the subsystem and, second, its contribution to the viability and performance of the overall system” (Bossel, 2001:3).

## 2.6.2 Viability chain in nested system

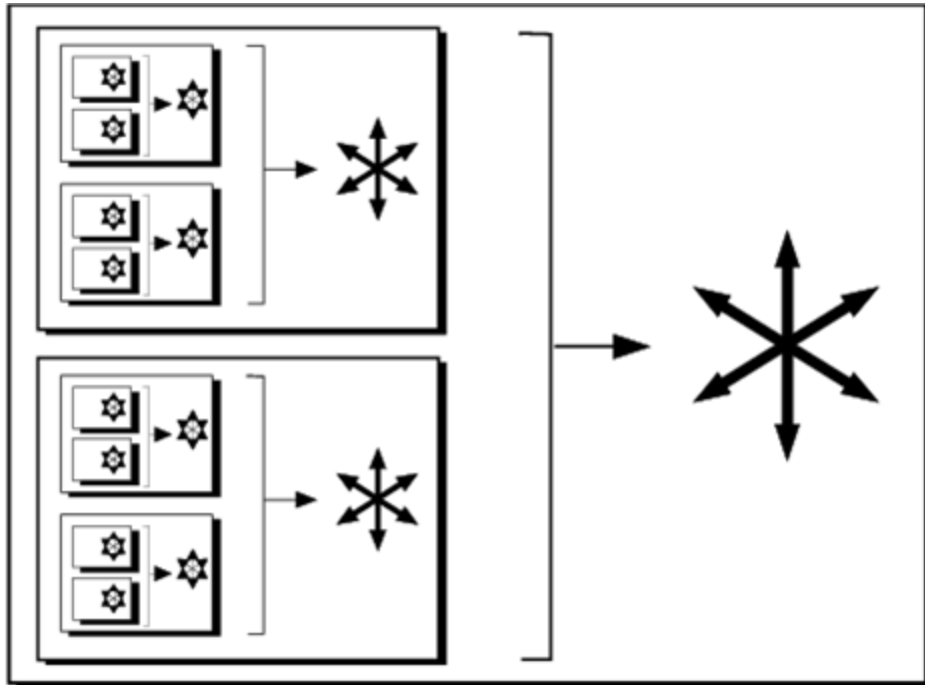


Figure 2.3: Viability chains in nested systems (Bossel, 2001:6)

“The viability and performance of the total system depend on its component systems, which depend on their own subsystems. Each subsystem must not only be viable (symbolised here by the orientor star) but also contribute to the viability of its supra-system (bracket and arrow)” (Bossel, 2001:6).

Bossel (1999:260) further states that,

“Therefore, for the system to maintain its viability status, it must have the capacity to adapt to challenges before they cause serious damages. This implies that it is advisable to focus on indicators that look at the rate of viability threats (threat to a system’s basic orientors) to the rates of evasive response”.

Therefore, a viable organisation should have a system that manages challenges. Indicators express the contribution of each sub-system to the viability and performance of total system. As a result of the difficulties in identifying appropriate indicators, since one sustainable

development indicator was found to be impossible, a multitude of indicators are needed to address all areas of sustainable development in their application (Bossel, 2003). The environment has an influence on system viability. The indicators of performance for a given system should show performance under the effects of its particular environments. Thus, it is expected that irrigation schemes in different environments might reflect different levels of viability and performance.

“Sub-system viability contributes to the viability of the overall system. Generally, the viability and performance of a system depends on the viability and performance of its sub-systems. Subsystem indicators reflect the viability and performance of the subsystem and second, its contribution to the viability and performance of the overall systems” (Bossel, 2003:251).

In a typical human society, fundamental properties constrain development possibilities and limit management opportunities on all spatial scales. The situation in which human kind development is characterised by institutions, rules and laws of nature and logic cannot be altered and that constrain the spectrum of possible physical, technical and biological process (Bossel, 2003). Opportunities are limited by resource challenges of the global environment, available space, the waste-absorption capacity of soils, river, oceans and atmosphere, soil fertility and climate. Variability in irrigation scheme performance is brought by unpredictable weather and other natural phenomenon, random events, human behaviour and population dynamics of organisations. Bossel (2003) argues that the influence of human society on viability is composed of interacting systems that depend on the dynamic function of a more or less autonomous natural system. Each system is in some way dependent on, interests with, or affects other systems. The behaviour of a single element influences the other, which provokes an active response that impact on its own interests negatively.

There is a relationship between viability and sustainability. Viability is the capacity of an organisation to work or function as an independent unit. Sustainability is long-term viability that assists intra and intergeneration without degradation of resources. The two terms, viability and sustainability come together where resources are limited (Russel, 2010). Measures of viability are vital to sustainability. “Viability theory can be used to answer important questions about the

sustainability of systems, including those studied in macroeconomics, and can be used to determine sustainable policies for their management” ( Krawczyk and Pharo, 2010:23).

### **2.6.3 The concept of sustainability**

“Sustainability as defined in Agenda 21 has four dimensions: the social, economic, environmental and institutional one, reflected in the four categories of indicators chosen by the Conference on Sustainable Development” (Spangenburg, 2002:8). Whereas the environmental dimension is the “sum of all bio-geological processes and their elements (environmental capital from economists’ point of view)”, the social dimension (social plus human) is difficult to define. Individual human beings, their skills, dedication, experiences and the resulting behaviour are its focus, with the borderline to institutions (as an achievement of human interactions, confusingly called “social capital”) not always easy to draw. Institutions are understood as including not only organisations, but the system of rules governing the interaction of members of a society as well. This kind of societal interaction and the social norms behind are necessary preconditions for economic activities, which they shape ([www.circularecology.com](http://www.circularecology.com), 2015.06.12). Apart from that, the economic dimension (physical capital) has been identified as one of society’s subsystem, that enables the institutional, social and environment to propel. Separating these four dimensions may distort the real world integration. Only a balanced economic, social, environmental and institutional aspect can achieve true sustainability ([www.circularecology.com](http://www.circularecology.com) 2016.06.12). To maintain and enhance sustainability, the focus must be on economic, social and environmental subsystem. A sustainable way of mutually reinforcing the four capitals must be made to avoid deadlocks.

### **2.6.4 Sustainability Theory– Sustainable Livelihood Framework (SLF)**

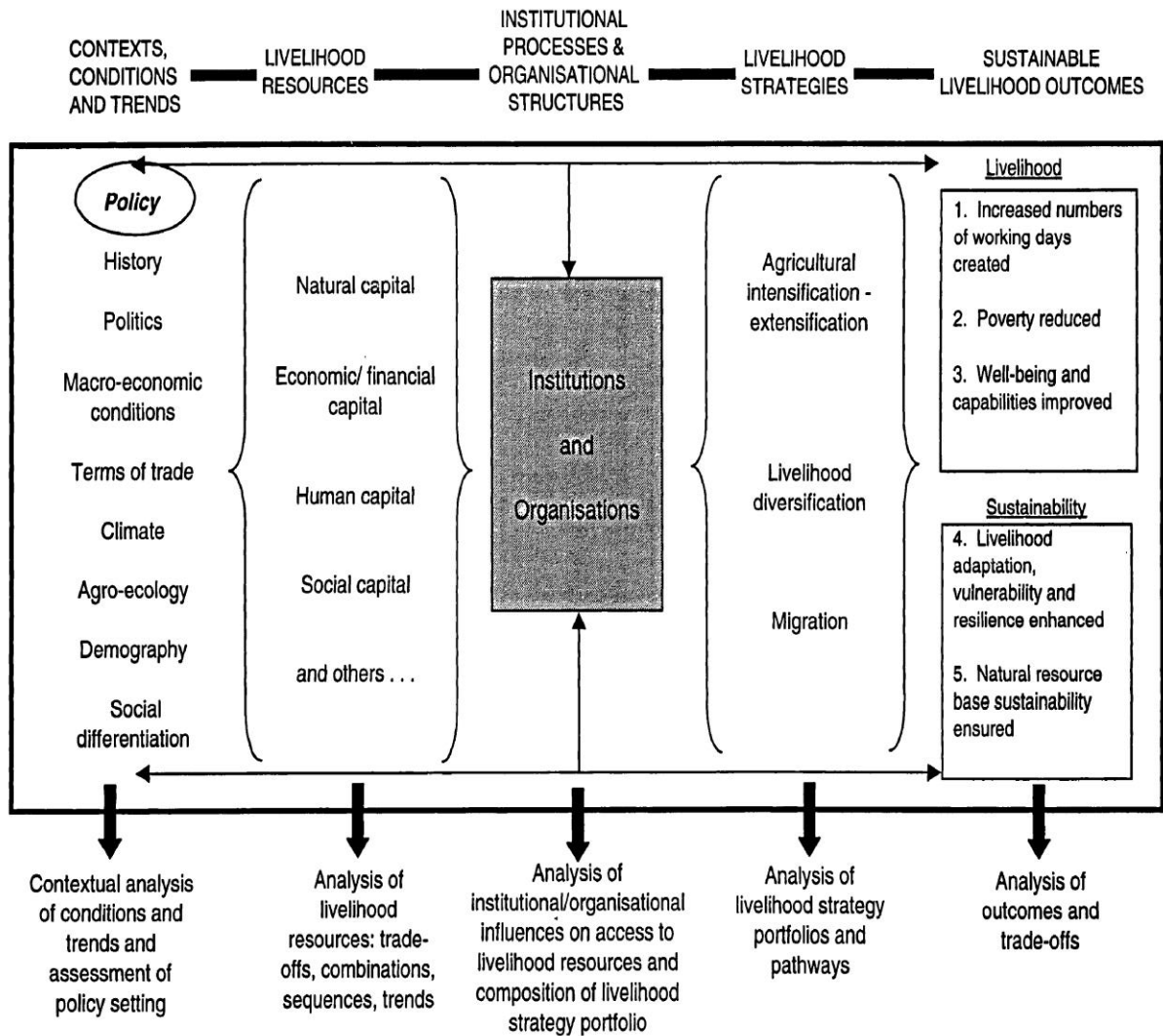
The Sustainable Livelihood Framework is used as a tool to analyse livelihoods and poverty reduction. The framework states that vulnerability context characterised by shocks, seasonality and national economic trends have an influence on rural projects and programmes. The context which a project is in can affect either positively or negatively asset utilisation. Assets can be used to avert unfavourable conditions but institutions, processes and organisational structure would have created an atmosphere conducive to efficient and effective utilisation of assets. Institutions and organisations deter or facilitate livelihood strategies. The theory enables vulnerable

communities to access to assets. Institutions and organisations are transforming processes; hence, can deliver or negatively affect sustainability in rural livelihoods (Scoones, 2010).

The theory presents vulnerability context, assets and institutions as factors influencing people's livelihoods. It presents the vulnerability contexts as exogenous factors that can influence the performance, and assets as endogenous components that contribute to positive livelihood outcomes. It explores the role of public and private institutions in averting vulnerability context and the transformation of assets for sustainable development.

This in turn helps to identify the entry point for livelihoods support. The framework unleashes the role of institutions, both formal and informal, in enhancing or constraining social integration and social cohesion. It links institutions with endowments and how they are accessed to avert vulnerability and facilitate positive livelihood outcomes. The framework entails how institutions are used in organisations to manage common property resource and in resolving collective action challenges to attain positive livelihood outcomes. Sustainability would result in positive livelihood outcomes, though it is not a simple one-way relationship. The greater the resource people have, the more impact they exert. Smallholder irrigation is a livelihood activity that should be developed by enhancing sustainability. The greater the social utility, the higher the degree of institutional alignment result in sustainability in livelihood development. Despite the context, conditions and trends, sustainability in irrigation schemes is influenced by technical capacity, governance, farm profitability and management of water resources to achieve a positive sustainable livelihood outcome.

### 2.6.4.1 The Sustainable Livelihood Framework



**Figure 2.4: IDS sustainable rural livelihoods – a framework for analysis**

(Source: adopted from Scoones, 1998:4)

### 2.6.4.2 Sustainability in smallholder irrigation agriculture

Institutions have rules and regulations that guide and constrain individuals and organisations behaviour and shape the interaction of human beings.

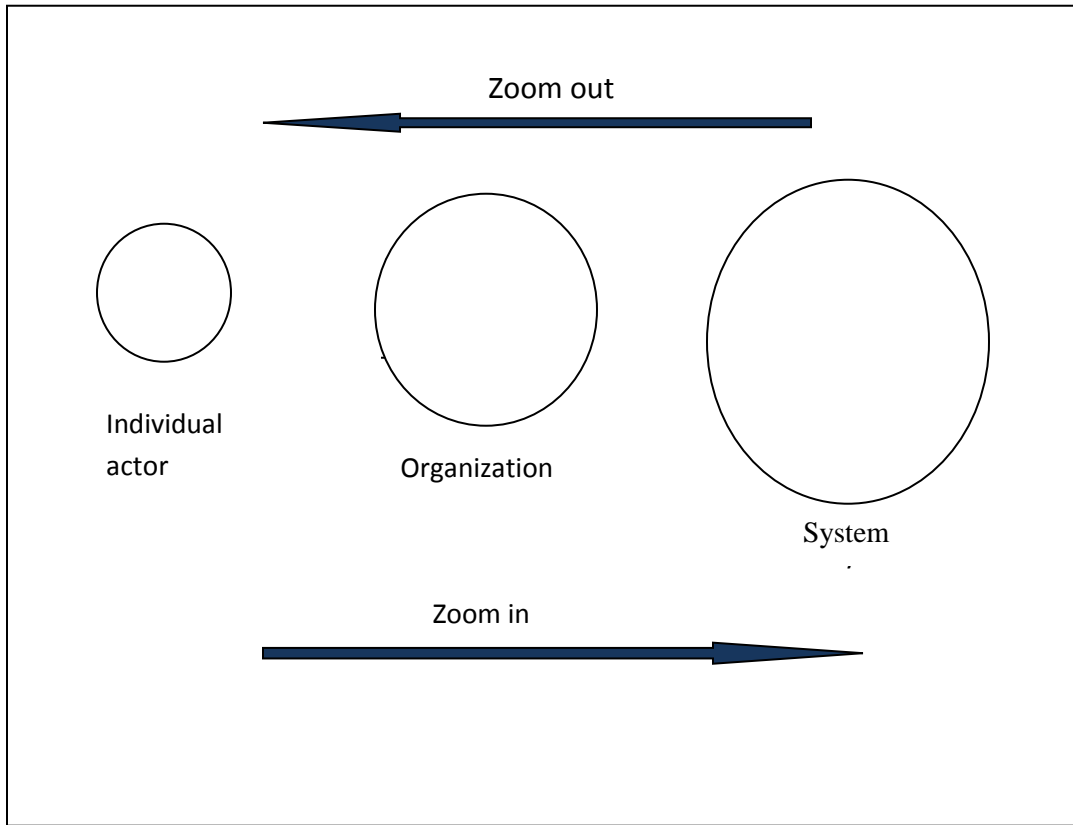
“An institution should be deemed sustainable if it has strength to survive and develop to fulfil its functions on a permanent base with decreasing levels of external support. An institution is sustainable if it is able to secure necessary inputs and support to provide, efficiently and effectively, a continuous stream of activities and outputs that are valued by its stakeholders for as long as the institution is needed” (Oslo, 2000:5).

The question that arises is about how performance can be derived from rules or norms of behaviour. Moreover, it is not the institution that performs, but their presence, which influences the performance and efficiency of smallholder irrigation schemes (Oslo, 2000). Nhundu’s 2013 study sought to evaluate the effectiveness of both the formal and informal institutions on water management and their overall well-being. The question that his thesis was addressing is whether “irrigation institutions are really effective in water resource management especially for enhancing welfare of the water users and nation at large” (Nhundu, 2013:114).

## **2.7 DIMENSIONS OF CONCERN WHEN ASSESSING VIABILITY AND SUSTAINABILITY**

While it has been demonstrated in the preceding sections of this chapter that there are many theories and approaches that are applicable to the assessment of viability and sustainability of smallholder irrigation schemes, the Viability System Based Theory and Sustainable Livelihoods Approach appear to be the most appropriate for this study. This is because they address key features at individual, organisational and systems levels, as shown in Figure 2.4.

## ENTRY POINTS – ZOOMING IN AND OUT



**Figure 2.5: Two dimensions of concern when assessing viability and sustainability.**

(Adopted from Oslo, 2000:17)

Based on the model presented above, the assessment zooms in first, on organisational capability, human resources and lastly on the total system (Oslo, 2000). This implies that assessments are carried out with the use of certain lenses and categories, which help to focus attention on matters and dimensions that are important at any level. Different lenses are used to throw light on and cover different aspects of irrigation schemes. The approach looks at schemes from more than one side and changes lenses from time to time. In this context, sustainability is assessed on dimensions of capacity of individual, organization and system levels. Since an institution does many things, its success depends on adequate performance in a number of areas, and the criteria for success must reflect this complexity.

In relation to smallholder irrigation schemes, zooming in entails that the success of a smallholder irrigation scheme starts with the irrigation farmer as an individual. His or her competence and level of alignment with the institution would lead to an organisational strategy, management and culture that are efficient and effective. These are automatically the pillars of the systems of the institution or scheme in terms of its linkages, priorities and performance, as well as how they relate to the national and international community. As shown in Figure 2.5, communication should be two way. In addition, the level of participation by the individual farmers should be high in order for the organisation and systems of the scheme to succeed. If accountability, ownership and responsibility start with the farmer as an actor, the organisations and systems succeeds. By contrast, ignoring the individual farmer's potential contribution might lead to limited success. This implies that the individual level builds the organisation while its organisational level determines the level of success within its system. Systems level without the individual and the organisational level would be like a foundation-less pyramid. A farmer as an individual needs to be equipped with organisational strategy, organisational management of his/her plot, financial resources and economic independence, technical resources, performance to meet short-term targets, owning the plot, and participating in decision making. At organisational level, a farmer should be affiliated to certain organisations that provide support farmers and assist them in times of need, be it financially, socially or technically. These organisations are institutions that support the system, which is in turn is composed of various organisations connected and assisting the farmers' interest in developing viability and sustainability. Therefore, sustainability of institutions and rural livelihoods activities are influenced by the way levels of institutional development function. Players within an organization, start with an individual then a team of players would give an organisation arms to facilitate the operation of the scheme and the system level brings in the rules and regulations assisting the operation of the supra-system. Under zooming out, the system would be placing the organization at strategic position for networking, backward and forward linkages for the success and continuity of the scheme. It should be noted that when exogenous and endogenous factors have an influence on a project their effects may be unforeseen and beyond the project manager's direct control (Oslo, 2000:17).

Emphasis must be put on assessment of scheme viability and sustainability, which is required in the stages of the project cycle. There is need for a review of historical performance that indicates

the organisation's resilience but qualified analysis of the context needs to supplement the data. Therefore, there should be compliance and alignment at each level of the institutional scale for viability and sustainability to prevail (Ozerol, 2013).

## **2.8 SUSTAINABILITY ASSESSMENT METHODOLOGIES**

For one to gauge the sustainability in projects, integration of political, social, economic and environmental aspects need to be taken into consideration. Ex-post evaluation is one of the alternatives for judging effectiveness of an organization. However, in any form of evaluation indicators are crucial when judging the effectiveness of the organization.

### **2.8.1 The Concept of Indicators**

Indicators, according to Sparrenburg (2001), are defined based on their role in providing guidance in decision making to achieve sustainable development. The indicator's purpose defines their quality. They lay the groundwork for improved data gathering, and enable a comparative analysis that is country specific and progress towards sustainable development.

### **2.8.2 Sustainability assessment indicators**

Sustainability achievement by an organization is determined through viability assessment (Phahl, 2005). The indicators crafted by the Commission for Sustainable Development in 1995 are not enough to for assessing institutional effectiveness (Sparrenburg, 2001).

“They narrowly focused on aspects of organisational entities implementing sustainability policies. For example, the existence of the Environmental Management Agency (EMA) in Zimbabwe does not guarantee effective environmental policies. The improvements in policy making for sustainable development involve not just the monitoring of policy implementation but also the building of administrative and political capacities to recognise policy failures and develop and implement alternatives” (Pfahl, 2005:86).

This can only be done if there are indicators that can be used to assess the progress of policies and projects. Meaningful indicators should be (Spangenberg et al., 2002:67):

- “scientific, based on sound science and accepted in the scientific community
- relevant, cover crucial aspects of sustainable development
- transparent, selection, calculation and meaning must be obvious
- quantifiable, as far as possible based on existing data or data easy to generate
- independent, each indicator must be meaningful in itself
- indicative, an indicator must be representative in describing the phenomena it intends to characterise
- robust, still valid even with slight methodological changes or improvements in database.

Spangenberg (2005:87) further states:

“Indicators are only one tool to approach the ‘measurement’ of viability and sustainability and even if indicators i.e. specific goals, targets and timetables are available for specific institutions, it remains unclear whether these goals are sufficient or truly sustainable and what they imply for the institutional setting as a whole, in addition to criteria for whether the goals to be achieved are indeed sustainable in the long-term”.

A human development condition change overtime and

“new information about its sustainability impacts emerge. Current indicators may not be sufficient to judge the sustainability of institutions. The sustainability of an institution (organization) depends on the national context and the actors involved in determining sustainability targets and specific goals for similar institutions like national environmental agencies or sustainability policies might be very different. At the end, the setting of sustainability goals is a search process that has to be continuously monitored and revised” (Rothmans et al., 2001; Pfahl, 2005:92).

Although, this does not undermine the credibility of the indicator-based approach, it prescribes the scrutiny of those informal institutional aspects (Spangenberg et al., 2001).

### **2.8.3 Viability and sustainability indicators**

Viability and sustainability indicators are variables that compress “information concerning a relatively complex process, trend or state into a more readily understandable form” (Becker, 1997:2).

“Indicators provide comprehensive information about the systems shaping sustainable development. Indicators summarize complex information of value to the observer. Indicators are for the viability of a system and for its contribution to the performance of another system. They provide the current state and corresponding viability of that system” (Bossel, 1999:13).

According to Spangenburg, 2002:106,

“The Commission on Sustainable Development (CSD) set of sustainability indicators were developed to measure the progress achieved against the purposes of the respective institution. The CSD referred the institutional indicators to seven themes of agenda 21 under the following chapters (8-23, 32, 35, 37, 38, 39, 40), proposing a total of 15 indicators”.

The aim of using indicators of sustainability is to provide simple tools of communicating decision-making process towards sustainable development. Indicators should also reduce complexity, easily understandable and few, remain flexible to future developments, covering broad areas for Agenda 21 and all sustainability aspects in agreement with international standards. For them to provide a social base in decision-making, they have to be general, indicative, sensitive and robust in nature (Spangenburg, 2002). Indicators measure the performance of an organization.

Oslo (1999) gave four options for measuring performance:

1. The goal attainment approach, which entails that success, is measured through results. However, the problem is more in identification and measurement of goals and that performance needs to be evaluated by more than the goals achieved.
2. The systems approach where goals are not ignored but are only one of the several evaluation criteria. It emphasises multiple criteria that increase sustainability of the

organization through resource acquisition capabilities, managing its internal affairs, interacting, and adapting successfully to its external environment. This approach implies that organisations are composed of interconnected parts and if one part experiences poor performance, this affects negatively on the total system. The application of the systems approach presents some limitations when applied as a sole tool for sustainability assessment. Sustained performance requires awareness and successful interactions with external stakeholders.

3. The stakeholder approach states that effective institutions should satisfy the requirements of those stakeholders supporting it. It is an intriguing approach though it provides scope for a bottom up approach. Even though it is difficult to follow in practice, it accommodates beneficiaries.
4. The approach brings in the ability to organize internal dimensions and relate to external dimension. If an institution has, a combination of these abilities its chance of success is enhanced (Oslo, 1999).

Having captured all the concepts and indicators relating to sustainability other theoretical views would act as factors influencing sustainability in smallholder irrigation.

## **2.9 DIMENSIONS OF SUSTAINABILITY**

Wichelns et al. (2012) have examined the institutional sustainability of smallholder water user associations supported by Oxfam America and NGO partners in Ethiopia, in relation to farmers' efforts to produce irrigated vegetables for the market. The research assessed five categories of sustainability: Technical Capacity, Financial Management, Governance, Farm Profitability, and Land and Water Resources. Short form surveys asked respondents to state how they allocate a sum of money towards reducing risk across a number of scenarios that might enhance the sustainability of their smallholder water systems in Ethiopia (Wichelns et al., 2012). However, the study was not holistic in its approach and did not address irrigation as a system, yet the concept of institutional development embraces not only individual actors, but also organisations and social systems, which consist of a variety of activities at each level. Failure to address all levels and dimensions of institutional development in smallholder irrigation agriculture would result in viability and sustainability weaknesses.

### **2.9.1 Technical capacity and financial management**

Technical capacity encompasses technical infrastructure and administrative equipment. There is need to check whether the scheme has the required fixed assets or resources that are enough to sustain an organisation. In this context, sustainability is measured based on the ability to use and maintain the infrastructure and equipment required for the proper functioning of a smallholder irrigation scheme. This encompasses the maintenance of engines, pumps, canals, fencing materials, water rationing, human capital (expertise on irrigation and farming management) and crop programme formulation. Mwendera et al. (2013:136) report that “one of the Operation and Maintenance (O&M) problems in smallholder irrigation-scheme systems is prevalence of a vicious cycle of insufficient maintenances of irrigation infrastructure leading to the downgrading of fixed assets, which results in inefficiency in operation”. FAO (1999) shared the same view that maintenance of infrastructure system is crucial in guaranteeing the sustainability of irrigated agriculture. Mwendera et al. (2013) further argue that efficiency and timeous rehabilitation of irrigation scheme /assets improve the performance in the distribution of water. Mwendera et al. (2013) also state that while resource evaluation and proper technical maintenance are a backbone to the success of smallholder irrigation scheme, sufficient maintenance systems determine viability and sustainability in schemes. On administrative equipment, capacity is measured in terms of whether the institution controls the necessary administrative tools and equipment like crop rotation and water supply procedures or not. As alluded to by Nkambule (2013), the lack of proper irrigation scheduling in smallholder irrigation schemes contributes to reduced crop productivity. Resultantly, there will be no provision for flexibility taking cognisance of the changing seasons.

### **2.9.2 Financial management**

Financial management focuses on financial resources and economic independence. Sustainability is assessed because of sufficient operational and capital costs. The assessment is based on whether the scheme’s income stability and budget is adequate for the institution to fulfil its mandate or not. This includes rate payment by farmers and management of funds to repair equipment and other services (Wichelns et al., 2012). Regarding economic independence, the assessment of the viability of an organization is based on the ability of the organization to control

or influence its future income. Morales and Mongcopa (2008) report that financial constraints and poor collection of cash inflows by farmers lead to poor management of the schemes. Shar et al. (2002) observed that in developing countries, scheme management institutions are even failing to set up price charges for operation and maintenance cost for the sustainability of the schemes.

A scheme may engage in income generating projects to sustain itself and fund future expenses. The self-sustainability of the institution is critical (where the organisation does not depend on external financial support). A study in Ethiopia by Wichelns et al. (2012) revealed no persistent problems involving the technical capacity or financial management of any association, or any problems of inadequate or untimely water deliveries.

One of the main threats to O&M is mainly when members of smaller water user association who rely on a single motor and pumping station. In Ethiopia, some associations reported that they had established a small savings account for repair or replacement of equipment, but their financial resources were insufficient. Other associations collected funds from members when a breakdown occurred. None of the smaller associations had yet had a breakdown, but the experience of the older, larger associations suggests the risk: farmers in one association, for example, have replaced electric motors four times in seven years, which affected their membership and placed them at higher risk (Wichelns et al., 2012:1). Financial resource related challenges that irrigation schemes experience are not unique to specific schemes but are widespread. Tafesse (2003) highlights other regional studies showing the importance of financial support in rehabilitation of irrigation schemes. The sustainability of a scheme is measured in terms of its success in the areas mentioned above. Failure of the scheme to address the aforementioned challenges would result in discontinuity of the project.

### **2.9.3 Governance**

The term *governance* captures organisational strategy, organisational management, linkages, legal and political frameworks, external cultural frameworks and participation and legitimacy (Tafesse, 2003). Focusing on organisational strategy, sustainability is measured based on whether members managing the schemes are aware of the mission and vision, i.e. whether the scheme has realistic objectives and also whether the objectives are in line with state obligations,

clear to all staff and flexible. Regarding organisational management, focus is on the capability of executive bodies (IMC), competent bodies providing overall direction, ability to face challenges, making feasible decisions. The bodies' planning systems are operative, a system with effective administration and financial procedures in place like an accounting system. The body has adequate mechanisms in place to control internal affairs, monitoring and evaluation activities. With regard to organisational structure, the institution is placed under appropriate superior agencies (Wichelns et al., 2012). The internal structures of the organization should conform to administrative principles that have to do with the span of control, well spelt out authority and clear roles and responsibilities and existing structures running new projects. The structure supports effective implementation of work and can run new projects. The major thrust of linkages/networks, is on alliance and connections, relations to donors and competitors and rivals. Assessment is based on institutions' connection to local and international stakeholders, capacity of institutions to utilise its connections productively. It should have reliable donor support. The donors coordinate their efforts and follows known practices. Donors assist in growth and development of institutions. Whether the institution has few rivalries and competitors or not and the capacity of the institution to manage competitors or rivalries well is captured.

The legal and political framework is mandated to look at whether the scheme is legal and free to do what so ever it deems necessary. Institutions should be linked to official policy, political support maintained and stability in local and national stakeholders. External culture framework focuses on indigenous knowledge and values of official agencies. The institutional environment permits the schemes to perform with no ethnic misunderstandings and gender discrimination affecting the institution negatively. The thrust of participation and legitimacy is on local ownership and participation, trust and legitimacy in community. Assessment is based on the presence of staff ownership spirit, participatory planning and implementation of activities. Stakeholders perceived schemes as their local asset with local control. Support by major stakeholders is shown through transparency in all its operations (Oslo, 2000).

“The Water Users Associations (WUA) in Ethiopia formed committees to address standard issues of governance through traditional and modern by-laws, and meet on a regular schedule. The older associations had good experiences with elections, and very little conflict was reported. Most members participate in elections,

including women and during the course of the researchers' visits and interviews in an Ethiopian case, they met several women who served as vice-chairs of a WUA, but they did not meet any women serving as chairperson" (Wichelns, 2012:1).

The legal status of associations would be a helpful enhancement in governance, as it would allow the associations to engage in a full range of financial and market transactions on behalf of their members. 'Unions for WUAs could also help them attain larger discounts in purchasing inputs, and better prices when negotiating with commodity brokers' (Wichelns et al., 2012). All of the associations in Ethiopia reported very little conflict among users regarding water allocations or irrigation scheduling. Only in one association did they discover a non-trivial conflict involving several members of a WUA.

"Certain members of water users associations have stopped paying the monthly membership fee of 10 ETB (currency) per month, yet they continued to divert water from the community canal into their crop fields and they extended their diversions beyond the time normally allocated for irrigation turns. Senior members expressed concern about this situation, but they have not yet developed a solution" (Wichelns et al., 2012:1).

Benjamin et al. (1994) confirm that farmer-managed irrigation schemes are associated with productive working relations in terms of a high level of social integration and active involvement in the development of rules and their level of alignment. These productive patterns of relationships are the basis upon which high levels of irrigation performance are attained. A study of 127 irrigation systems from Nepal indicated that governance structures are an important variable affecting irrigation performance and control other factors (Benjamin et al., 1994). Effective functioning of WUAs or IMC influences viability and sustainability systems of agriculture in smallholder irrigation (Mishap et al., 2011). Therefore, the capacity of the plot holders in a scheme to follow the constitution, norms and values of the local community would result in viability and sustainability but failure by irrigators to follow formal and informal rules and regulations would result in the abandonment of the scheme.

#### **2.9.4 Farm profitability**

Farm profitability is about the performance, productivity, performance demands and controls of operations in schemes. Focus is on the capacity of the scheme to demonstrate the capability of an organization to achieve its own strategies. The products must comply with quality standards at national level. The scheme should demonstrate its potential to accomplish tasks within stipulated timelines. On farm profitability, the capacity of the scheme to meet immediate targets needs to be assessed. The benefits should be more than the costs incurred in production. Under performance, demands and control, the institution's exposure to external competition compelling improved performance is assessed. It is crucial for authorities to acknowledge that performance meet acceptable standards.

Most of the farmers visited in the Tigray and Central Rift Valley in Ethiopia were pleased to have gained access to irrigation, as it enabled them to produce marketable yields of vegetables in two or three crop cycles each year. "Farmers reported that when output prices are high, they earn substantial profits. Yet when market prices are low, they fail to earn enough revenue to offset their costs of production" (Wichelns et al., 2012:2). An important challenge to sustainability was that of interacting successfully in markets (input and output) when producing high-value horticultural crops and the inability of the farmers to collectively address this problem. Vegetable crops are largely perishable and they must be brought to market soon after harvest. Lack of cold storage facilities and absence of forward contracts give most farmers little room for bargaining over prices when their crops mature. Intermediaries offer low prices that fail to cover the total cost of production.

Therefore, it is important for farmers to reduce the gap between them and the final buyer since the intermediaries are an exploitative force unfair prices and unsustainable (PLP, 2005). This was again realised by Morberg (2013) when the Fair Trade Company assisted smallholder banana growers in the Caribbean in marketing their produce to Sainsbury supermarket in the United Kingdom. Consumers and industrial observers have raised questions about who is benefiting from the retail price charged for the products. Many consumers assumed producers are benefiting when in fact that was far from reality. There was a huge discrepancy between producers and retail prices for the marketed commodities. Asked about the discrepancies in retail

and producer prices for Fair Trade versus conventional bananas, spokesperson for Sainsbury pointed out that some of the retail price difference is returned to growers communities as a social premium. However, the social premium generated by each 42-kilogram box of Fair Trade fruits is US \$1.75. The cost of producing each box was \$5. Given that the contents of each box would retail for about US \$53, it is evident that the social premium is a very small share of the total value of each box. Clearly then, much of the retail price differential between fair trade and conventional products is not returned to producers or communities to which they belong (Moberg, 2013:172). This actually shows how the intermediary traders take advantage of smallholder farmers.

As Longwe et al. (in press) state, producers sold at farm-gate level or local market to traders and NGOs who transport the produce to processors or consumers in urban markets. This shows that in all the channels there is no direct contact between the producers and the majority of the final users. With the existence of several intermediaries participating in the marketing chains, farmers get lower prices than they would get if they sold their produce directly to final users.

In the “Tigray and the Central Rift Valley regions of Ethiopia, many farmers cultivate only 0.25 ha of irrigated land, it seems sensible to consider some form of cooperation in which groups of farmers come together when purchasing inputs and when marketing their products” (Wichelns et al., 2012:2). Most smallholder households who gained access to irrigation for the first time would not have savings accounts from which to pay for inputs. Thus, farmers need access to affordable credit. Farmers should also have access to crop insurance, so that a crop failure due to weather or pest infestation would not cause long-lasting financial harm. “Some partners provide farmers with crop production loans through revolving credit mechanisms, but it is not clear that such an approach is widespread or sustainable, and there is no explicit transition strategy” (Wichelns et al., 2012:2). Hence, failure to get access to credit, crop insurance and partnership would result in viability and sustainability not being realised.

Nhundu et al. (2010) questioned the economic viability of smallholder irrigation schemes in Zimbabwe and pointed out that certain smallholder irrigation schemes have failed and are underutilised due to poor management, lack of inputs and irrigation experiences by farmers.

Benjamin et al. (1994), who confirmed that viability of the irrigation systems is largely hinged upon the performance of irrigation officials, highlighted this in earlier research.

### **2.9.5 Water resources management**

This refers to appropriateness and adequacy of irrigation water management capacity. Focus would be on irrigation water laws like effective provisions of conflict-solving mechanisms, irrigation water policy (payment of irrigation water, private sector participation, linkage with other economic policy), administration irrigation water (effectiveness of farmers association in canals, IMC, suppliers and markets) and updates and maintenance of data. A major challenge to sustainability pertains to long-term water availability (Wichelns et al., 2012). Water sources of irrigation schemes may be drawn from a stream, river or dam. Reliability of water availability from these sources would determine the sustainability of the institution. A siltation free water source (dams) is reliable and sustainable since storages are regarded by Benjamin (1994) as major components in an irrigation system. Storage facilities such as dams provide water, which can serve as buffer against uncertainties.

Some water sources are perennial while others are seasonal. “Schemes with perennial sources have little or no challenges as compared to seasonal ones. Adequacy, equity of water distribution and dependability of water supply constituted the main performance indicators of water delivery system” (Hitcher et al., 1999:38). Dependability of water supply is a sign of a reliable system of the irrigation to perform as expected and is indicative of timelessness and adequacy of promised deliveries (Hitcher et al., 1999). “The adequacy of an irrigation scheme is a measure of the ability of the water supply schedule to meet the water demand for optimal plant growth” (Hitcher et al., 1999:59). The composition of an irrigation system is associated with the canals and the water as common pool resources. Bravo and Marelli (2000) add that, despite management challenges of the two Common Pool Resources at the same time, communities across the world fell into this tragedy. In most cases as given by Ostrom (1992) and Tang (1992), this was resolved by coming up with sound rules and regulations in line with local conditions and the ability to compel users to share the resource equitably thereby contributing to the maintenance of the infrastructure. Out of a total of 120 farmers in the Somnene Irrigation Scheme in Bulilima District in Zimbabwe, only seven remained in the scheme due to failure to raise money for

electricity bills (Dube, 2013). This explains the extent to which payment of water bills is a challenge if farmers operate individually. Withdrawal by most farmers in the scheme was prompted by their failure to work collectively and lessen operational costs. Similarly, several analysts have expressed concern regarding the sustainability of irrigated agriculture in the Lake Ziway region in Ethiopia.

“Many farmers perceive increasing demand pressure on regional water resources. Further declines in the average level of the lake and any substantial increase in salinity have potentially severe impacts on farmers, herders, and many other residents of the Central Rift Valley. The threat of increasing salinity is made more pressing by the construction of a dam at the point where the Lake discharges into the Bulbula River” (Wichelns, 2012:3).

#### **2.9.6 Socially constructed performance assessment**

For performance assessment to be effective in meeting the needs of stakeholders, a conscious social construction involving negotiation, informal rules, accountability and attribution is required (Johnson and Wilson, 2000). It involves “agreeing, investigating and testing informal rules between stakeholders about sustainable development and sustainability and about plans for intervention in the contexts in which it is intended to occur” (Johnson and Wilson, 2000:73). Usually assumptions around the interventions relate to a situation “within which a given intervention takes place, material, financial and human resources available and the social context of the implementation process itself” (Johnson and Wilson, 2000:76). Many development projects and programmes fail because of the failure to account for assumptions.

In development programmes, agreed responsibilities, time-lines and decision making implying negotiating on scheme’s framework for accountability is key in performance assessment. Apart from attribution and assumptions, of most importance among the three is accountability. ‘Those responsible for taking stock of events give regulations and guidance on interventions. The development of performance assessments is of crucial importance to donor requirements (upward accountability), the supposed beneficiaries (downwards accountability), to benefactors,

or due to conditions imposed by stakeholders (multiple accountability), and also to all stakeholders' (Edwards and Hulmes, 1995; Johnson and Wilson, 2000). Failure to account to any of the above-mentioned offices would affect the sustainability of an organization. This would affect future funding by the donor.

Lastly, attribution is a process that explains the observed impact of interventions. "Establishing processes of monitoring and evaluation which allow discussion and understanding by stakeholders of what particular output and outcomes can be attributed to the intervention. It turns the data of monitoring into the information of evaluation" (Johnson et al., 2000:77). A project may have goals of improving livelihoods for poor farmers in the depressed regions and over two to three years monitoring may show livelihood improvement. This may result from the project but it may also result from external factors. Donors like Overseas Development Association (ODA) have established that:

"a major difficulty in attempting to measure the benefits, to determine the extent to which it is possible to attribute improvements to the project as opposed to factors external to the project such as economic growth, increasing demand for labour, investment in public services and infrastructure, all of which have a positive impact on well-beings" (Robinson and Thin, 1993:26; Johnson and Wilson, 2000:76).

Attribution is a measure of viability and sustainability since it determines the asset or outputs accrued to an individual after a particular period in the scheme. Resources acquired by plot holders like farm implements, school fees and plot owner as a status symbol separates plot holders and non-plot holders. One can measure the success of the plot holder by comparing plot holders' assets and their quality of life before inception of the irrigation scheme and after. One would observe the changes that would have taken place in the plot holder's life through resource acquisition. Furthermore, one can compare non-plot holders and plot holders in terms of their quality of life and resource acquisition.

### **2.9.7 Social coherence**

The level of social cohesion or dissonance is important in any project environment. Social cohesion is one of the elements influencing viability and sustainability of development processes. Social networks, reciprocity, integration amongst groups can influence project success. Cohesiveness is considered to be an important element in processes that determine functioning in small groups. Moody and White (2003) argue that social cohesion is a property of the relationships that consider how group members are networked. Morton Dutch, a student of Lewin, regards cohesiveness as the forces bringing people together and refutes destructive tendencies (Moody and White, 2003). He found that cooperative group members were rewarded more due to cohesiveness than those competitive ones.

Social cohesion is a subject common on common property resource management. However, this would vary due to external and internal environments. Social cohesion is influenced by organisational institutions. Using Mukwada, 2012)'s Capacity Continuum Drivers Model, individuals in a project have the right to make their own choices about whether to pursue Social Utility (SU) or Individual Utility (IU). In this case, utility is a measure of satisfaction derived from sparing use of a resource. In an experiment on the relationship between SU and decision making Lowenstein et al. (1989, in Mukwada et al., 2012) observe that when individuals felt equality was not possible amongst themselves, they proffered that the other part be relatively at a negative side, indicating that individuals put their interests before group interests when confronted with crises. Social utility enhance cooperation while individual utility promote competition. Social utility thrives on social capital and promote cooperative behaviour amongst group members. However, there is a threshold of willingness among community members to cooperate and participate in common pool resources management and this occurs at the stage where social utility is equal to IU. Beyond this threshold, collective capacity becomes insignificant, rendering common pool resources management impossible hence compromising the viability and sustainability of the project. Therefore, SU enhances viability while IU renders viability impossible. This implies that in a smallholder irrigation scheme, understanding one another as farmers would contribute to the success of the scheme. The opposite is true when social dissonance prevails.

When IU exceeds SU collective effort is diminished, compromising viability, while the opposite is true where SU exceeds IU. Competition amongst plot holders in schemes and lack of cooperation among them leads to a tragedy, which compromises maintenance of infrastructure and disrupts linkages between stakeholders, hence affecting the viability and sustainability of the scheme negatively. Therefore, individuals vacillate between the two scenarios depending on the changing dynamics of demand for resources and on the nature of drivers that affect their livelihoods. This scenario changes with space and time. If resources are scarce, SU declines as people pursue options to maximise IU whereas cooperation denotes social cohesion, competition reflects social dissonance in community managed projects. The demand component in the model affects viability of projects. Scarcity of a resource is expected to increase as demand rises resulting in competition for the remaining resources and resultantly compromising collective stewardship. As population rises, demand for resources increases as well, resulting in competition amongst resource users. In smallholder irrigation schemes, competition over water or markets causes social dissonance, which would undermine reciprocity and the performance of associations like the water users associations. This would compromise the viability and sustainability of smallholder irrigation schemes.

The third component is the drivers' component. These are factors that determine how resources are used and managed in an environment where supply is 'fixed' while some drivers induce cooperation and bind community's collective proprietorship and the capacity to implement common pool management with the community; others enhance social dissonance because they promote individual utility and competition that may lead to resource overuse, scarcity and depletion. An example of a driver is the shock, stress or the vulnerability context of the community. In a study by Mukwada et al. (2012),  $IU > SU$ , due to social stratification, political conflict and variations in institutional arrangements. In Zimbabwe, the role of government agencies like the Environmental Management Agency and Forestry Commission were constrained by the collapse of the Zimbabwean national economy. Mukwada et al.'s (2012) study in Mufurudzi was on social stratification as a cause of dissonance based on the heterogeneity and highly fragmented society resulting from differential levels of education, type of environmental knowledge held by individuals, gender and religious differences amongst community members. This enhanced social dissonance and undermined Community Based Natural Resources Management.

“The heterogeneity that characterised the community created different levels of entitlements i.e. ‘the range of possibilities that people can have’. Mufurudzi had people from different political divide and polarisation had been responsible for disagreements between the supporters of the two leading political parties resulting in disrespect of lineage leaders, putting further strain on social cohesion” (Mukwada, 2012:120).

FAO (2000) carried out a study in Rozva irrigation, and found out that the scheme was facing challenges related to conflicts among village heads, whose subordinates are beneficiaries of the scheme. The two village heads who were involved failed to cooperate on water resource scheduling and on matters related to water fees defaulters. The reported conflict dated back to the 1950s, well before the establishment of the scheme. The village heads accused each other of being unproductive, negating scheme management and uncooperative. This affected the performance of the scheme negatively. That is why Sweden and Rukuni (1994) noted that the emergence of conflict in irrigation schemes in Zimbabwe is due to absence of functional institutional and organisational framework and lack of community based democratic systems of allocating water resources equitably in several ways like power struggle, minor misunderstandings ([www.waternetonline.org](http://www.waternetonline.org) 14.04.2015).

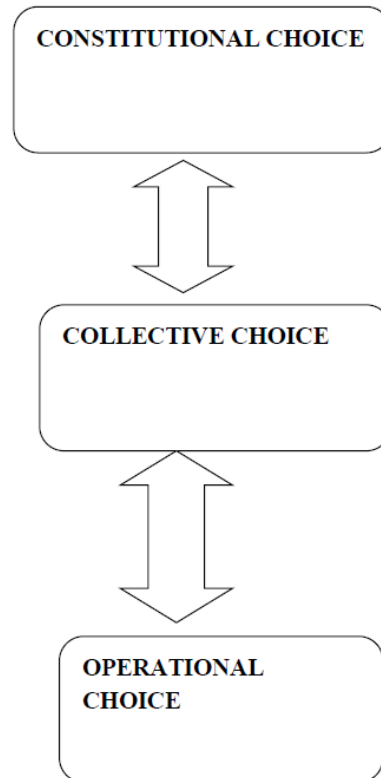
## **2.10 FACTORS INFLUENCING VIABILITY AND SUSTAINABILITY IN SMALLHOLDER IRRIGATION**

Many factors can influence viability and sustainability in smallholder irrigation agriculture as a rural livelihoods development activity. The institutional scale and alignment theory, the conventional theory of a firm, the farming style theory, the social capital and formal-informal institutional interaction model have highlighted some of these factors.

### **2.10.1 Institutional Scale and Institutional Alignment model**

Institutional scale is the “hierarchical levels of operational, collective choice and constitutional choice proposed by Kiser and Ostrom in 1982” (Ozerol, 2013:26). Ozerol (2013) perceives institutions as permitted rules that provide structure to interact. The participation of farmers in

irrigation schemes is analysed based on formal and informal institutions. Formal institutions are a hierarchy of rules from constitutions to statutes and common laws, to specific bylaws and finally to individual contracts. Informal institutions are unwritten constraints coming from socially transmitted information and are part of heritage that one can call culture (North, 1996:46). In smallholder irrigation schemes, farmers work under a constitution, rules and regulation that would bind them together for their success. Institutions of farmer participation in schemes are operationalized using ‘zero-order, first-order and second-order level’ as an institutional scale (Ozerol, 2013). The zero-order level is the operational level, first-order level is the collective choice level and lastly the second-order level is the constitutional choice level, as shown in Figure 2.6.



**Figure 2.6:** Levels of choices made by farmers within an institutional scale (Adapted from Ozerol, 2013: 76)

The operational rules are the zero-order institutions and relate to farmers’ actions about water usage. This relates to how farmers should behave within a scheme, which is in line with the rules and regulations in the constitution of the scheme. The collective choice is the first-order

institutions which relate to the participation of farmers in defining, monitoring of the rules in operation. It can be ‘monitoring of compliance to rules’. They are the rules that shape how farmers should interact during their operations within the scheme. The constitutional choice is the second-order institutions, which entails farmers’ involvement “in changing the first-order rules, the second-order rules are defined for each first-order rules” (Ozerol, 2013:77).

First order rule is the discipline a farmer should have for him to succeed in agricultural activities. The second order is the order or behaviour that a farmer should reveal to the other farmers in a team so that they work in compliance with set rules. This discipline or “good behaviour” builds the scheme’s constitution. This defines changes or maintenance of rules based on performance of the institutions. If there is no order at ground level or on farmers’ interaction, amendments should be made on the constitution. Therefore, it is the constitution of the scheme that influences collective behaviour and this cascade to the operations on the ground.

Institutional alignment reveals inclination of the rules at various levels of institutional scale. The degree of alignment of institutions is due to top-down and bottom up integration of rules. If the higher rules (constitutional rules or collective choice rules) constraint revision of rules at a lower level, this would imply poor alignment, for example, on collective choice rules. If second-order rules envisaged that “only the top management of the water user organisation in this case IMC can change the rule”, this implies poor alignment since the farmers are not incorporated in management decision. Low degree of alignment means low influence on viability and sustainability. A higher alignment level is linked to smooth resolution of collective challenges. Hence, viability and sustainability are enhanced by a higher degree of alignment, which would result in resolving collective action problems. This approach was applied in Harrain plain in Turkey, where there was water logging and soil salinity, a collective action problem (Ozerol, 2013). However, there were inadequate approaches in monitoring of the irrigation association operations in the area. The theory gave the hierarchy of institutional management and the extent to which practices in schemes are aligned to the principles of irrigation sustainability.

### **2.10.2 The conventional theory of a firm**

Equating irrigation schemes to firms can enhance viability and sustainability in smallholder irrigation schemes. The theory of the firm is the theory of production in economic terms. Here,

“a firm is taken as a production function or possibility set that transforms inputs into outputs” (Nhundu, 2013). A firm is taken as an organisation making an effort to maximise financial profits. Usually, the bigger the organisation in scope and size, the larger the profits and multi-products the organization is expected to generate (Nhundu, 2013). However, this is not always the case since there are other factors beyond organisation’s controls that can affect profitability. A firm is an engine of productivity, hence sustainability. However, this would depend on the feasibility of the technology, input prices and demand schedule. These factors have been applied by Nhundu (2013) on the effectiveness of smallholder irrigation water-management institutions in Zimbabwe, thus taking irrigation, as firms would enhance efficiency and effectiveness hence viability and sustainability. The Conventional Theory of a Firm is much obsessed with farm profitability, which is just but one of the components of sustainability, but ignores issues of governance, technical and water resource management, which also influence institutional sustainability. Profit in organisations does not always lead to sustainability. Undermining or suppression of other stakeholders would make an organisation profiteer but unsustainable.

### **2.10.3 Farming style theory**

“The farming style theory “was developed by Jan-Douwe Van der Ploeg and co-workers at Wageningen University in Netherlands to study, characterise and explain diversity in farming with particular sub-sectors of agriculture production in Europe” (Van Averbeke et al., 2006:137). Farming styles were specific farming strategies, which are conscious responses of farmers to the prevailing ecological and socio-economic conditions. “Farming styles are an expression of how farmers combine and order the elements that are used in the process of agriculture production.” (Van der Ploeg, 2003:101). The approach in farming on irrigation schemes is shaped by the situation prevailing. Therefore, the farming style in line with the prevailing conditions should be practiced for the sustainability of the enterprise. This implies that the socio-economic and cultural context shapes the style of farming in any particular scheme. The farming style is influenced by strategies or models employed, structure, social and cultural domains.

“The strategic notion responds to the cost-benefit relationships that have been determined by farmers. On the social domain, a farming style reflects the interaction of farmers with the external world through relationships with other

actors featuring in the farming sector such as other farmers, suppliers of services and goods, traders, government and society at large. In order for viability and sustainability to prevail, relationships must be developed and sustained in an active manner” (Van der Ploeg, 2003, in Wim van Averbek, 2006:136).

Culturally, farming style should be a particular way of practising agriculture that is adapted to local agro-ecological conditions, available technology and markets. “A cultural repertoire is a store of indigenous knowledge that is shared and reproduced among farmers and that acts as a normative framework guiding the handling of land and the objects of farming” (Wim van Averbek, 2006:138).

The farming style approach has been investigated by Wim van Averbek et al. (2006) in the Dindi irrigation scheme in South Africa where it revealed that ecology, society and the economic environment determine the style of farming a smallholder scheme. However, the approach dwells much on culture and ignored the legal political framework and linkages that can influence viability and sustainability (Van der Ploeg, 2003).

#### **2.10.4 Social capital and formal-informal institutional interaction model**

Social capital explains the contribution of local networks, reciprocal relations, trust and shared norms in solving collective problems while institutional theory explains processes by which structure becomes registered guides of people’s interaction. Scholarship on the commons was dominated by prisoners’ dilemma and tragedy of the commons school of thought that having predicted the inability of resource users to manage their commons, favoured state intervention (Hardin, 2000). However, widespread unsuccessful experiences with the way states manage common pool resources led to the development of alternative theories, which are generally a reaction to the tragedy of the commons. This marked transverse section from a belief in the tragedy of the commons thinking to the understanding of the potentialities of communities in managing their local resources. There has also been a shift from rating informal institution as exclusively destructive to taking them as constructive. “Current schools of thought in the common property resources management have therefore highlighted the importance of social capital in instituting successful management arrangement.” (Zuku, 2010)

- **Conceptualization of social capital**

The popularity of social capital in academia is attributed to Bourdieu (1986), Coleman (1988) and Pitman (1993), though modern sense usage of the term was started as early as 1920 (Knowels, 2006; Nhodo, 2013). Social capital is based on the notion that totally rejects conventional economics and shows that people can still cope without economic resources due to their access to social capital. In short, they cope through the assistance rendered to them by others. Social capital refers to “features of social organisation such as networks, norms and social trust that facilitate coordination and cooperation for mutual benefit”. Putriam (1993)’s definitions capture relationships in families, kinships, networks, friendship, acquaintances, civil attachments and institutional ties (Nhodo, 2013).

Social capital increases the number of mutually beneficial trades, resolves collective action problems, improves the flow of information and reduces monitoring and transactions costs. “Collective action is forwarded on the use of mutually agreed upon rules, norms and networks to place group interests above of the individual” (Zuku, 2010:22). Where individuals may be reluctant to cooperate or be socially engaged, social capital is relied upon to achieve group consensus and actions by ensuring compliance with collective desirable behaviour.

However,

“reliance on social capital can result into negative outcomes such as operation of gangs and gangsters. It can close off the market to anyone who is not part of the network. Cooperation is good to members within the group but not those outside the group. Social capital is an appropriate concept for this study, since community management of smallholder irrigation schemes faces a number of challenges including rent dissipation and high transaction and enforcement costs as irrigation services are rival and non-excludable. Thus, without a fair and transparent water allocation system, the resources would be characterised by conflicts, inequalities and inefficiencies. Social capital helps water-user group members to cooperate in water resource use and management. More relevant to the study is the fact “that social capital allows individuals, groups and communities to resolve collective problems more easily. Social capital provides the foundations for resource use

rules, monitoring and enforcement mechanisms that are prerequisites for the success of community managed common property resources” (Zuku, 2010:25).

“A society’s institutions can be regarded as cultural or social capital” (Berkes and Folke, 1992; Nhundu, 2013:84).

“Social capital is closely linked to collective action in irrigation water management in developing countries. Some consider social norms, cultural values, trust and reciprocity and social sanctions as social capital” (Rudd, 2000; Wolcock, 1998; Nhundu, 2013:84).

Social capital is productive, self-reinforcing and cumulative and can improve economic performance. Social capital enables participants to act effectively to pursue shared objectives. There are “stronger incentives for cooperative action by local groups in cases where exploitation would occur from purely individualistic behaviour under ‘common property resource systems’” (Ostrom, 1990; Nhundu, 2013:84). This interaction of stakeholders spelt the performance of formal institutions as supported by informal institutions as Helmike and Levitsky (2004) depict.

Social capital is important in a study of viability and sustainability in smallholder irrigation schemes since it examines the way an organisation or scheme is governed, the systems and procedures, linkages and networks to donors, competitors and rivals, as well as alliances and connections (Helmike and Levitsky, 2004). It also captures the legal, political and cultural frameworks of the institutions/scheme, level of participation of the beneficiaries and how the organisational goals, purpose relate to the main government policies. It examines the interaction amongst farmers, IMC, suppliers, markets and other related organisations like government, donors and how they influence positive relationship for the benefit of the scheme as an organisation hence sustainability.

### **2.10.5 Formal-informal institution interaction model**

The Formal-Informal Institution Interaction Model is a model, which explains the nature and outcomes of the interaction between formal and informal institutions. The model explains “processes by which structures, including schemes, rules, norms and routines, become established as authoritative guidelines for social behaviour” (Scott, 2004; Zuku, 2010:25). New

institutionalism encompasses cultural, economic and historical forms of institutionalism, which all provide an understanding of the sources, performance and consequences of institutions. Normative institutionalism stipulates that:

“The best way to understand both individual and collective behaviour is through the logic of appropriateness that individuals acquire through their participation in institutions. The understanding is that people functioning within institutions behave as they do because of set normative standards, rather than their desire to maximise individual utilities” (Peter, 2000; Zuku, 2010:25).

The second variant is natural choice, which focuses on the relationship between rules of the game and the preferences of the individual actors. Individual preferences are pursued through incentives, but predominantly emphasise that the policies and structures “made at the inception of the institution will have a persistent influence over its behaviour for the remainder of its existence” (Zuku, 2010:25). There is a strong belief according to Zuku, 2010:28 that “many rules of the game that structure and guide people’s life are informal institutions that are created, communicated and enforced outside of officially sanctioned channels”. Zuku (2010) further argues that “there is much assumption and focus that actors’ incentives, actions and expectations are shaped primarily, if not exclusively, by formal rules”. Informal rules improve the performance of informal institutions, shape formal institutions and enhance sustainability. Whereas informal rules result in a substantially different outcome, formal and informal rules diverge, and where outcomes from the new institutions are not substantially different, formal and informal converge. Effectiveness of formal institutions looks at the extent to which rules and procedures that exist on paper are enforced and complied with in practices (Nhundu, 2010).

In the context of smallholder irrigation schemes subjected to Irrigation Management Transfer (IMT), a WUA constitution may be based on foreign principles and procedures such that informal institutions might violate formal ones. This means that certain rules may not be applicable to the farmers in the scheme. Hence, unfamiliar principles may not be received well by the farmers. Therefore, to increase individual access to resources, one has to corrupt the system of resource distribution. The Formal-Informal Institutional Interaction Model is relevant

to this study of community management of irrigation schemes that are experiencing power and responsibility transfers from government to irrigation farmers. Formal institutions are in constitution while informal are outside the constitution (Nhundu, 2013). Informal rules are deeply rooted in local traditions. Therefore, the success of the community management of smallholder irrigation schemes depends on the complex interaction between formal and informal rules and regulations. The rationale for integrating social capital concept and formal-informal institutional interaction model is that there is a strong relationship between social capital precepts and informal institutions or unwritten rules passed through oral tradition (Knowles, 2001). In other words, dependence on social capital within a formal institutional management framework inevitably brings formal institutions into interaction with informal ones (Zuku, 2010:32). Zuku's (2010) analysis is applicable to this study of smallholder irrigation schemes since it focuses on 'community rules and norms, rules and norms in official agencies'. It also captures ethnic conflicts and gender discrimination affecting operations of smallholder irrigation scheme. Furthermore, it examines the linkages between institutions and their operations at national and local levels. The theory captures all the indicators under viability and sustainability assessment in smallholder irrigation agriculture. It relates to how farmers, suppliers, market, government and other support agencies interaction, work together, supporting each other for continuity of the schemes.

#### **2.10.6 Socio-demographic factors and viability in smallholder irrigation schemes**

Socio-demographic conditions such as the farmers' age, gender, marital status, family size and other conditions can influence the viability and sustainability of smallholder irrigation schemes. These conditions have proved to have a decisive effect on the performance of Zimbabwean smallholder irrigation schemes. In a study by Chauke et al. (2013), it was established that:

“schemes were dominated by men and the elderly, less educated members with poor access to credit, non-membership to cooperatives, substantial access to irregular extension services, and dependence on other farmers for market information. Inferential statistical analyses detected a negative impact of educational achievement and investment in production costs (inputs) to accessing credit ...The more educated a farmer was the less likely for him or her to have

accessed credit since having secondary or tertiary education both affected credit access negatively relative to no education at all. Being a member of an agricultural cooperative also had a negative impact on farmers' access to credit although this variable was not significant" (Chauke et al., 2013:1079).

Chauke et al. (2013:99) further states:

"The negative impact of both higher educational attainment and membership to cooperatives was unexpected. Farmers that have been exposed to higher educational opportunities and membership to agricultural cooperatives were expected to be more conversant with how to manage their plots than their counterparts. However, in this study, most irrigation scheme leaders were not only poorly educated but were also elderly, factors that impact negatively on access to new information and promotion of active economic participation in farming".

- **Age distribution in smallholder irrigation**

The younger the farmers are the more economically active they are. Elderly farmers have experience, but old age is a factor that has a negative effect on access to new information and promotion of active economic resilience in farming. Furthermore, as individual job performance tends to decrease from around the age of 50 years, particularly for tasks that require problem solving, learning and speed. Elderly farmers are however desirable in jobs requiring experience and verbal abilities, particularly in maintaining a high level of productivity. Manzungu (1999) indicated that extension workers revealed that elderly people are slow in pace in grasping new technological concepts that differ from what they have already mastered as organisms in those that they had acquired many years of experience. Though not significant, age had an impact on the likelihood of viability.

- **Marital status**

Chauke et al. (2013) observed that the marital status of households is usually used to determine the stability of a household in African families. It is normally believed that married household heads tend to be more stable in farming activities than unmarried heads. The majority of single and divorced women tend to suffer due to social exclusion in accessing support services in rural areas.

- **Gender distribution in smallholder irrigation**

It has been shown in several studies that women participate in farming mainly for ensuring family food security rather than being driven by profit motives. The dominance of males is therefore a matter that needs immediate redress. Patriarchal societies tend to favor males in most benefit. ‘This could be achieved by changing mind sets that regard women as inferior to men, particularly through education and women empowerment, including focusing financial assistance towards women led farming ventures has serious implication for the sustainability of irrigation schemes in particular and food security generally’ (Randela, 2005).

## **2.11 CHAPTER SUMMARY**

Agriculture is a livelihood strategy and the backbone of the economy for the Zimbabwean rural population and its growth for the past years could not match population growth rate. The growth in agricultural production per year has been well below government target set out in its economic reform programme. This has been the case, especially since Zimbabwe launched its land reform programme in 1999. Though there is an effort by farmers to increase agricultural production, smallholder irrigation agriculture is experiencing serious challenges. As such, the long-term development of agriculture in Zimbabwe is based on realising the potential of smallholder irrigation agriculture. Increasing income and productivity of farmers in irrigation agriculture seems to be the most modest way to attain growth and development in agriculture. The success of IMT can only be determined by improved lifestyle, a large proportion of income from schemes, low cost of self-management and effective management of transaction costs. The viability of smallholder irrigation schemes in Zimbabwe is largely dependent on the capacity of the farmers to organise, and manage their operations, and to enforce institutions to resolve conflicts, while the sustainability of the schemes is the outcome of that viability. The Viability System-Based Theory has indicated that the success of smallholder irrigation schemes or any other farming organisations is based on the positive influence by subsystem to the system and its total environment. Failure of the subsystem would compromise system and supra system respectively. In this context, sustainability can be viewed as viability plus long-term management of resources. Viability and sustainability “come together where there is perceived limit on

resources. The viability theory can be used to answer important questions about the sustainability of systems.” (Blackie, 1994: 335) Therefore, the Sustainability Theory complements the Viability System Based Theory to achieve sustainable livelihood outcomes. It is the theory that explains the vulnerability (viability context) of the scheme or organisation, taking cognisance of the national or global economic trends, seasonality and shocks. Assets are factors used to attain or influence viability and sustainability through institutions, structures and processes that create an enabling environment for sustainability (economic, social, environmental and institutional) to prevail. However, to determine sustainability, indicators are important since they refer to the chosen targets, ability to signal the success or failure in approaching them.

The next chapter presents the research methodology and a description of the study area, the research design, the study population and sample, the research instruments that were used in the study, the procedures of data collection, analysis and the presentation of data that were employed in the study.

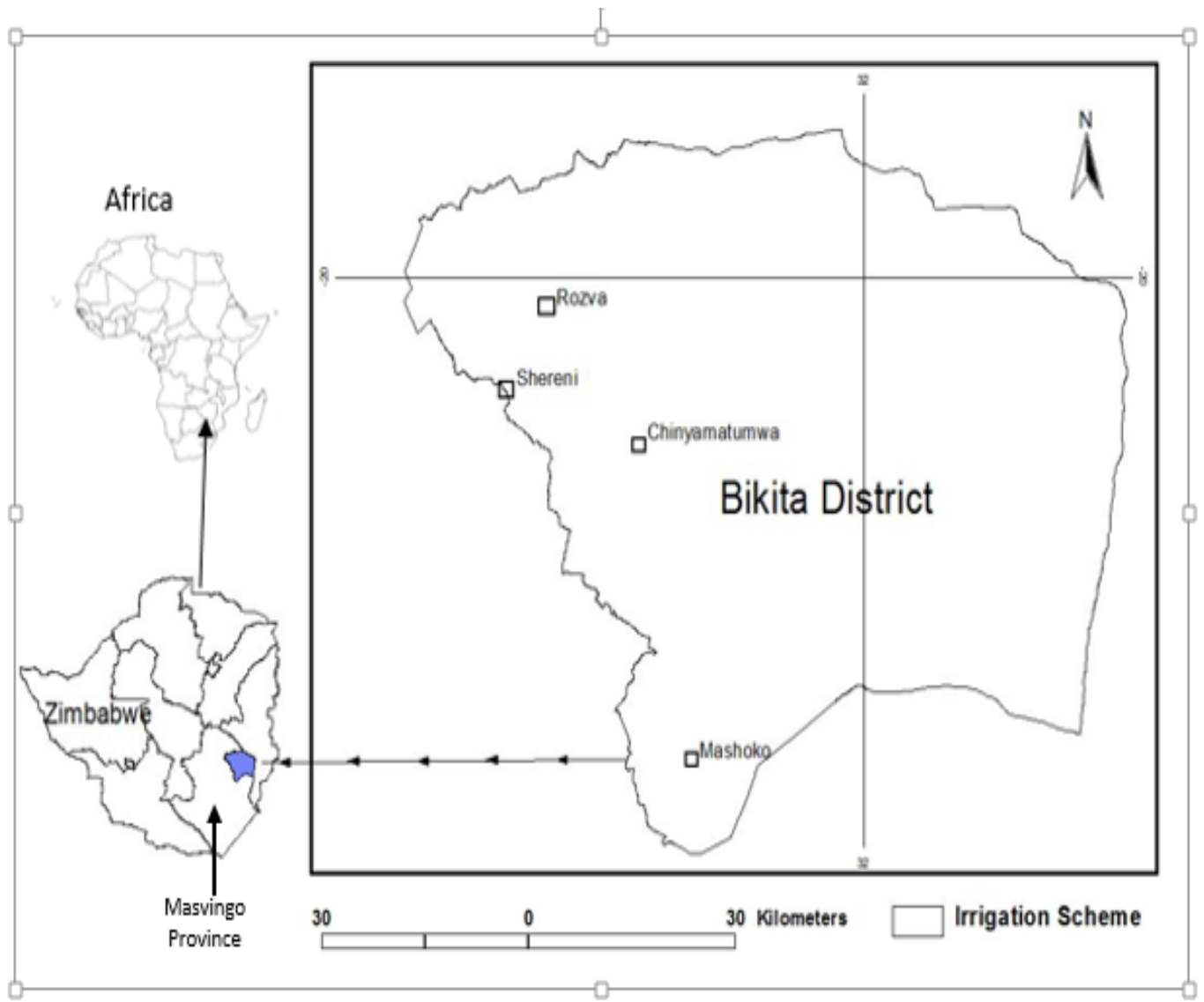
## **CHAPTER 3 METHODOLOGY**

### **3.0 INTRODUCTION**

The research process was guided by the indicators used to characterize the viability and sustainability of smallholder irrigation schemes, critical factors that influence the performance and viability of the schemes and the need to draw up recommendations that can guide the planning of smallholder irrigation schemes in Bikita. This chapter provides a description of the study area, but also the research design, methods of gathering data, sampling techniques' and procedures, how the collected data was presented and analyzed, and lastly issues related to the validity, reliability and ethical considerations that were made during the research. The methodology of the study was informed by both the positivist and constructivist paradigms. A sequential exploratory design was employed, whereby the collection and analysis of qualitative data was followed by a collection and analysis of quantitative data. This mixed-methods approach created the “opportunity to compensate for inherent method weaknesses” (Harwell, 2011:149), capitalizing on the inherent strengths of each approach and offsetting inevitable methodological biases. The justification for the paradigms used and research methods chosen is discussed in this chapter. Furthermore, random (use of computer-generated random-number tables from scheme register) and purposive (use of maximum variation) sampling techniques and procedures employed in the research are also discussed. The research data collection tools used, the nature of the data that were gathered, and the source of the data (respondents) are also covered in this chapter.

### **3.1 STUDY AREA**

Zimbabwe is in Africa south of the Sahara as shown in Figure 3.1. The study area, Bikita District, is one of the seven districts found in the Masvingo Province of Zimbabwe. Figure 3.1 shows the location of Bikita District.



**Figure 3.1: Location of Zimbabwe on the African Continent**

“Zimbabwe is a land locked country with a surface area of 390,757 km<sup>2</sup> and estimated human population of 12.5 million. About 70% of the population lives in the rural areas, eking a living out of agriculture. The agriculture sector is the backbone of Zimbabwe’s economy providing livelihoods for more than 75% of the population and contributing 16 to 20% of the country’s Gross Domestic Product (GDP)” (Girma et al., 2012:10). ‘Yet only 37% of the country receives rainfall that can be considered as adequate for agriculture. Over the past 15 years, the agricultural sector has experienced serious challenges because of the combined effects of the FTLRP, hyperinflation, capital constraints and government control over domestic markets. However, the

sector has shown its resilience in the face of difficult market conditions' (World Bank, 2010). "Bikita District is located between latitudes 19<sup>0</sup>57'-20<sup>0</sup>35' S and longitudes 31<sup>0</sup>46'-32<sup>0</sup> 16' E. It has an average elevation of 656 metres above sea level (masl), an average daily temperature of 18 °C, and an average annual rainfall of 450 mm to 600 mm. The total population of the district is 181 863, with a population density (pop/km<sup>2</sup>) of 34.64" (Girma et al., 2012:8).

Zimbabwe can be divided into five agro-ecological regions, and Bikita District lies in agro-ecological region 4. Most of the district is hilly and most of its streams flow throughout the year. The soils are sandy. Maize, sorghum, groundnuts and *rapoko* are the main crops that are commonly grown in the area. Bikita District is characterized by a hot, wet season from mid-November to March (summer), a cold, dry season from April to July (winter), and a hot, dry season from August to mid-November (spring). The average maximum temperatures in summer hover around 30 °C, although temperatures exceeding 40 °C are not unusual during summer months (Mupaso et al., 2014). The daily winter temperatures range between 11 °C and 20 °C, while mean maximum daily temperatures can exceed 32 °C during spring. The threat of frost is minimal (Chikobvu et al., 2010). An earlier study by Nhundu (2013) reveals that rainfall reliability decreases from north to south as well as from east to west. The effect that the economic downturn in Zimbabwe had on the agricultural community of Bikita has made it necessary to investigate conditions that characterize the viability and sustainability of agriculture based livelihoods in the district.

Bikita District was chosen for this study because it is a district that has a large number of farmer-managed irrigation schemes compared to other districts in Masvingo Province (AGRITEX, 2013). Bikita is also the district that has schemes that were established long before the IMT programme was implemented. The IMT involved the decentralization of responsibilities and authority to farmers in smallholder irrigation schemes from the state. This provided scope for a comparative analysis of differences between the period before government withdrawal of support and the period when farmers took over the responsibility. The IMT programme disturbed previous existing relationships between farmers, thereby negatively affecting the capacity of rural households to develop projects and programmes. The ecological fragility of Bikita determined the choice of research sites (Gukurume, 2014). From the 10 provinces of Zimbabwe, Masvingo Province was selected because it is predominantly an arid region. Bikita falls in a

medium drought-risk zone (Chikobvu, 2010). Therefore, the research contributes to the aversion of viability and sustainability challenges facing farmer-managed schemes, which may be detrimental to people’s livelihoods and undermine government effort to reduce poverty. The irrigation schemes where the study was undertaken are shown in Table 3.1. The Table 3.1 shows the irrigation system in use, water source, potential irrigable area beneficiaries and area in use.

**Table 3.1: Smallholder irrigation schemes in Bikita District**

Scheme Name	Irrigation System	Water source	Potential Irrigable area (ha)	Area equipped (ha)	Area in use (Ha)	Beneficiaries
Rozva	Drag hose surface	Dam	138	80	50	95
Mashoko	Surface	Dam	34	30	30	128
Chinyamatuwa	Flood	Dam	34	34	34	136
Shereni	Surface	Stream	20	20	20	43

Source: AGRITEX Office Bikita, 2013:8

### **3.1.1 Smallholder irrigation schemes in Bikita**

Irrigation systems in Bikita were initially confined to the mountainous areas in the northern parts of the district, where farmers diverted water from perennial streams by unplanned canals and pipes made from tree bark. The water was driven by gravity flow. These earlier smallholder irrigation schemes were started by farmers who intended to improve their crop yields and food security. The construction of dams in these and other areas saw the development of properly planned schemes improving productivity in the schemes where plot holders were accorded government support through inputs and training from Agricultural and Technical Extension (AGRITEX). Initially, four major schemes were constructed, namely Rozva, Shereni, Chinyamatumwa and Mashoko. Rozva and Shereni were wholly funded by the government and the European Union, respectively, while Chnyamatumwa and Mashoko were jointly funded by the Zimbabwean and Japanese governments. A wide range of crops is grown in these schemes and these include maize, wheat, sugar beans and a variety of vegetables. However, due to the withdrawal of government support resulting from the recent economic crisis, the farmers have been facing several challenges, including the unavailability of markets, which made the viability of these schemes difficult. The existing schemes were largely dependent on government support

for their operations. Another two schemes, Nharira and Nyahunda, are still under construction, and were therefore not included in this study.

### 3.2 RESEARCH DESIGN

Table 3.2 presents the methodological overview of the research approach and design employed in this study.

**Table 3.2** The research design and methodological overview

<p><b>Research Design</b></p> <p>Both qualitative and quantitative in nature</p> <p>Phenomenological and sequential exploratory</p> <p>Guided by positivism and constructivism</p>
<p><b>Data Collection Strategies (Methods)</b></p> <p>Mixed method in data collection tools</p> <p>Key informant interviews, observations, focus group discussion, document analysis and questionnaires, accompanied by validity and reliability tests.</p>
<p><b>Data Collection Strategies (Participants)</b></p> <p>Purposive sampling : to key informants (4 Irrigation Management Committees, 8 AGRITEX officers, 4 irrigation staff, 3 NGO staff, 4 village heads, = 23 using interview guides (Appendix 2)</p> <p>Mixed methods in selection of participant</p> <p>Random sampling : using computer generated random number tables through scheme registers in Excel (see Appendix 4)</p> <p>Questionnaires = sampled household in each scheme</p> <p>Focus Group Discussions (FGDs) = 96 (two groups of 12 from Mashoko and Rozva, 3 groups of 12 from Chinyamatumwa and one group of 12 from Shereni considering their number)</p> <p>Key informant interviews = 23 (distributed as aforementioned under purposive sampling)</p>

<p>Total =139 sample size calculated using a sampling formula.</p> <p>Document analysis= 15 from AGRITEX, 5 from irrigation department, 20 from NGOs (complementing and verifying what key informants' views).</p>
<p style="text-align: center;"><b>Transcription and Member Checking</b></p> <p style="text-align: center;">Researcher, 5 research assistants and participants involved</p> <p style="text-align: center;">Ethical Considerations</p>
<p style="text-align: center;"><b>Data Analysis Plan</b></p> <p style="text-align: center;">Both qualitative and quantitative data analysis</p> <p>Qualitatively: Thematic analysis plus constant comparative method, thematic analysis- factors affecting viability and performance in the schemes</p> <p>SPSS 16.0 : using descriptive statistics on social coherence, resource attributed to schemes, financial management status socio-demographic profile versus yields (output / ha), ANOVA on viability of the schemes (wheat and maize productivity) and how statistically different are the scheme performances which has implications on viability and sustainability</p> <p>Analysis of Variance (ANOVA) – to determine variation in outputs in the four schemes</p>

The research design summarized in Table 3.2 is logical in that it links the data that were collected to the initial questions of the study. In this study, a mixed-methods research approach was used. This approach combined both qualitative and quantitative methods. A sequential exploratory approach was employed, where the collection and analysis of qualitative data were followed by the collection and analysis of quantitative data or vice versa. Results from qualitative data were used to interpret results from quantitative data.

### **3.2.1 Research philosophies guiding the research study**

The research philosophies that guided this study are positivism and constructivism. These paradigms informed the logic followed in the use of indicators to assess the viability and sustainability of the smallholder irrigation schemes.

- **Positivism**

Positivism is the belief that reality is stable and can be observed and described from an objective viewpoint (Levin, 1988; Flick, 2014). It is based on values of reason, truth and validity. The focus is purely on facts, gathered through direct observation and experience and measured empirically using quantitative methods, which incorporate surveys, experiments and statistical analysis (Flower, 2009). Positivism is revealed in organizational context, as positivists assume that what truly happens in organizations can only be discovered through categorization and scientific measurement of the behaviour of people and systems, and based on reality (Flower, 2009). In line with this philosophy, a questionnaire survey was used to collect data from respondents. The questionnaire that was used is presented in (Appendix 1). As shown in the questionnaire (Appendix 1), some of the questions that plot holders responded to were socio-demographic questions or questions on farmers' level of familiarity with the indicators, indicators characterizing viability and sustainability, or levels of viability and sustainability as perceived by plot holders. Some questions were five-point Likert scale questions.

However, as noted by Hall (2010), positivism has its own limitations. It was unable to account for people's preferences and the values (both proximate and ultimate) that shape their actions in full (Hall, 2010). Questionnaires could not capture farmers' views feelings in indicators, viability, performance and factors influencing sustainability. They failed to take into consideration what Weber (1914), in Hall, (2010) called "sociological explanations", perceived as the interpretive understanding of social action, which is a form of action that takes into account the behaviour and actions of other stakeholders like AGRITEX, Grain Marketing Board and village heads. Hall (2010) views that attempts to deal with facts as if they have no bias in values are depoliticizing and de-contextualizing. Therefore, on its own, positivism was unable to generate predictions or provide generalizations about solutions to problems of social policy. A conjunction of methods was proposed, a mode of inquiry that is discursive and contextual and embraces uncertainty by employing "participatory intermingling" (Hall, 2010). Realizing that the study deals with socio-cultural context, questionnaires alone would not suffice, and therefore a complementary approach was not an option.

- **Constructivism/ Interpretivism**

Rural communities, such as those found in smallholder irrigation schemes, are social organizations that exist within particular socio-cultural contexts. Hence, qualitative social science research methodologies guided by the phenomenology paradigm employed in this study and complimented by quantitative approaches to address the complexities that characterize smallholder-irrigation schemes in Bikita. It was for this reason that the interpretive approach was used alongside positivism. The emphasis of constructivism is on interpretation and compelling explanations rather than empirical proof (Hall, 2010). People perceive or make sense of situations based upon their experiences, memories and expectations. Understanding what people are thinking and feeling, as well as how they communicate verbally and non-verbally is considered as important in qualitative approaches to data gathering (Flower, 2004; Mujuru, 2014). In this study, the use of Focus Group Discussion (FGDs) was the main constructivist and qualitative approaches used. It involved the sharing of experiences and memories by group members in each scheme. Each member would state the indicators they are familiar with in the assessment of the performance of their plots. Members discussed the factors affecting their performance and viability of the schemes, which would entail more than what words translated (see Appendix 3). Key Informant Interviews (KII) was another qualitative approach that was used in the study because of its interactive nature. These are done to collect data from key informants from AGRITEX, NGOs and among village heads. Stakeholder reports and minutes revealed the dimensions and sub criteria used to assess viability and sustainability of the schemes. The open-endedness of interviews allowed respondents to open up and relate to the challenges and opportunities experienced in the schemes (see Appendix 2). Selecting respondents conveniently or purposively took place through interaction with stakeholders, determining the knowledgeable people on operations within the schemes. Thematic analysis, augmented by constant comparative methods, was applied on qualitative data analysis, which needed categorization into themes like governance, financial management and productivity, social coherence and technical capacity and water resources management for easy analysis (Chinyoka, 2013). The descriptive statistics on viability of schemes were complimented by a summative viability comparison of schemes based on the respondents' ratings using a five-point Likert scale rankings (unsatisfactory, fair, satisfactory, good and excellent) (see Appendix 1). Respondents were asked to rate their schemes based on selected sub criteria on governance,

social coherence, financial management, technical capacity and water resources management. On the specified criteria, the dominant responses from plot holders were used to describe the overall performance of the scheme on the basis of those criteria. Comparative methods enabled the comparison of views amongst FGD members and between the groups on aforementioned themes for validity purposes. To validate the results from the questionnaire survey, FGDs were held with AGRITEX officials who gave overall scores on each criterion, based on its level influence on the scheme's performance. It has been observed by Flick (2014) that no single research methodology is intrinsically better than another, since each has its own strengths and weaknesses. Many researchers call for a combination of research methods, as adopted in this thesis.

### **3.2.2 Target population**

A participant population is the target group with whom the research is undertaken (Chinyoka, 2013). The total population in this study comprised 402 individuals, including 356 farmers from the four smallholder irrigation schemes, 23 key informants, among whom were 4 IMC members, 8 AGRITEX officers, 4 irrigation staff members, 3 NGO staff members and 4 village heads.

### **3.2.3 Sampling techniques**

According to Bless and Higson-Smith (2010), a sample is a subset of the whole population which is actually under review by a researcher, and whose characteristics features are generalized to the entire population. Both probability and non-probability sampling methods were used to select respondents. Probability random sampling was used to select farmers from scheme registers. Computer generated random number tables were used for this purpose (see Annexure 4). Table 3.3 shows the number of farmers who were selected from each scheme using this procedure. The sampling intensity was 35%, where 139 respondents were sampled from 402 plot holders, which is large enough to give precise and useful results. The formula that was used to determine sample size is as follows:

$$s = \frac{\chi^2 NP(1 - P)}{d^2(N - 1) + \chi^2 P(1 - P)}$$

Where:

S = required sample size

$\chi^2$  = the table value of chi-square for degree of freedom at the desired confidence level (3.841)

N = the population size

P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (0.05) (Krejce et al., 1970; Munyati et al, 2013)

Purposive sampling was the non-probability sampling approach that was used to select key informants among village heads, NGO staff, AGRITEX, Irrigation staff, District Development Committee Members, IMCs in each of the four schemes. These stakeholders were drawn from AGRITEX documents on stakeholder mapping in the district (AGRITEX Bikita,2013). Stakeholder mapping involved the identification and engagement of partners around the scheme who are relevant to the project. They were identified through purposive sampling. Purposive sampling saved time, effort and money in finding informants because of its flexibility. The AGRITEX officers who were interviewed directed the research team to other participants involved in irrigation development in the area (see Figure 3.4)

**Table 3.3: Sample size**

<b>Irrigation scheme</b>	<b>Total number of beneficiaries and stakeholders</b>	<b>Sample size</b>
Rozva	95	33
Mashoko	128	44
Chinyamatumwa	136	47
Shereni	43	15
<b>Total</b>	<b>402</b>	<b>139</b>

### **3.3 DATA COLLECTION METHODS**

To come up with the indicators for characterizing viability and sustainability in smallholder irrigation agriculture, the mixed-methods approach was employed. The adoption of the two philosophical paradigms mentioned above necessitated the use of methodological and instrumental triangulation. Triangulation is the use of multiple methods in data collection in

order to pave way for collecting credible, reliable and valid data. It reduces personal and methodological biases and increases the chances of generalizing the results in a meaningful way, as illustrated below.

### 3.3.1 Illustration of the methods in data collection

Figures 3.3 and 3.4 illustrate the procedures and stages that were followed during data collection, while Table 3.4 shows the methodological mix of the study.

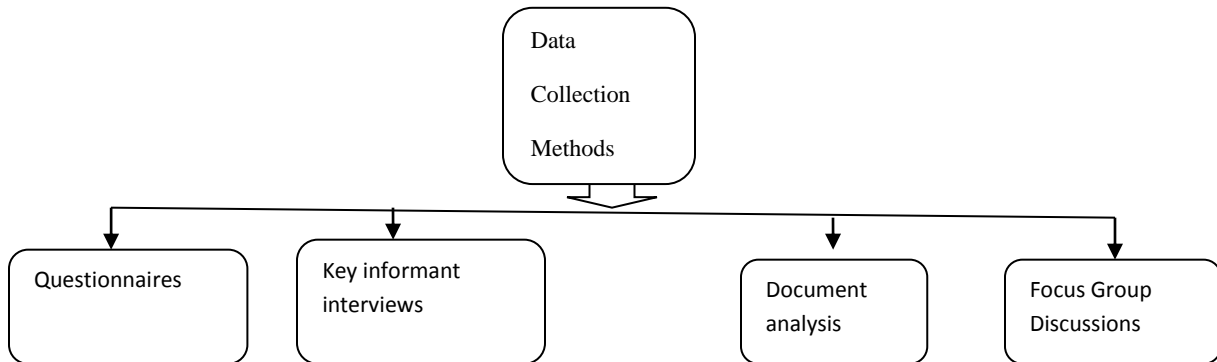


Figure 3.2: Data collection methods

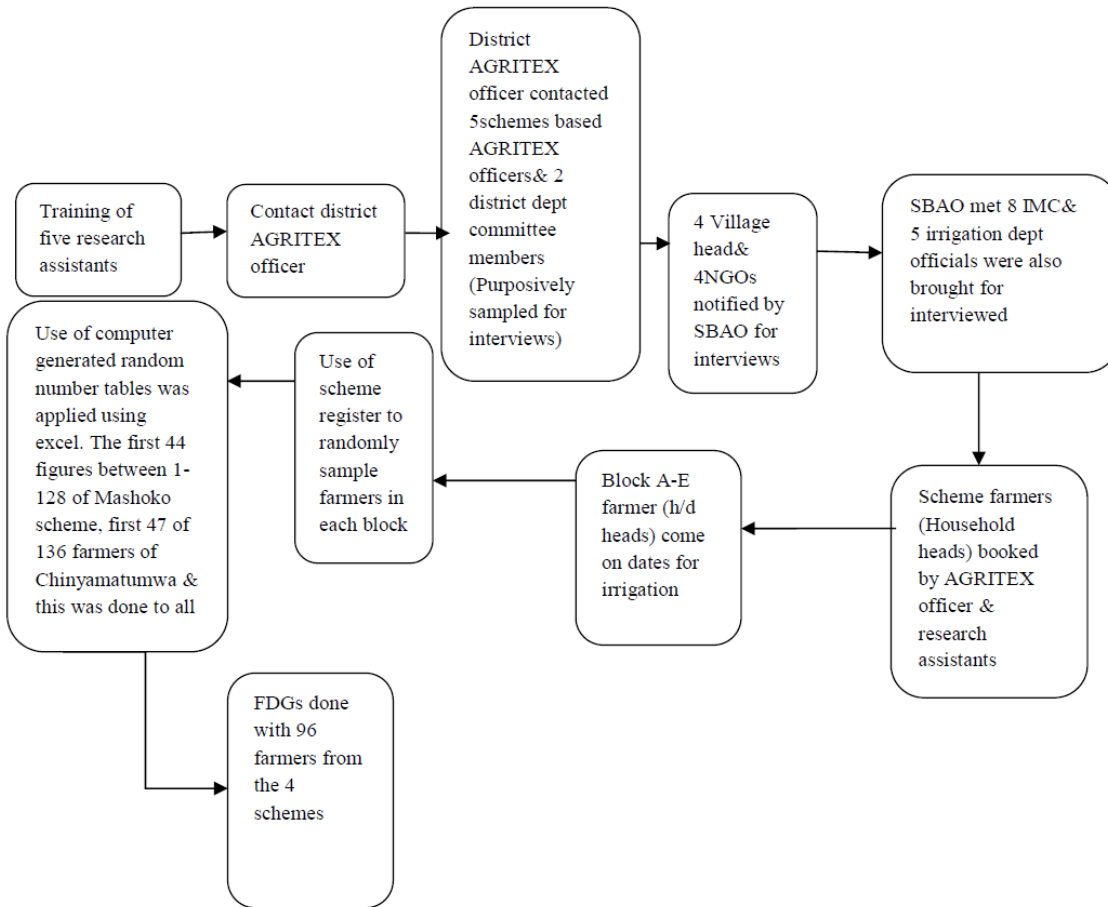


Figure 3.3 Stages followed during data collection. (NB: SBAO-Scheme Based AGRITEX Officers)

The researcher conducted a training workshop for five Research Assistants and contacted the Bikita District AGRITEX Officer. The District AGRITEX Officer in turn contacted four schemes based AGRITEX Officers who in turn notified the village heads and wards councillors. The Scheme-Based AGRITEX Officers had a meeting with the Irrigation Management Committee before researchers entered the study area. The farmers who were selected from the scheme registers were invited to a meeting by the AGRITEX Officers and were asked to attend in person or to send their household representative, in the event that they were unable to attend.

It was during these meetings that assistant researchers issued out the questionnaires. Questionnaires were used to gather information about the key indicators used to characterize the

viability and sustainability of smallholder irrigation schemes in Bikita, the critical factors that influence the performance and viability of the smallholder irrigation schemes (Girma et al. 2012) and to draw up recommendations that can guide the planning of smallholder irrigation schemes in the district.

Regarding FGDs, an arrangement was made with the AGRITEX Officers to use *Chisi* (sacred non-working day) for the discussions. In the Bikita District, every Thursday of every week is a ‘*Chisi*’ for the farmers. The computer generated random number table was used to select plot holders for the FGDs. In the three scheme; Rozva, Mashoko and Chinyamatumwa 24 potholders were selected for the FGDs while Shereni had one group of 12 because its 15 farmer participants. In each of the three schemes, two FGDs were conducted in Mashoko and Rozva and each group had twelve members, while three FGDs were conducted in Chinyamatumwa since it has more plot holders compared to others. On selection of participants, the random number table was used (see Appendix 4). Two of the five research assistants moderated the discussions, while the other two recorded the responses. Issues covered during FDGs were based on themes presented in Appendix 3, including items like technical infrastructure and maintenances, financial management, governance and social cohesion in the scheme) and how they influence conditions characterizing viability and sustainability of smallholder irrigation schemes. Key informants were interviewed during follow up visits that were organized after the questionnaire survey. The financial reports and other records of each scheme, as well as the mission statements of the schemes and minutes of meetings held in the schemes, registers of complaints and other internal documents belonging to the schemes were analyzed. Thus, comparative document analysis complimented and validated information sourced from the key informants.

### **3.3.3 Methodological matrix used in the study**

The methodological matrix shown in Table 4 was adopted in the study and objectives were used to address the research questions; data collection and validity and reliability of the tools used.

**Table 3.4 Methodological matrix used in the study**

OBJECTIVES	RESEARCH QUESTIONS	DATA COLLECTION TOOL	RESPONDENTS	VALIDITY/ RELIABILITY approach
To identify the key indicators that can be used to characterize the viability and sustainability of smallholder irrigation schemes in Bikita	What are the indicators used to assess viability and sustainability in (SHIS) Smallholder irrigation agriculture?	Questionnaires  Interviews  Document analysis	Key informants: IMC, AGRITEX staff, irrigation department staff.	Pilot tested questionnaire, , follow-up visits for clarity; methodological and instrumental triangulation done
To assess the viability & sustainability of smallholder irrigation schemes in Bikita	How viable are SHIS in Bikita  How sustainable are SHIS in Bikita	Document analysis Questionnaires Interviews FGDs	Beneficiaries Key informants: IMC, AGRITEX staff, irrigation department staff, village heads.	Pilot tested questionnaire, FGDs have high face validity, all expressed diverse opinion in groups of 12, follow-up visits for clarity; methodological and instrumental triangulation done
To determine the critical factors that influence the performance and viability of smallholder irrigation schemes in Bikita	What are the factors influencing the performance and viability of smallholder irrigation schemes	Document analysis Questionnaires Interviews FGDs	Beneficiaries Key informants: IMC, AGRITEX staff, irrigation department staff., village heads	Pilot tested questionnaire, FGDs have high face validity, all expressed diverse opinion in groups of 12, follow-up visits for clarity; methodological and instrumental triangulation done
To draw up recommendations that can guide the planning of smallholder irrigation schemes in	What proposals would be made to guide the viability and sustainability for policy and planning in smallholder	Document analysis Questionnaires Interviews FGDs	Beneficiaries(household heads) Key informants: IMC, AGRITEX staff, irrigation department staff., village heads	Pilot tested questionnaire, FGDs have high face validity, all expressed diverse opinion in groups of 12, follow-up visits for clarity;

Bikita.				methodological and instrumental triangulation done
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### 3.4 ETHICAL CONSIDERATIONS

Permission to conduct the study was secured from the Free State University research board, Ministry of Agriculture, Masvingo AGRITEX provincial and Bikita District office in Zimbabwe, as well as the Bikita District Administrator, NGOs and AGRITEX offices and IMCs of the selected irrigation schemes. All stakeholders showed their approval to participate in the research study by signing the consent forms. All agreed to participate in the research out of their own interest. Participants were informed that their participation was voluntary and that there were no consequences for refusing to take part in the research. The researcher pre-empted the nature of the research in a way that appeared clear to respondents. The researcher explained to the participants how the data that was gathered during the FDGs, interviews, document analysis and questionnaire survey would be used after the research. For the sake of confidentiality, it was emphasised that the names of the respondents would not be traced back to responses. Every participant was assured that the research would not cause any harm to their reputation. The research also respected the rights, dignity and worth of all the respondents. Anonymity among the participants was also assured. Only the researcher conducting the FGD, interviews was aware of the names of the participants. Notes were taken down as the research progressed. The researcher promised that the findings of the research would be shared with the community to ensure that the community benefits from them.

### 3.5 DATA ANALYSIS

Quantitative data were analysed using Statistical Package for Social Scientists (SPSS) augmented by Excel. Descriptive statistics were calculated using SPSS. ANOVA was done in the Excel environment to determine whether any statistically significant differences existed between the yields of the smallholder irrigation schemes. With the descriptive statistics, tables and figure were plotted, revealing the extent to which governance, social coherence, financial management status of schemes and resource or assets attributed to the schemes influences viability. The Analysis of Variance (ANOVA) was used because the data was normally distribution. The data

was tested for normality using Shapiro-Wilk statistic. Homogeneity of variances was tested using Levene's test. The technique is important in determining the factors that affect crop yield in schemes. For maize and wheat outputs, three schemes were used (Rozva, Shereni and Mashoko). Chinyamatumwa had no records on yields. Before maize and wheat output data was analyzed, its normality was tested using the Shapiro-Wilk test. Thus based on the Shapiro-Wilk test results, the researcher then chose whether to take a parametric test (for normally distributed data) or non-parametric test (for data that is not normally distributed). ANOVA was carried out on the production trends in the aforestated smallholder irrigation schemes. For each scheme, data for three seasons per year for maize and wheat yields (see Appendix 10) were extracted from AGRITEX records, and analyzed to determine if there were statistically significant differences between the yields of the three schemes. Excel was used to determine the relationship between the socio-demographic conditions of the schemes and the average yield of both maize and wheat in the three schemes, as shown in Appendix 12. It is these scheme averages that were used to determine the number of plot holders whose yields were below or above scheme average yields. (Appendix 12). The proportion of plot holders above and below were calculated as percentages.

Qualitatively, thematic process of data analysis was done complimented by the constant comparative method, respectively. The process entails data display after collection, in which reflections are done followed by coding. Data is distilled (reduction), and generation of themes follows. However, one should note that reflection, coding and data distillation is done iteratively and simultaneously to monitor the process. From theme generation, story interpretation or discussions are done to reach a research conclusion (Creswell, 2008; Chinyoka, 2012).

On assessing viability of scheme qualitatively, the thematic analysis approach was used in the organization, categorization, and synthesis of data and analysis of the contents at the same time constant comparison done on data gathered in FDGs, documents, interviews and questionnaires. The research used open coding method to derive meaning from the data, a qualitative mode of content analysis that categorize and synthesis themes (Chinyoka, 2013). As Yin (2012) alludes, this examines, select, categorize, compare, synthesis and interpret the data sought to address the initial propositions of the study. The texts were dissected into manageable and meaningful text segments based on research questions. The coding framework was based on pre-established criteria on research instruments (see Appendice 1, 2 and 3). Organization of themes was done on

the research instruments. The method revealed assessment sub-criteria for conditions characterizing viability and sustainability of smallholder irrigation schemes. Identification of these sub-criteria derived from dimensions provided depth to the insights about viability and sustainability assessment. Similar groups of indicators were aggregated together to form a major idea from the data. Complementing the questionnaire were the interviews, FGDs and document analysis acting as database to be analysed. As De Vos et al. (2012) allude, this procedural approach facilitated the emergence of new sub-criteria to be looked and scrutinized under each theme. The constant comparative method approach was invited to describe all issues and constantly looking for new incidents.

### **3.6 CHAPTER SUMMARY**

From the above discussion, it has been shown that fieldwork could only be accomplished when one has a design, based on knowledge of the total population of the study area, data collection tools and an accurate sampling technique to get an appropriate sample size. Rural communities are social organisations that exist within particular socio-cultural contexts. Therefore, a mixed research approach is necessary. Qualitative social science research methodologies guided by the phenomenology paradigm and complimented by quantitative approaches proved to be useful in answering questions like how many, what percentage of and to what extend rural communities collectively plan and manage their irrigation schemes. In addressing the viability, performance and sustainability of operations in schemes, interviews, FGDs and a questionnaire with the marked semantic differential scale was used in the schemes showing as checklist: a tool for the assessment of viability and sustainability is critical. The methods used to collect and analyze data are the basis for the next chapter, which presents the results of the study.

## **CHAPTER 4 RESULTS OF THE STUDY**

### **4.0 INTRODUCTION**

The main thrust of this chapter is to present the results derived from the analysis of the data that were collected by means of questionnaires, interviews, document analysis, Focus Group Discussion (FGD) and observations. Some of the results, including frequencies and percentages of respondents who gave specific responses during the questionnaire survey are presented in form of tables and figures. As noted in Chapter 1 and Chapter 3, indicators characterizing the viability and sustainability of the investigated irrigation schemes were analyzed using descriptive statistics, and Analysis of Variance (ANOVA), augmented by the thematic process of data analysis. Indicators were systematically identified and arranged in themes and categories for thematic discussion as shown by Table 4.1. The presentation of results is addressing the objectives, research questions, themes derived from the dimensions of viability and sustainability.

### **4.1 INDICATORS CHARACTERIZING VIABILITY OF SMALLHOLDER IRRIGATION AGRICULTURE**

The identification of indicators of viability and sustainability was the initial stage of this research. Indicators were obtained through FGDs and interviews held with stakeholders, including AGRITEX, Non-Governmental Organisations, Irrigation Management Committees (IMCs) and plot holders. Findings from policy documents and interviews revealed that the sustainability of smallholder irrigation schemes assumes different dimensions, namely governance and viability indicators, social coherence and performance indicators, financial management indicators, indicators for technical capacity and water-resource management capabilities. The focus is on those things found in the smallholder irrigation schemes, which reflect on governance, the level of social coherence and capacity for financial, technical and water resource management.

However, it should be noted that it was from these dimensions that indicators were derived. AGRITEX and their NGO partners used millstones and benchmarks in determining success

when measuring viability and sustainability of schemes and the performance of farmers, as noted in their Monitoring and Evaluation reports. From the FGDs held around the schemes, what was common was that each representative stated the indicators they were familiar with in assessing the viability of their own activities. Table 4.1 was an inventory of indicators categorized following discussions.

**Table 4.1: Indicators characterizing viability of irrigation schemes**

DIMENSION	VIABILITY & SUSTAINABILITY INDICATORS
Governance & viability indicators	<ul style="list-style-type: none"> <li>• Capacity of IMC</li> <li>• Level of alignment with the constitution</li> <li>• Monitoring and Evaluation</li> <li>• Participation by local actors</li> <li>• Transparency in operations</li> <li>• Ownership levels</li> <li>• Linkage with other stakeholders</li> </ul>
Social coherence & performance indicators	<ul style="list-style-type: none"> <li>• Bureaucratic rules &amp; norms conducive to performance</li> <li>• Scheme ethnic conflicts</li> <li>• Accountability</li> <li>• Attribution</li> <li>• Assumptions(Informal rules)</li> </ul>
Financial management indicators	<ul style="list-style-type: none"> <li>• Use of budgets in programming</li> <li>• Application of accounting systems</li> <li>• Financial reporting</li> <li>• Auditing</li> <li>• Savings</li> <li>• Productivity of the scheme</li> <li>• Quality standards of produce</li> <li>• Ability to meet set targets</li> <li>• Cost Benefit Analysis</li> <li>• Exposure to outside demands</li> <li>• Standards of performances</li> </ul>
Technical capacity	<ul style="list-style-type: none"> <li>• Level of operation and maintenance of assets</li> </ul>

& Water resources management capabilities indicators	<ul style="list-style-type: none"> <li>• Water rationing</li> <li>• Crop scheduling</li> <li>• Competence of technical human resources</li> <li>• Irrigation water conveyance efficiency</li> <li>• Adequacy of water source</li> <li>• Adequacy of Integrated Watershed Management</li> <li>• Payment of water bills</li> <li>• Private sector participation</li> <li>• Links with economic policy</li> </ul>
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A checklist of indicators drawn from Table 4.1 was used to measure the performance of the irrigation schemes.

#### **4.2 VIABILITY OF THE SMALLHOLDER IRRIGATION SCHEMES IN BIKITA**

Stakeholders and plot holders’ responses were used to assess viability of schemes using indicators outlined in Table 4.1 that are under the aforementioned four thematic areas.

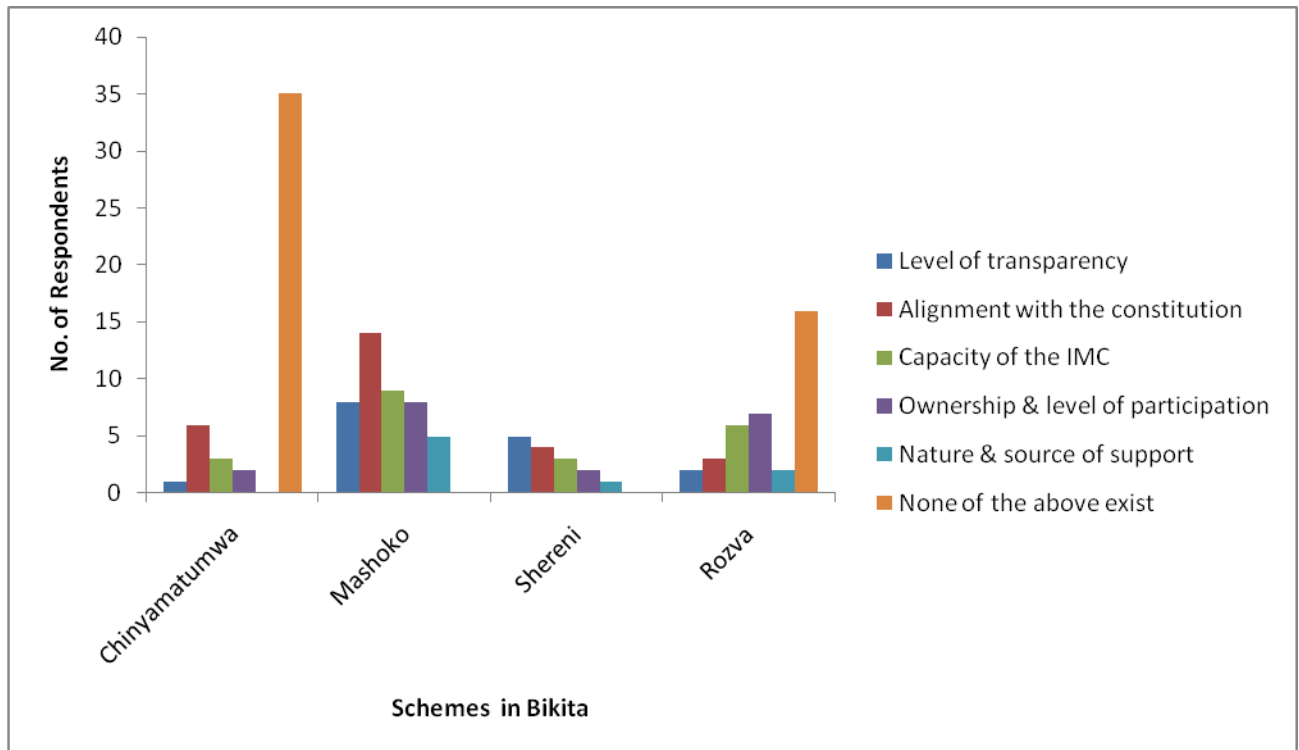
##### **4.2.1 Thematic dimensions of viability assessment in irrigation schemes**

A close examination of the themes demonstrates how plot holders in these schemes, as well as the level of the viability of the schemes, perceive the performance of the schemes. Below is a comparison of the four schemes based on the six thematic elements or criteria mentioned above.

##### ***Governance in smallholder irrigation schemes***

The governance of a smallholder irrigation scheme is determined by the capacity of Irrigation Management Committees (IMC) to manage the operations of the scheme, level of alignment between the scheme’s operations and the constitution, participation and ownership of the scheme by stakeholders and farmers, as well as level of transparency in the management of the scheme’s operations. Figure 4.1 shows the questionnaire responses of plot holders on the status of governance within the four schemes. From Figure 4.1, Chinyamatumwa and Rozva revealed poor levels of governance compared to the other two, as shown by the ‘non-existence of the

attributes' element, revealing the highest of all. These two schemes had low levels of transparency and poor nature and source of support while others had satisfactory standings. Variations in how the status of governance was perceived by plot holders in the schemes concurred with revelations from FGDs, interviews and observations which all reflected poor capacity of governance in Chinyamatumwa, compared to the other schemes. In an interview with the key informants, it was shown that governance in Chinyamatumwa collapsed due to its IMC's failure to monitor informal rules. They failed to respect the operational and collective choice rules. Similarly, Rozva experienced internal conflicts because it had no constitution. These conflicts were worsened by chieftainship wrangles, which co-opted irrigation beneficiaries.



**Figure 4.1: Governance status in smallholder irrigation schemes in Bikita**

Mashoko proved to be better organized, as there was productivity of the scheme’s operations. In this case, as shown in Table 4.2, interviews revealed that Chinyamatumwa received no assistance from the NGOs due to political controversies among farmers, but farmers in Mashoko smallholder irrigation scheme received skills development support from GTZ (a Germany development agency), through training, and inputs from FAO, Shereni had GTZ support and inputs from CARE and Rozva had GTZ alone. It is evident that the performance of these schemes partly varies due to differences in the levels of external support received.

**Table 4.2 Type of external support rendered to smallholder irrigation schemes in Bikita**

Schemes	Type of support rendered and source of support	
	Source of training	Source of inputs
Rozva	None	GTZ
Shereni	GTZ	FAO and CARE
Mashoko	GTZ	FAO
Chinyamatumwa	None	None

In an interview with the District Administrator, Shereni received positive comments:

*No recorded conflicts spilled out of the committee. They had conflict resolution mechanisms in place and review meetings regularly held fortnightly.*

Regarding the level of alignment to the constitution, Chinyamatumwa, Mashoko, and Shereni were labelled satisfactory since elections were held fairly and timeously, while rules and regulations were followed in these schemes. In Rozva where there was no constitution, the IMC did not administer the scheme well. The 2008 political stalemate that Zimbabwe experienced in its Ward 14 of the Bikita west constituency labelled the majority of irrigators in Chinyamatumwa scheme as Movement for Democratic Change (MDC) sympathisers, resulting in them being expelled from the scheme by the Ward councillor, who belonged to the ruling party. The MDC is

an opposition political party in Zimbabwe while the ZANUPF is party in government. During this period, the constitution of the scheme was suspended due to political misunderstandings. In a FGD held at Chinyamatumwa, one of the farmers said:

*My son; after the MDC legislator and a councillor won the Bikita west constituency, irrigators in the ward were labelled MDC sympathisers.*

Observations revealed that although payment of rates was a challenge to farmers in all schemes, they felt that the schemes belonged to them, except in Chinyamatumwa where refusal to pay rates, and costs of maintenance and fuel for the scheme's water pump was indicative of low sense of ownership and proprietorship. One of the farmers in Chinyamatumwa in FGD remarked:

*If the scheme was ours, we would have sourced funds and resuscitated it. Let the powerful use their power and turn the scheme back to its viable state.*

As far as linkages with other stakeholders, what was common among the four schemes were the poor connections with input suppliers. All schemes experienced delays in accessing seed varieties related to their soil type. Key informants' interviews attributed this to poor planning by extension workers across the schemes, which was blamed on their lack of experience. Apart from that, the District Administrator decides which supporting donor agency should go where, when they come to assist farmers. Therefore, GIZ, FAO and CARE come with different forms of assistance to different schemes, resulting in variations in benefits by schemes. This also results in varied performance and continuity in IMCs across schemes.

### ***Social coherence***

Social coherence was expressed in terms of social cohesion, bureaucratic rules and socially constructed performance assessment indicators, as highlighted in the discussion below.

#### ***Bureaucratic rules conducive to performance***

Table 4.3 shows the varied responses regarding their views on the extent to which they regarded whether the rules that they apply in their schemes were conducive to the performance of the scheme. All respondents in Chinyamatumwa regarded the rules as ineffective, though the majority in other schemes only regarded the rules as effective. The second highest percentage

was recorded in Rozva, where 50% of the respondents considered the rules as either very ineffective or slightly ineffective. Thus, the percentage of plot holders who were satisfied with the rules that are applied in the governance of their scheme is higher in Mashoko and Shereni smallholder irrigation schemes. The level of alignment between practices and the scheme's constitution was much higher in these schemes compared to the other two. Chinyamatumwa and Rozva lacked functional institutions and organizational structures to promote equitable community-based democratic allocation of water resources or for adjudicating disputes amongst plot holders, which was exactly the opposite of what prevailed in Shereni and Mashoko irrigation schemes.

**Table 4.3** Percentages of plot owners holding perceptions on the effectiveness of operational scheme rules

<b>Scheme</b>	<b>Very ineffective</b>	<b>Slightly ineffective</b>	<b>Neutral</b>	<b>Slightly effective</b>	<b>Very effective</b>
Chinyamatumwa	40	60	0	0	0
Mashoko	0	20	20	60	0
Rozva	10	45	45	0	0
Shereni	0	0	45	10	45

Interviews with AGRITEX officers revealed that in Rozva and Chinyamatumwa, smallholder irrigation schemes were characterized by misunderstandings over the selling price of their produce, which were not standardized. They were also characterized by squabbles related to power struggles and polarization of political affiliations. In both Chinyamatumwa and Rozva IMCs were silent on ratepayer defaulters, to such an extent that both schemes were driven more by individual utility than social utility.

#### *Social conflict management in schemes*

As shown in Table 4.4, Shereni IMC was very effective in managing conflict, compared to the other three. In an interview with the headmen, Chinyamatumwa and Rozva's social stratification

were heterogeneous and highly fragmented. Their level of agricultural knowledge and religious backgrounds were diverse. For instance, the two schemes had large numbers of Seventh-Day Adventists, who do not conduct business on Saturdays and Apostolic sects, whose beliefs prevent them from conducting business on Fridays. Members of the two religious groups are often at loggerheads, since occasional meetings for the scheme was supposed to be done on either of the two days.

**Table 4.4:** Percentages of plot owners holding perceptions on effectiveness the conflicts management measures undertaken in their scheme

<b>Scheme</b>	<b>Very ineffective</b>	<b>Slightly ineffective</b>	<b>Neutral</b>	<b>Very effective</b>
Chinyamatumwa	80	20	0	0
Mashoko	0	0	100	0
Rozva	20	0	80	0
Shereni	0	20	20	60

In an interview with AGRITEX, it transpired that misunderstandings between village heads were prevalent in Rozva, to such an extent that social dissonance was the order of the day. This heterogeneity was augmented by polarization generated by misunderstandings between village heads, which were discussed earlier.

#### *Socially constructed performance assessment*

An analysis of levels of accountability, attribution and assumptions (informal rules) as pillars of viability and sustainability during interviews and FGDs revealed that accountability was non-existent in all the four schemes in Bikita. In all schemes, plot holders did not honour the agreements linked to the grain loan scheme, in which Grain Marketing Board (GMB) loaned out grain to farmers during a severe drought. In terms of the agreement, farmers were required to return the grain that had been loaned to them in order to prevent starvation. None of the plot holders was held accountable for not repaying the loans.

During a FGD, a farmer from one of the schemes remarked:

*If GMB could make follow-ups on its credit, farmers could realize their deficiencies, efficiencies or viability of their projects. However, GMB is not forthcoming and farmers themselves are not honest enough to return the loans they got*

The statement above, however, also illustrates that GMB officials have not been held accountable for their inefficiencies in recovering debts owed by farmers. Again, dishonesty by farmers failing to pay back loans after the farming season undermines the viability of the schemes.

Informal rules made by the farmers, AGRITEX and IMCs were important for the success of the schemes. Interviews with NGO staff and AGRITEX officials revealed that at Chinyamatumwa, informal rules were forgotten and not monitored. The collective and operational rules pivotal to the success of the schemes were not monitored. Consequently, the farmers, AGRITEX officials and IMCs were unable to take immediate remedial action when the water pump broke down. This was contrary to the situation at Mashoko, Shereni and Rozva, where informal rules were better managed. In Chinyamatumwa, the exclusion of the founding members of the scheme made informal rules easily forgotten and unmonitored, since the scheme had new households that were not there during the inception of the scheme, which resulted in the collapse of the scheme.

Attribution is one of the components contributing to the continuity of the schemes. In all the schemes, interviews with farmers, AGRITEX officials and IMCs revealed that important assets owned by plot holders (scotch carts and livestock), school fees and the improvement in quality of life were all attributed to the proceeds from the irrigation schemes. Figure 4.5 shows the questionnaire responses by beneficiaries of the schemes on attribution.

**Table 4.5:** Resources attributed to irrigation proceeds

	Chinyamatumwa		Mashoko		Shereni		Rozva	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Scotch cats	1	2.1	9	20.5	1	6.7	8	24.2
Livestock	0	0	10	22.7	5	33.3	13	39.4
School fees	2	4.3	16	36.4	2	13.3	6	18.2
Feed stocks	7	14.9	9	20.5	4	26.7	6	18.2
None of the above exist	37	78.7	0	0	0	0	0	0
Total	47	100	44	100	15	100	33	100

Table 4.5 indicates that the majority of the plot holders have benefited from irrigation except those in Chinyamatumwa. This is evidenced by the worsening of the livelihoods of those who forcibly removed from Chinyamatumwa smallholder irrigation scheme during a political upheaval that occurred in 2008. The 78.7 % have indicated that none of the above aspects accrued for them. This implies that number of beneficiaries were insignificant.

In a FGD in Chinyamatumwa, one of the farmers said:

*Since my removal from the scheme, life has never been the same again. My children, who used to attend school at Mashoko and Silveira high schools (boarding schools), are now going to Marirangwe day secondary school. I bought goats, ploughs and a two-roomed house at Nyika growth point with the proceeds from the scheme.*

This statement implies that better quality of life the farmer enjoyed was a result of the scheme. Failure to return to the scheme meant his downfall. Moving his/her kids from boarding to a day school was a downfall. The downfall was attributed to their removal from the scheme. Therefore, the attributions from the scheme would automatically influence the continuity of the scheme.

One NGO official said in an interview that:

*Not all households in the scheme are categorized as vulnerable because they had the capital base.*

Owning a plot was a symbol of status. Therefore, inclusion of households in the scheme by donor aid agencies motivated them to be productive and to aim for sustainability; which enhanced the viability of the scheme.

Therefore from the three 'A's; Accountability, Attribution and Assumptions (informal rules), what is positively common among the four schemes is attribution, where farmers and stakeholders attributed all the assets and opportunities they had to the beneficial operations of their schemes.

#### ***Financial management in smallholder irrigation schemes***

The state of capacity for financial management in Bikita smallholder schemes was related to levels of external financial support, accounting and financial reporting system, presence of savings accounts in the schemes, auditing of resources and levels of exposure to high inputs costs and low product prices. Table 4.6 shows the questionnaire responses of plot holders who were in agreement with the situation on the state of financial management in their schemes.

**Table 4.6:** Percentages of plot holders who responded on the state of financial management of their schemes

	Chinyamatumwa		Mashoko		Shereni		Rozva	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
High level of external support	0	0	15	34.1	5	33.3	2	6.1
Accounting & financial reporting	0	0	6	13.6	3	20	5	15.2
Presence of Savings	0	0	6	13.6	3	20	6	18.2
Auditing of resources	2	4.3	10	22.7	3	20	5	15.2
High input cost & low product price	15	31.9	7	15.9	1	6.7	13	39.4
None of the above exist	30	63.8	0	0	0	0	2	6.1
<b>Total</b>	47	100	44	100	15	100	33	100

Table 4.6 shows that Chinyamatumwa is totally different from the other three schemes in the level of external support the plot holders receive, as well as availability of accounting and financial reporting systems and existence of saving accounts by registering zeros, respectively, implying prevalence of poor financial management practices in the scheme. Conversely, it is the one registering the second highest percentage after Rozva, when it comes to exposure to high input costs and low product prices, although these challenges are also common in the other three schemes. Without savings or any capital for the day-to-day running of the scheme, operations in this scheme are compromised, thus severely undermining its viability. One of the Village Development Committee members (VIDCOs) revealed that financially, each farmer managed

his/ her own plot with support from remittances from family members living elsewhere. Many plot holders supplement their incomes from off-farm activities linked to rotating savings and credit associations, or sale of traditional beer, hunting and fruit gathering, among other income generation activities. Therefore, in Chinyamatumwa, the IMC did not have a budget for its operations. Money for rates and fuel charges was not drawn from any bank account, but collected upon request or when a problem arose. Therefore, there was no accounting system in practice. Neither was there any formal technical resource auditing, or financial reporting or record keeping. The IMC collected money from plot holders on the occasion of a breakdown. Everything was done informally and in an *ad hoc* manner, as opposed to the other three schemes; hence leading to a lack of transparency in the organization. This too compromised the viability and sustainability of the scheme.

What is also shown in Table 4.6 is relatively low performance Mashoko. This situation has resulted from lack of financial management skills. As remarked by one participant during a FGD in Mashoko:

*We have never been exposed to calculations. Therefore, use of books of accounts is Greek. Our inflows are from grain loan schemes from the Grain Marketing Board which has not been followed up since 2008. We have never received money that needs an account or to be saved for the irrigation scheme. We address requests or problems as they come. We are not yet exposed to other income generating activities as a scheme but we do things as individuals.*

This statement implies that the IMC of the scheme had no sufficient resources to cover recurrent and capital expenditures. The scheme also did not have funds in stock to fulfil collective obligations. Consequently, the scheme could not influence or control its future budgets. The IMC did not take the irrigation project as a business venture. Besides, income was generated by individual plot holders. Apart from credit associations, there were no other sources of income, which guaranteed financial security, or a collective fund for meeting shared expenses.

The IMC in Mashoko did some financial reporting as shown in Table 4.6, although it required additional financial support, compared to the other three schemes. Plot holders in Mashoko have managed to build a fund to sustain the payment of rates, even to an extent of making multiple

payments extending beyond a farming season. This allows them to invest their money in other areas. In all the schemes, AGRITEX assisted in assessing and evaluating farming operations and provided capacity-building services, but key informant interviews and observations revealed that this remained largely theoretical, since no day-to-day application of skills learnt took place.

### ***Farm Profitability***

During FGDs in Mashoko, farmers openly reported that they were not commercial but subsistence farmers and therefore they were not obliged to operate profitably.

*When we joined the scheme, nobody told us that we were supposed to be commercial farmers. Yes, we have records of being productive in our communal areas but we thought these plots were to complement communal agriculture.*

Responses from the farmers revealed that some farmers in the Mashoko smallholder irrigation scheme had no clear idea about the objectives of their scheme. This appeared to be common with the other three schemes as well, as key informants concurred that the goals and strategies of setting up the scheme were not clear to farmers. Plot holders were not trained to produce for sale but only for household consumption and self-sustenance.

A critical issue that required investigation is whether farmers whose goal is not profitability can contribute to the viability and sustainability of smallholder agriculture. The focus of assessing farm profitability in this context was to determine if these farmers had the ability to meet short-term targets, quality standards and performance. Table 4.7 shows the trends in production levels (tonnes per hectare) of the four schemes from the 2010 to 2014-15 seasons. Note should however be taken that, due to poor record keeping, produce of other crops such as tomatoes, vegetables and beans were not available.

**Table 4.7:** Production trends in smallholder schemes in Bikita (scheme averages in tonnes/ha)

<b>Schemes</b>	<b>Period (Years)</b>	<b>2010- 2011</b>	<b>2011-2012</b>	<b>2012-2013</b>	<b>2013-2014</b>	<b>2014- 2015</b>
<b>Rozva</b>	Maize	5	1,6	0,6	2,8	1
	Wheat	2	-	0,6	0,05	-
<b>Shereni</b>	Maize	2	1,5	2	2,5	2
	Wheat	1	-	1	1,5	-
<b>Mashoko</b>	Maize	3	3,5	4	5	5
	Wheat	1	1	1,2	0,75	-
<b>Chinyamatumwa</b>	Maize	-	-	-	-	-
	Wheat	-	-	-	-	-

NB: Data used are summaries of yields for three seasons (AGRITEX Bikita District, 2015:14)

Table 4.7 shows that of the four schemes, Chinyamatumwa had no records for yields. The trend is revealing Mashoko and Shereni more productive than the other two schemes.

#### *Maize output in the schemes*

There are some variations between the productivity of schemes regarding level of maize output. From Table 4.8 it can be noted that there is only Mashoko irrigation scheme which has significant variation in maize output, since the  $p$  value is less than 0.05. This can be explained in terms of the relatively higher yields that were recorded in Mashoko, compared to the other two schemes.

**Table 4.8** ANOVA of maize output in the schemes

		Sum of Squares	df	Mean Square	F	Sig.
Rozva	Between Groups	13.936	2	6.968	1.32547.	0.301922.
	Within Groups	63.084	12	5.257.		
	Total	77.02	14			
Shereni	Between Groups	10.125	2	5.0625	3.836842	0.062366.
	Within Groups	11.875	9	1.319444.		
	Total	22	11			
Mashoko	Between Groups	36.1	2	18.05	9.417391	0.003474.
	Within Groups	23	12	1.916667		
	Total	59.1	14			

NB: Data used are AGRITEX records of yields for three seasons, covering the period between 2010 to 2015, see Annexure 10). Chinyamatumwa was excluded because of unavailability of records.

*Wheat output in the schemes*

Regarding wheat production, there is no significant difference across all the schemes as all the *p*-values are above 0.05 as indicated in Table 4.9. The four schemes experienced common problems, including high input costs and low commodity prices resulting from manipulation by urban middlemen who take advantage of the marketing challenges facing smallholder irrigation farmers. Therefore, as shown in Table 4.9, the wheat yields for three of the schemes where output records were available did not shown any statistically significant differences at 95% confidence level.

**Table 4.9:** ANOVA of wheat output in the schemes

		Sum of Squares	df	Mean Square	F	Sig.
Rozva	Between Groups	3.035	2	1.5175	0.973276	0.430445
	Within Groups	9.355	6	1.559167		
	Total	12.39	8			
Shereni	Between Groups	1.326667	2	0.663333	3.778481	0.08669
	Within Groups	1.053333	6	0.175556		
	Total	2.38	8			
Mashoko	Between Groups	1.415417	2	0.707708	2.097345	0.17877
	Within Groups	3.036875	9	0.337431		
	Total	4.452292	11			

NB: Data used are AGRITEX records of yields for three seasons, covering the period between 2010 to 2015, see Annexure 10). Chinyamatumwa was excluded because of unavailability of records.

### ***Influence of socio-demographic conditions on maize and wheat yields***

The results of this study indicate that socio-demographic conditions had an effect on yields. This was the case in three schemes, namely Mashoko, Rozva and Shereni. Table 13 (in Annexure 11) shows the influence of age, gender, marital status and educational conditions of plot holders on maize and wheat yields. In all the three schemes, the majority of plot holders are aged 36 and above. However, only the 36-45 age group had yields exceeding scheme average in both maize and wheat. The yields that were recorded for those aged beyond 45 years were lower than the scheme average. Similarly, younger farmers (below the age of 36) recorded poor yields. As demonstrated by the results of this study, the aged plot holders were experiencing a number of challenges, which prevented them from meeting the scheme average crop yield. These included

lack of physical strength to perform tasks requiring hard labour. They also had difficulties in acquiring new technical skills due to poor education.

Despite the fact that they were better educated, these young farmers lack farming experience. As shown in Table 13, the proportion of male plot holders whose yields were above average was higher than that of females. Ironically, the results however show that the majority of the plot holders whose yields exceeded the scheme averages were the poorly educated farmers. Many better educated plot holders are usually engaged in off farm livelihood activities and consequently they devote less time to farming. Thus, although some plot holders had tertiary qualifications, their education did not necessarily contribute to productivity, as indicated by low average maize and wheat yields.

Surprisingly, though most plot holders who were headed by married couples were generally more productive than other plot holders, some households who were headed by widows were much more productive than many other households. This was particularly the case in Shereni where some widowed plot holders had long farming experience. It can therefore be inferred that age and experience are important factors in determining the viability of smallholder irrigation schemes.

#### ***Producer-retail price discrepancies in dollars***

The relationship between average irrigator prices and the retail prices charged by the intermediaries determines viability and sustainability of smallholder irrigation schemes. From Table 4.10, it is evident that the intermediaries doubled and trebled the proceeds of the ordinary smallholder farmer to the extent of compromising the success of the resource-poor farmers in these rural schemes. Tomatoes, leaf vegetables, beans and wheat prices proved beyond doubt the extent to which farmers in smallholder irrigation schemes are manipulated by the intermediaries. This is opposed to some farmers in Mashoko who directly dealt with nearby schools and a hospital and were paid at the retail commodity prices at their scheme gate without involving intermediary traders. However, in all themes the eighty percent of smallholder irrigation farmers revealed that they did not have access to urban and lucrative markets the intermediaries had. Farmers in the four schemes were resource constrained, especially regarding input supplies and financial capital needed for their operations. This limited the competitive potential of the farmers

to sustain the production levels of their plots. However, there were variations amongst schemes regarding their ability to implement strategies for meeting short-term targets and strategies for dealing with exposure to external demand. Chinyamatumwa and Shereni were unable to meet short-term goals, like rates payment compared to Mashoko and Rozva, due to remoteness of their sites. Mashoko and Rozva are along the main road that links them to big towns such as Chiredzi and Masvingo, respectively. They are more accessible to markets and to nearby towns where inputs are sourced than the other two schemes. Poor accessibility hampered the sustainability of the Shereni and Chinyamatumwa, compared to the other two, because of their remoteness. Furthermore, Rozva and Mashoko are well connected to rural services centres, such as Nyika growth point and Chiremwaremwa service centre, as well as towns like Chiredzi and Masvingo, where consumers compete for their products.

**Table 4.10:** Producer-retail price discrepancies

<b>Produce from schemes</b>	<b>Scheme gate prices (us\$/ Kg)</b>	<b>Retail prices at Nyika &amp; Chitima market in Masvingo (us\$/ Kg)</b>
Maize	0.25	0.35
Wheat	0.45	0.80
Leaf Vegetables	0,10	0.50
Tomatoes	1.80	3.60
Beans	1.60	4.00

***Technical capacity and water resources management capabilities indicators***

The operation and maintenance of the assets of an irrigation scheme, water rationing, crop scheduling, scheme conveyance efficiency and technical human resources (technical extension service) can influence the viability of the scheme. Table 4.16 provides an overview of the general state of infrastructure maintenance in the four schemes. A qualitative analysis of the state of the infrastructure of the four smallholder irrigation schemes in Bikita revealed that the level of infrastructure maintenance in Chinyamatumwa, Shereni and Rozva is generally unsatisfactory, as

discussed below. By contrast, Mashoko exhibited higher standards of infrastructure maintenance, even though some improvements are still needed, as highlighted by respondents during interviews and FGDs.

### *Maintenance of infrastructure*

From Table 4.11 it is clear that the majority of the schemes had water storage tanks that were poorly serviced. Only Mashoko and Rozva had protected and serviced tanks while Chinyamatumwa had protected but poorly serviced storage tanks. Shereni and Chinyamatumwa had similar scenarios of poorly serviced storage tanks.

The three of the water hydrants were poorly maintained, though most of them were well-protected hydrants. However, as shown in Plate 4.2 in Annexure 7, the hydrant in Shereni smallholder irrigation scheme was not properly protected. Consequently, the hydrant has been exposed to vandalism. Vandalism and poor maintenance of infrastructure have led to widespread damage of irrigation canals and pipes, as evidenced by leakages and invasion by weeds (Plate 4.4 and Plate 4.5 in Annexure 7). Weeds, especially the water hyacinth, were widely seen growing in some damaged canals and pipes as illustrated in Plate 4.5 in Annexure 7. Another form of infrastructure that is often vandalized is the security fence. At Chinyamatumwa, the security fence was vandalised and replaced with wooden posts, which are less durable and vulnerable to termite attack if untreated (see plate 4.6 in Annexure 7). Compared to steel posts, wooden posts are less durable and prone to termite attack. They are also more susceptible to elements of weather while.

During one of the FGDs at Chinyamatumwa fence, members said:

*We suspect that the jealousy former plot holders who were evicted are the ones who vandalized the fences. These wooden posts are a temporary measure we rely on while we await the leaders of the scheme to find a better solution. To my surprise, these posts are now a year old and even members of the committee seem to be comfortable with them.*

Infrequent weeding promotes the proliferation of weeds, especially *Lantana-camara*. Once *Lantana camara* has invaded an area, it tends to easily get out of control. Some plot holders regard it as an ornamental plant while others use it for live fencing.

**Table 4.11:** Level of infrastructure maintenance of the schemes

<b>Equipment</b>	<b>Chinyamatumwa</b>	<b>Mashoko</b>	<b>Shereni</b>	<b>Rozva</b>
<b>Storage tanks</b>	Protected but unserviced	Protected and serviced	Unprotected & poorly serviced (Plate 4.1)	Protected & serviced
<b>Hydrant</b>	Protected hydrant	Protected hydrant	Exposed hydrant(plate 4.2)	Protected hydrant
<b>Canal</b>	Unserviced canal with cracks resulting leakages	Well-maintained canals	Poorly serviced canals with weeds inside (Plate 4.3)	Canals experiencing leakages (see Plates 4.4 & 4.5)
<b>Pipe</b>	Well-protected & maintained	Well-protected & maintained	Well-protected & maintained	Broken & leaking pipes (Plates 4.4 & 4.5)
<b>Scheme gate</b>	Well-maintained gate	Well-maintained gate	Well-maintained gate	Poorly maintained gate (Plate 4.8)
<b>Ablution block</b>	Out of order toilets, unrepaired but gender sensitive	Sufficient toilets & gender sensitive	Sufficient toilet & gender sensitive	Insufficient & risky toilet for farmers & no gender sensitivity (Plate 4.9)
<b>Fence</b>	Untreated wooden poles prone to termites attack and susceptible to elements of weather	Satisfactory fence with well-spaced, treated poles	Fairly fenced with widely spaced treated poles not well tightened	Satisfactorily fenced scheme

However, some of the challenges related to poor maintenance of infrastructure resulted from limited extension services. The provision of AGRITEX services was generally limited in all schemes. One plot holder stated:

*Since 2008, extension workers were available but they were not active. They had no incentive due to the inflationary environment. From 2009 to date, efforts are being made to resuscitate the scheme but resource constraints are limiting progress.*

Where gates were broken, (Plate 4.8 in Appendix 7), crop fields were insecure. Both stray domestic and wild animals invaded the fields and undermined the productivity of schemes. Other examples of infrastructure that were in a state of dilapidation due to poor maintenance include toilets (Plate 4.9 in Appendix 7).

#### *Scheme operational services*

Scheme operational service involves water rationing, crop scheduling, technical extension service and water conveyance efficiency. Successful management of these components would result in scheme sustainability. Responses from FGDs held within the four schemes are shown in Table 4.12. Water was well managed and rationed except in Chinyamatumwa where some farmers complained about lack of equitable distribution of water within the scheme. In an interview with one key informant, this was attributed to differences in political affiliations. Chinyamatumwa was in the Bikita West constituency, which recorded the highest political violence and misunderstandings. Three quarters of the plot holders were labelled opposition party sympathisers, which resulted in their expulsion from the scheme. IMC members were suspended and the councillor replaced them with ruling party supporters. This problem spilled over to resource sharing in the scheme.

Water conveyance was inefficiently undertaken in all irrigation schemes, except in Mashoko smallholder irrigation scheme. This problem mainly resulted from poor maintenance of infrastructure, particularly in Chinyamatumwa and Shereni where canals were in a dilapidated state. Similar problems were evident in Rozva storage tank, pipes, and hydrants were deteriorating (Plates 4.2 and 4.3 in Appendix 7). Poor servicing of irrigation infrastructure

adversely affected crop production in the scheme. Consequently, plot holders ranked their schemes lowly in terms of water conveyance.

Similarly, performance in technical extension services was only good in Mashoko while the other three performed poorly. This was due to the affection by political misunderstandings among Chinyamatumwa farmers and lack of experience among the agricultural extension workers who were employed in these schemes. Due to lack of technical support famers applied incorrect planting practices, for instance, famers adopted incorrect spacing of maize and vegetables (see Plate 4.10 in appendix 7).

**Table 4.12:** Perception on Operational services

<b>Operational Services</b>	<b>Chinyamatumwa</b>	<b>Mashoko</b>	<b>Shereni</b>	<b>Rozva</b>
<b>Water rationing</b>	Unsatisfactory	Good	Good	Good
<b>Crop scheduling</b>	Satisfactory	Satisfactory	Satisfactory	Good
<b>Technical extension services</b>	Unsatisfactory	Good	Satisfactory	Unsatisfactory
<b>Water conveyance efficiency</b>	Unsatisfactory	Good	Satisfactory	Unsatisfactory

*Key: 1.Unsatisfactory 2.Fair 3. Satisfactory 4.Good 5.Excellent*

Though plot holders attributed this practice to an economic way of maximizing the limited amount of land available to them, as reported during FGDs, both leaf crops and maize are prone to leaf eaters, so they aid the proliferation of pests. Furthermore, vegetables are overshadowed by maize, giving rise to smothering (reduced leaf size of vegetables) and stunted growth, resulting in low yields and poor quality produce. The chlorosis evidenced in the crop (shown in Plate 4.11) is a sign of nitrogen deficiency. FGDs cited insufficient of training by newly employed extension workers who had received only six month training at the onset of the Fast Track Land Reform Programme.

During a FGD, one plot holder said:

*Since their employment, we have been experiencing difficulties with our extension workers. At the beginning they had no salaries or incentives to encourage them to make follow up visits to our plots, so they could not check if the instructions they gave us.*

Poor technical support results in reduced productivity among farmers. However, key informants (including AGRITEX officials) viewed that crop scheduling in the schemes as unsatisfactory. From the foregoing discussion it can be concluded that since water rationing, water conveyance efficiency and technical extension service were unsatisfactory within the four schemes, the sustainability of these schemes was seriously compromised.

#### ***Water resources management indicators***

An assessment of water resources management capacity of the schemes revealed that dams in Chinyamatumwa and Shereni schemes did not have the capacity to supply these schemes with water throughout the year. Such a situation undermined the sustainability of the schemes, leading to serious implications on the viability and sustainability of these smallholder schemes in the area. For example, in 2007, the Shereni Dam dried up, leading to a situation whereby plot holders ended up resorting to rain fed. By contrast, those in Mashoko and Rozva had a more permanent and reliable source of water because they depended on perennial rivers. In all the irrigation schemes, dams are deeply affected by siltation. In Chinyamatumwa (Figure 4.6), is situated in a catchment where excessive deforestation is taking place. Irrigation water in Block A (plots marked closer to the dam) is returning into the dam with a lot of silt from the edges of the scheme as shown in Figure 4.6.



**Scale: 1:2400**

**Figure 4.2: Google image of Chinyamatumwa Dam and the scheme plots (25 October, 2014)**

In Mashoko (Figure 4.3) (see Appendix 7), the stream bank cultivation by Mashavira communal farmers has increased the erodibility of the soils, leading to the siltation of the dam. In Shereni (Figure 4.4 in Appendix 7) deforestation in the stream catchment led to siltation. However, this problem has not been as widespread in Rozva compared to the other three schemes. Siltation reduces the amount of water that a scheme has access to and increases the tear and wear of irrigation equipment such as water pumps, thus leading to an increase in costs of production and a reduction of viability and sustainability. Due to their location in rugged areas, the diesel engine water pumps in Chinyamatumwa, Shereni and Rozva make it costly for the resource poor farmers to fuel the pump often, since the gradient does not permit gravity flow of water. Farmers in Rozva smallholder irrigation scheme (Figure 4.5) (see Appendix 7) do not experience this challenge because they depend on gravity irrigation. In Chinyamatumwa smallholder irrigation

scheme poor management of water resources is worsen by the lack of a water user association. The WUA of this scheme collapsed as a result of political conflict.

Responses in the Table 4.13 are the dominant responses given during the questionnaire survey on specified criteria. It provides a summary of the comparison of the four schemes based on plot holders' responses on a five point Likert scale in the questionnaire (Appendix 1). The results of this study demonstrate that Chinyamatumwa was the least viable among the four schemes.

Table 4.13: Perceptions on viability of the smallholder irrigation schemes

	Sub-criteria	Irrigation Schemes			
		Chinyamatumwa	Mashoko	Shereni	Rozva
<b>Governance &amp; viability indicators</b>	<b>Capacity of IMC</b>	-unsatisfactory	-fair	-satisfactory	-unsatisfactory
	<b>Level of Alignment with the Constitution</b>	-unsatisfactory	-satisfactory	-good	-unsatisfactory
	<b>M and E</b>	-unsatisfactory	-fair	-fair	-unsatisfactory
	<b>Participation by Actors</b>	-unsatisfactory	-satisfactorily	-satisfactory	-unsatisfactory
	<b>Transparency in Operations</b>	-unsatisfactory	-satisfactory	-satisfactory	-fair
<b>Social coherence &amp; viability indicators</b>	<b>Bureaucratic rules &amp; norms conducive for performance</b>	-unsatisfactory	-good	-excellent	-fair
	<b>Scheme ethnic conflicts</b>	-unsatisfactory	-satisfactorily	-fairly	--unsatisfactory

	Sub-criteria	Irrigation Schemes			
		Chinyamatumwa	Mashoko	Shereni	Rozva
	Attribution	-fair	-good	-good	-fair
	Informal rules	-unsatisfactory	-excellent	- excellent	- fair
Technical capacity & water resources management capabilities indicators	Level of Operation and Maintenance of Assets	-unsatisfactory	-fairly	-unsatisfactory	-unsatisfactory
	Water Rationing	-unsatisfactory	-good -	-satisfactory	-satisfactory
	Crop Scheduling	-satisfactory	fair	-fair	-satisfactory
	Technical Human Resources	-fair	-satisfactory	- satisfactory	-unsatisfactory
	Adequacy of Water Source	-satisfactory	-satisfactory	-unsatisfactory	-fair
	Adequacy of Integrated Water Resource Management	-unsatisfactory	- unsatisfactory	-unsatisfactory	-fair

	Sub-criteria	Irrigation Schemes			
		Chinyamatumwa	Mashoko	Shereni	Rozva
	<b>Payment of Water Bills</b>	-unsatisfactory	-fair	-unsatisfactory	-unsatisfactory
	<b>Private Sector Participation</b>	Unsatisfactory	-unsatisfactory	-satisfactory	-unsatisfactory
	<b>Links with Economic Policy</b>	-satisfactory	-fair	-excellent	-good
<b>Financial management indicators</b>	<b>Use of Budgets in Programming</b>	-unsatisfactory	-good	-unsatisfactory	-unsatisfactory
	<b>Application of Accounting Systems</b>	-unsatisfactory	-fair	-unsatisfactory	-unsatisfactory
	<b>Financial Reporting</b>	-unsatisfactory	-fair	-good	-unsatisfactory
	<b>Auditing</b>	-unsatisfactory	-excellent	--unsatisfactory	--unsatisfactory
	<b>Productivity of the Scheme</b>	-unsatisfactory	--satisfactory	-fair	-fair

	Sub-criteria	Irrigation Schemes			
		Chinyamatumwa	Mashoko	Shereni	Rozva
	<b>Quality Standards of Produce</b>	-fair	-satisfactory	-fair	fair
	<b>Ability to Meet Set Targets</b>	-unsatisfactory	-good	-fair	-fair
	<b>Cost Benefit Analysis</b>	-unsatisfactory	- good	- fair	- fair
	<b>Exposure to Outside Demands</b>	-unsatisfactory	-good	-unsatisfactory	-good
	<b>Standards of Performances</b>	-unsatisfactory	-satisfactory	-fair	-fair

Key:

1. *Unsatisfactory – unable to influence viability & sustainability*
2. *Fair – fairly able to influence viability & sustainability*
3. *Satisfactory – satisfactorily able to influence viability & sustainability*
4. *Good – sufficiently able to influence viability & sustainability*
5. *Excellent – excellently able to influence viability & sustainability*

### 4.3 CRITICAL FACTORS INFLUENCING PERFORMANCE AND VIABILITY OF SMALLHOLDER IRRIGATION SCHEMES – THREATS AND OPPORTUNITIES

#### *Plot holders' Familiarity with the viability indicators in schemes*

Table 4.14 shows that the majority of the respondents (55%) were familiar with all the indicators but the level of familiarity varied amongst farmers in different schemes, especially on indicators such as technical capacity, water resource management, governance and financial management.

**Table 4.14 Plot holders' familiarity with the criteria in schemes**

<b>Assessment criteria</b>	<b>Respondents (%)</b>
Governance	5.0
Financial Management	5.0
Social coherence	20.0
Technical capacity & Water Resources Management	15.0

This showed that not all farmers in these schemes were familiar with viability and sustainability indicators. This concurs with a response on one FGD:

*We were not aware of all these indicators. We would like a workshop on how to use these on our day-to-day basis so that we will not be found on the negative side of the benchmarks listed and this should be done seasonally.*

This revealed that most farmers who are based in the four schemes are not aware of indicators that characterize their performance or viability their schemes. They were not aware whether they are using scheme resources well or not and some had knowledge about how to meet set time lines. Furthermore, there were some plot holders who were not even aware that elections for IMC are mandatory. This actually revealed that there is no way schemes would achieve sustainability where stakeholder lacked critical knowledge or information.

Table 4.15 reveals that governance, social coherence, financial management and productivity, technical capacity and water resource management have an influence on the viability and performance of smallholder irrigation schemes. In FGDs held with AGRITEX officials, there was consensus that the status of governance was considered to be good in Mashoko, poor in Chinyamatumwa and fair in Shereni and Rozva. Social coherence was satisfactory and fair in Mashoko and Shereni, respectively, and poor in Chinyamatumwa and Rozva. Financial management and productivity in schemes seemed fair in all schemes, except in Chinyamatumwa. Technical capacity is still a challenge in Chinyamatumwa and Rozva, while Mashoko and Shereni have good and satisfactory attributes. Lastly, though good in Mashoko, water resources management leaves a lot to be desired amongst the other three schemes as revealed by the poor performance by the schemes.

**Table 4.15:** Assessment criteria and their level of influence in viability and performance of the schemes

Assessment criteria	Schemes ratings by AGRITEX			
	Mashoko	Chinyamatumwa	Shereni	Rozva
<b>Governance</b>	Good	Fair	Fair	Satisfactory
<b>Social Coherence</b>	Good	Poor	Satisfactory	Poor
<b>Financial Management &amp; Productivity</b>	Fair	Fair	Fair	Satisfactory
<b>Technical Capacity &amp; Water Resource Management</b>	Good	Poor	Satisfactory	Poor

Scale: 1-Poor; 2-Fair; 3-Satisfactory; 4- Good; 5- Excellent

Therefore the higher the level of appreciation by AGRITEX officials, the greater the criteria's contribution to the viability and sustainability of the scheme as shown by Mashoko and Shereni. The lower the level of appreciation by AGRITEX officials the lesser the criterion's contribution to viability and sustainability of the smallholder irrigation scheme.

## 4.6 CHAPTER SUMMARY

Viability and sustainability starts with an individual farmer, followed by the association to which that farmer belongs, based on operational systems characterizing a scheme, which in turn is influenced by the attributes of the farmer, including age group, social position and level of education attained by the farmer. These attributes are interrelated and they complement each another. However, social cohesion seems to be the most important determinant factor in viability and sustainability of smallholder irrigation schemes. Social dissonance in schemes has resulted in poor governance, to the extent that the capacity of schemes to raise funds to sustain themselves has been diminished. It also resulted in undermining of critical operational and collective rule of the scheme. Failure to raise funds brings technical capacity related bottlenecks in irrigation schemes. Since viability influences sustainability, it follows that unviable schemes cannot achieve sustainability. For viability to take place, governance, social coherence, financial management and technical and water resources management capacity should be achieved.

As reflected by the results of the study, assistance by NGOs, land, water and irrigation infrastructure are forms of capital that plot holders require in agricultural operations in smallholder irrigation schemes. These forms of capital have an influence on the viability and sustainability of these schemes. In terms of the Sustainable Livelihood Framework, land and water are key forms of physical capital needed for successful smallholder agriculture, while forms of infrastructure such as dams, water pumps, hydrants and canals are examples of physical capital. These forms of capital are controlled at the second order level in terms of Ozerol's (2013) classification organization. However, other forms of physical capital such as scotch carts and ploughs, are under the direct control of individual farmers, i.e. at the zero order level. Within the context of the SLA, social capital takes a variety of forms, including assistance rendered by neighbouring plot holders and NGOs. Such forms of capital, as shown by the results of this study can be critical determinants of successful agricultural operations. It has been demonstrated that social cohesion is an important component of social capital.

Other forms of capital that are necessary for the viability and sustainability of smallholder irrigation schemes are human and financial capital. As demonstrated in the preceding sections of this chapter lack of human capital in the form of expertise, experience or able-bodied personnel

for meeting physical labour requirements, as well as lack of skills are some of the critical elements that limit farming operations in all schemes. Lack of financial resources, for instance, often leads to the deterioration of equipment or failure to acquire inputs or failure to market agricultural produce. Thus, access to land alone is not enough to make irrigation plots viable or sustainable.

## **CHAPTER 5 DISCUSSION OF RESULTS**

### **5.0 INTRODUCTION**

As demonstrated by the results presented in Chapter 4, conditions characterizing the viability and sustainability of smallholder irrigation schemes are a function of both endogenous and exogenous drivers. In the case of smallholder irrigation schemes in Bikita, the endogenous drivers included governance by IMCs, social coherence and the performance of farmers in schemes, as well as their capacity to successfully manage financial resources and operations, technical capacity, and availability of skills to manage the water resources available to them. The exogenous drivers include the prevailing socio-political conditions that characterize national economic trends, seasonality and prevalence of shocks. The implication of these findings is that both categories of drivers should be considered when government designs smallholder irrigation agriculture. However, since viability and sustainability varied from one scheme to another, different schemes were characterized by different levels of viability and performance, different plans and policies must be designed for the schemes, depending on the capacity of the farmers in these schemes and the choices they make.

### **5.1 INDICATORS CHARACTERIZING VIABILITY AND SUSTAINABILITY OF SMALLHOLDER IRRIGATION SCHEMES**

As shown by the findings of this research study, the indicators that were used to assess viability, namely governance, social coherence, financial management and productivity, as well as technical capacity and water resources management varied from one smallholder irrigation scheme to another. Table 5.1 shows all the indicators that were used in this study, although farmers were not uniformly familiar with them throughout the four schemes. Social coherence emerged as the most influential category of indicators. Social coherence defines the levels of social cohesion and social dissonance in a scheme and the level of understanding and cooperation of the scheme members. In this study, it has been demonstrated that lack of cooperation by farmers results in social dissonance, which brings competition amongst scheme members. Competition in turn leads to the “tragedy of the commons” within the schemes. As shown in Chapter 4, the technical capacity in water resource management is partly determined by

the level of cooperation among scheme members. Similarly, the management of financial resources is influenced by the level of cooperation (social cohesion) in a scheme. Therefore, social cohesion influences governance, financial management and productivity, as well as technical capacity and water resources management within the scheme. Social cohesion influences the functions of all committees governing in schemes, including the finance and technical committees, like water users associations and IMCs. Thus, social cohesion stimulates social utility and consequently the viability and sustainability of the scheme. Therefore, variability in social coherence adoption in smallholder irrigation schemes also determines variability in schemes performance and their sustainability. In smallholder irrigation schemes like Mashoko and Shereni, where social cohesion was high, there was a high level of alignment between the operations of the scheme and the constitutions of these schemes, transparency, operation and maintenances, efficient water rationing and scheduling, timeous payment of water bills, sound financial reporting and auditing, productive and the overall performance of the schemes. Chinyamatumwa and Rozva experienced the opposite due to a high level of social dissonance. However, the other categories of indicators, namely governance, financial management and productivity and technical and water resource management were also an important reflection of schemes' viability and sustainability.

The use of indicators reminds organisations and farmers about the objectives, mission and vision of their schemes. Indicators provide farmers with a mechanism for monitoring their own progress at regular intervals. In its vulnerability assessment of Zimbabwe, FAO (2010) recommended that AGRITEX should make use of indicators like crop output per hectare to determine whether the government should prepare food handouts early in the event of anticipated crop failure. The FGDs held in this study indicated that the majority of farmers in the irrigation schemes where this study was conducted were not familiar with these benchmarks, which explains why their schemes performed poorly. Poorly performing schemes like Chinyamatumwa (which was on the verge of collapse) and Rozva may not be collapsing altogether, but they do experience stagnation in their growth, which is why there is a prevalence of high input costs and low product prices. Bossel (1999) maintains that indicators in an organization or institution provide comprehensive information about the systems shaping sustainable development.

Therefore, by assessing the current state of indicators within the schemes, it is possible to deduce information about the viability and sustainability of to the schemes and compare the state of the schemes with alternative development paths for those schemes. Indicators give the researcher sufficient information about the system's contribution to the performance or continuity of other systems or organisations that rely on them. Indicators act as generic expressions for quantitative and qualitative variables (Becker, 1997). This implies that the way water is rationed, how financial reporting is done and the level of accountability prevailing in the scheme would spell out why Chinyamatumwa has low viability, or why Shereni is more viable and also why group gardens are emerging and proposed schemes do not succeed. In this study, the System Based Theory has provided a comprehensive set of indicators that cover all important aspects of a system's viability and performance. Spangenberg (2002) indicates that sustainability indicators serve as a simplifying communication tool that helps to guide political decision making towards sustainable development. Indicators reflect the viability of essential component systems. If satisfactory qualitative answers are obtained in all the subsystems and the total system, one can conclude that the system is viable and performing satisfactorily. If one of the categories of indicators is in an unsatisfactory state, "this could indicate the existence of a problem with the potential to endanger viability of the whole system" (Bossel, 2001:11).

## **5.2. VIABILITY OF SMALLHOLDER IRRIGATION SCHEMES IN BIKITA**

### **5.2.1 Governance and Social Coherence in Smallholder Irrigation Schemes**

The results of this study revealed the prevalence of good governance in Mashoko and Shereni and its non-existence in the Chinyamatumwa and Rozva smallholder irrigation schemes. A high sense of ownership and adherence to the scheme's constitution are more readily undertaken in Mashoko and Shereni, compared to Chinyamatumwa and Rozva. Mwendera et al. (2013) posit that for a scheme to be viable there must be people who feel sufficiently motivated to sustain the irrigation system. Motivated plot holders maintain operational and collective rules that are critical in organizational performance as depicted by Ozerol (2013). This confirms Benjamin et al.'s (1994) findings that farmer-managed irrigation schemes are associated with productive working relations in terms of a high degree of mutual trust, active participation in the constructing and monitoring of rules and a high level of rule conformance. "These productive

patterns of relationships are the basis upon which high levels of irrigation performance are attained” (Benjamin et al., 1994:105). Farmer-managed schemes are public goods assumed to have institutions or rules and regulations governing their operations. A smallholder irrigation scheme is a public entity whose beneficiaries come from different socio-economic backgrounds, political affiliations and chiefdoms. Institutional weaknesses arise from political misunderstandings and chieftainship wrangles in Chinyamatumwa and Rozva. As a result of these conflicts, public resources become open to abuse and unsustainable exploitation. Canals, irrigation water and other forms of irrigation infrastructure are also public resources whose maintenance requires collective planning and management. Failure to do so results in limited responsibility, accountability and lack of a feeling of ownership among beneficiaries, since public goods are no man’s resource (Benjamin et al., 1994). In the case of smallholder irrigation schemes in Bikita, political misunderstandings cascaded down to organizations and committees that are found in the schemes, like the water user and associations, thus compromising the relations amongst stakeholders. Individual farmers would operate in isolation due to limited interaction among the players that constitute the sub-systems suggested by the System-Based Theory. According to the System-Based Theory, most subsystems interact with other systems that are essential for their viability. Viability and performance of the total system depends on its component systems, which in turn depend on their own subsystems. Each subsystem must not only be viable, but it must also contribute to the viability of the supra-system. Therefore, farmers in isolation are not viable, and that lack of viability undermines the viability of the smallholder irrigation scheme as a system.

In smallholder irrigation schemes in Bikita, there are variations in the performance and viability of the four schemes, all of which are related to governance. Benjamin et al. (1994) make similar observations about irrigation schemes in the Nepal. They conclude that farmers should be given incentives to engage in the governance and management of their schemes. Though the effective functioning of irrigation scheme subsystems such as Water Users Association or IMC influences proper operation, maintenance and sustainability of an irrigation system (Mishap et al., 2011), the viability of any system is also hinged upon the performance of irrigation officials. The demise of the IMC and WUA in Chinyamatumwa and Rozva had serious ramifications on the operations and infrastructure maintenance of the two schemes. The constitutions of these schemes have rules and regulations that define to whom, when and how water is distributed, how

canals are serviced, and other ‘dos’ and ‘don’ts’ associated with the day-to-day running of the scheme. They also indicate the forms of punishment prescribed for those deviating from the norm. However, in order to remain viable, a system must be able to meter out punishment before deviation leads to serious damage. In Chinyamatumwa and Rozva smallholder irrigation schemes, threats of punishment have been ignored, leading to the persistent usurping of the constitutions of the two schemes.

### **5.2.2 Financial management and productivity**

Findings from smallholder irrigation schemes in Bikita show that the schemes are financially constrained. This is due to low levels of external support, poor savings, lack of financial reporting, and high input costs and low product prices. There is poor recording of financial inflows and outflows. Morales and Mongcopa (2008) who reported that financial constraints and poor revenue collection from scheme beneficiaries lead to inadequate operations and maintenance in irrigation schemes support these results. Chinyamatumwa has almost collapsed due to lack of savings. This actually shows that smallholder irrigation schemes in Bikita operate under unviable and unsustainable conditions, given the incompetence levels of the IMCs and unavailability of reliable extension services. In some schemes, rates were collected as problems arose, a loophole confirmed by Shar et al. (2002), who note that scheme management institutions in developing countries even fail to set up irrigation charges that cover actual operation and maintenance costs for their viability and sustainability.

The financial, resource-related challenges that irrigation schemes in Bikita experience are not unique to that region. Tafesse (2003) highlights some regional studies, which show that availability of financial resources for the effective operation and rehabilitation of smallholder irrigation schemes is a major constraint affecting other indicators in smallholder irrigation agriculture. The fact that accounting and financial reporting is limited in these schemes actually entails no application of gross margin analysis, a tool which Gittinger (1984) recommends for evaluating farming enterprises and cost and benefits, is not practised (Hagos et al., 2009). Lack of financial resources cause a ripple effect leading to the incapacitation of IMCs, which in turn undermines social coherence in the schemes.

### 5.2.2.1. Productivity

Smallholder irrigation schemes in Bikita recorded considerable variations in crop output, especially on maize and wheat. Mashoko had the highest output for maize, while wheat outputs were high in Shereni but not significantly different from the other two schemes. Common problems affecting productivity among the schemes were high input costs and low prices of produce due to inaccessibility of the schemes to lucrative markets and lack of capacity by IMCs to undertake market research. Farmers are manipulated by exploitative intermediaries or middlemen. As Longwe et al. (in press) state, producers sell at farm-gate level or local markets to traders and NGOs who transport the produce to processors or consumers in urban markets. This shows that there is no direct contact between the producers and the majority of the consumers. With the existence of several intermediaries participating in the marketing chains, farmers get lower prices than they would actually be expected to get if they sold their produce directly to the consumers. The Practitioners Learning Programme (2005) views ‘middlemen as an exploitative force in the lives of the poor producer, controlling production, paying unfair prices for labour and goods and participating in fraudulent practices to maximise their own gains’. This was also noted by Morberg (2013) when an organization called Fair Trade assisted smallholder growers in marketing their produce to Sainsbury supermarket in the United Kingdom (Morberg, 2013:172):

“Many consumers assumed producers were benefiting but this was far from reality. There was a huge discrepancy between producers and prevailing commodity retail prices. Though the middlemen talked of social premium returned to farmers, it was realized that social premium generated by each 42 pound box of the Fair Trade Company was a very small share of the value of each box”.

The above excerpt shows how the intermediary can take advantage of smallholder farmers, which explains the figures in Table 4.8. The exploitative impact of intermediaries is also confirmed by Nhundu et al. (2010), who question the economic viability of smallholder irrigation schemes in Zimbabwe and point out that some smallholder irrigation systems have been unsuccessful due to poor management, lack of input and lack of irrigation experience by

farmers. However, Benjamin et al. (1994) argue that the viability of the irrigation systems largely hinges upon the performance of irrigation officials. The capacity of the IMCs, the degree of mutual trust amongst scheme members, active participation in the crafting and monitoring of rules and the level of conformance to the constitution are the basis upon which high levels of irrigation performance are attained. This implies that where there is poor governance, sustainability is likely to fail, as observed in Nepal by Hatcher et al. (1999). Therefore, productivity is an outcome of the state of governance prevailing in a scheme. Variations in forms of governance lead to variations in the level of productivity in the schemes. The profitability of the schemes sustains farming activities and improves livelihoods by motivating them to engage continuously in farming. Therefore, the viability of the scheme, as suggested in the Systems-Based Approach, is influenced by the viability of farmers in the scheme to contribute to the viability of the supra-system, which constitutes the scheme as a whole. Therefore, the systems approach highlights the role that viable farmers play within the system as a whole. Farmers that are not viable contribute to the viability challenges of the total system of the scheme. Thus, unviable farmers in Chinyamatumwa do not contribute viably to the overall performance and sustainability of the scheme.

### **5.2.3 Technical Capacity and Water Resource Management of the Scheme**

The results of this study revealed two main issues regarding the availability of technical capacity within smallholder irrigation schemes. First, the levels of infrastructure maintenance in the schemes were unsatisfactory, a problem that seems to be common in all smallholder irrigation schemes. For instance, research by Mwendera et al. (2013) shows that one of the operational and maintenance problems in smallholder-irrigation scheme systems is the prevalence of a vicious cycle of insufficient maintenance of irrigation infrastructure, leading to the downgrading of infrastructure. In turn, this results in poor performance and low cost recovery. Poorly maintained fences and collapsing toilets in Chinyamatumwa, unrepaired pipes, subserviced hydrants and reservoirs in Rozva and Shereni are indicators of poorly maintained forms of irrigation infrastructure. FAO (1999) in Mwendera et al., (2013) notes that ‘the maintenance of infrastructure is crucial in guarantying the sustainability of irrigated agriculture, whereas the efficient and timely maintenance of irrigation assets improve the efficiency of water distribution and management’. Mwendera et al. (2013:134) argue that

“while accurate assessments of resources and good engineering are basic requirements for the success of smallholder irrigation schemes, an effective operation and maintenance system is one of the factors that determine long term performance and sustainability of a small holder irrigation scheme”.

Secondly, water rationing was one of the problems affecting the schemes, especially in Chinyamatumwa. This problem resulted in poor crop scheduling. Nkambule (2013) states that lack of proper irrigation scheduling contributes to reduced crop productivity, because calculations for water supply or requirements for cropping patterns are not discussed or agreed upon among the farmers. As a result, there is no provision for flexibility to allow for changes in cropping patterns, especially during the dry season when irrigation water demands are high. This again compromises the sustainability of the schemes. Furthermore, the technical extension services were of a low standard, particularly in Rozva and Shereni. The provision of technical services in Rozva, Shereni and Chinyamatumwa dwindled during the recent economic recession in Zimbabwe. Lack of technical extension services often lead to poor performance amongst irrigation officials. For instance, poor performance of irrigation scheme officials was reported to have compromised the viability of schemes in Nepal (Nkambule, 2013). Therefore, the ability of officials to maintain accountability and good governance can all contribute to the sustainability of the scheme.

When applying the SLF, it becomes evident that technical capacity is linked to human and natural capital. Human capital is an important asset in the attainment of positive livelihood outcomes in irrigation schemes. Poor maintenance of this asset undermines the viability of the schemes negatively. Chinyamatumwa and Rozva have poor maintenance of technical resources, which compromises their viability. At Shereni, Chinyamatumwa and Mashoko, water sources are vulnerable to siltation due to deforestation, group gardens and stream bank cultivation, respectively. These problems result from poor maintenance of natural capital. However, human and natural forms of capital by themselves cannot determine the sustainability of smallholder irrigation schemes. The vulnerability of the schemes should be controlled by human capital, but that can only happen if there is social cohesion among farmers, which however is generally lacking.

#### **5.2.4 Water resources supply and management**

As revealed by the findings of this study, the prevailing regime of water resource management depicts the seasonality of streams and high siltation levels of rivers and dams arising from widespread deforestation in Chinyamatumwa and Shereni, as well as soil compaction along the most frequently used footpaths, all of which undermine water resource management in the irrigation schemes. Other serious problems that undermine the sustainability of the schemes include sabotage by the Mashavira communal farmers (around Mashoko Dam) and high water pumping costs due to nature of the landscape in Chinyamatumwa and Shereni. Wichelns et al. (2012) maintain that a major challenge to sustainability pertains to long-term water availability. Hence, water supply disturbance through the siltation that takes place in Chinyamatumwa, Mashoko and Shereni is a serious threat to viability and sustainability. For a scheme to be sustainable, it should have committees that address basic issues of water governance and reduce water use conflicts by means of traditional and modern by-laws (Wichelns et al., 2012). Individualism brings competition among farmers and leads to the “tragedy of the commons”, arising when individual utility supersedes social utility (Mukwada, 2012).

As demonstrated in this research, an irrigation system is actually composed of two different common resources, the canals and water. The canals can pose supply problems if not regularly maintained, usually at costs shared by users. Excessive water use triggers appropriation problems mainly linked to the distribution of the water among users with respect of water rights (Bravo and Marelli, 2000). Bravo et al. (2000) observe that many communities across the world experience this tragedy due to the challenging task of managing the two Common Pool Resources at the same time. Mutambara and Munodawafa (2014) regard limited access to irrigation water as a threat to the sustainability of the schemes’ production levels. In the south-eastern Lowveld of Zimbabwe, about 90% of the farmers had times during the year when they had limited access to irrigation water due to electricity load shedding by Zimbabwe Electricity Supply Authority, as well as due to reduced discharge of the Save River, especially between September and November. Problems associated with low river discharge are more conspicuous in schemes that do not have access to perennial rivers and stream, for example Chinyamatumwa, Shereni and Rozva. Frequent pump breakdowns and delays in the repair of irrigation equipment undermine the productivity and viability of these schemes. These problems are aggravated by the

lack of knowledge in the operation and maintenance of equipment. Experiences with community-managed schemes in northern Ghana showed that many schemes have completely deteriorated during the past decades due to insufficient maintenance (Nhundu, 2013).

Political rivalry undermined the operational and maintenance competencies of the Chinyamatumwa IMC, because it led to poor alignment between operations and the scheme's constitution. In this scheme, there is also a lack of participation of private actors and poor transparency, all of which further undermine the sustainability of the schemes. Payment of water bills was a peculiar challenge amongst plot holders in Chinyamatumwa and Shereni. This problem seems to be common in Zimbabwean smallholder-irrigation schemes. For instance, out of the 120 farmers who owned plots in the Somnene irrigation scheme in the Bulilima District, only seven remain due to failure to raise money for electricity bill (Dube, 2013). In the case of the Chinyamatumwa smallholder irrigation scheme, some plot holders dropped out of the scheme because they could not raise enough money to pay water bills. This also compromised the sustainability of the scheme. The escalating water prices in the Mushandike irrigation scheme in Masvingo District of Zimbabwe is another example of a smallholder irrigation scheme where farmers withdrew due to unaffordable water and electricity bills, an experience which they had never been exposed to since independence (Chazovachii, 2012).

The availability of reliable water source, adequacy and dependability of water supply and equity of water distribution constitute the main performance indicators of a water delivery system (Hitcher et al., 1999). Hitcher et al. (1999) argue that the dependability of water supply is an expression of the confidence in the irrigation system to deliver water as promised. It is indicative of timelessness and adequacy of promised deliveries, and accordingly the adequacy of an irrigation scheme is a measure of ability of the water supply schedule to meet the water demand for optimal plant growth. The increasing adequacy and dependability of water sources has a likelihood of enhancing the sustainability of the schemes. Due to inadequate and unavailability of dependable water supply, the Shereni smallholder irrigation scheme often relies on rain fed agriculture. According to the SLF, seasonality of operations can be regarded as a source of vulnerability (Scoones, 2010). The Shereni water shortage situation in some seasons is best explained by this theory. Typically, seasonality explains why farmers are vulnerable during periods of poor water supply. Under such circumstances, the vulnerable farmers use social

capital to transform this unfavourable scenario into a positive livelihood outcome by altering prevailing institutions. A siltation-free water source, (reservoirs) is reliable and sustainable since storages are regarded as major components in an irrigation system (Benjamin, 1994). Storage facilities such as dams and other reservoirs provide interventions, which can serve as a buffer against uncertainties. This supports the idea that viability and sustainability cannot only be achieved through profiteering, but also by the protection of the catchment area of the dam, conserving the harvested water in the dams and other water storage facilities through continuous maintenance and use of water-saving irrigation technologies and making sure that the efficiency of water conveyance and scheduling is monitored (Mwendera et al., 2013). Such measures reduce the cost of water and promote productivity and profitability of plot holders in irrigation schemes.

### **5.3 CRITICAL FACTORS INFLUENCING THE PERFORMANCE AND VIABILITY OF SMALLHOLDER IRRIGATION SCHEMES**

#### **5.3.1 Socio-demographic profile on crop yields**

The results of this research study revealed age, gender, marital status and educational conditions of plot holders had different effects on productivity. Despite uniformity on plot holder participants who were all 26 years and above in the three schemes, the economically active age group performances differed in terms of their yields in relation to scheme average. It can be argued that the age of the plot holders was one of the most important socio-demographic factors influencing the viability of smallholder irrigation schemes. In all schemes, the aged plot holders were experiencing challenges in meeting the scheme average yield since individual job performance tends to decrease from around the age of 50 years, particularly for tasks that require problem solving, learning and speed, as well as hard labour. Results from this research study confirm findings from earlier research studies. For instance, it has been argued that whereas elderly farmers are desirable in situations requiring experience and verbal abilities, they are slow to grasp new technological concepts that differ from what they have already mastered (Chauke et al., 2013). The sustainability of the smallholder irrigation schemes depends on “new and fresh blood” that can spearhead irrigation projects in future while the old and experienced “veterans” could play a supervisory and advisory role. Unfortunately, no participants among plot holders in the schemes were below 26 years. Male dominance in smallholder irrigation schemes seemed

advantageous since most of them exceeded yields above scheme average as shown in Mashoko and Shereni. However, the results of this study show that level of education attained by an individual does not necessarily translate to productivity. The more educated the farmers are, the less the proportion of plot holders exceeding yields above average. Plot holders exposed to higher educational opportunities were expected to be conversant with better farming methods but this was the opposite as the majority were failing to have yields exceeding scheme average especially in Mashoko, and Shereni. Engagement in off-farm activities by the more educated plot holders reduces the amount of time that they invest in farming. These farmers, therefore, have more diversified livelihood portfolios.

The married who are the majority were productive and exceeding yields above average. This is supported by an observation in African families that marital status of a household's head usually determines the stability of the household (Randela, 2005). As noted in Table 13 in Appendix 11, farming activities that are associated with married household heads tend to be more stable than those undertaken by unmarried ones. In rural areas, social exclusion is the main limiting factor undermining access of support services by single and divorced women. This is witnessed in all schemes, where only a few widowed and divorced own plots (Table 13 in Appendix 11). However, all the three widowed plot holders recorded yields that were above scheme's average, indicating that marital status does not always present limitations on productivity and viability.

### **5.3.2 The link between performance and viability of smallholder irrigation schemes and the Sustainable Livelihood Framework (SLF)**

The findings of this research study reveal that the governance of schemes, social coherences, financial management and technical and water resource management are key factors contributing to the viability, performance and sustainability of smallholder irrigation schemes. These factors can be categorized into five forms of capital, in terms of the SLF, as shown in Table 5.1. The implication of these results is that these forms of capital or assets are affected by rules and regulations governing smallholder irrigation agriculture, and consequently determine the vulnerability context and livelihood outcomes that prevail in these schemes.

**Table 5.1: Factors influencing performance and viability**

<b>Forms of capital</b>	<b>Viability &amp; Sustainability factors in schemes</b>
Human	Governance
Social	Social coherence
Financial	Financial management & productivity
Physical	Technical capacity and water resources management
Natural	Technical capacity and water resources management

### *Human capital*

Human capital is a stock of capabilities among farmers and their IMCs, which can yield a flow of services. As shown in the results of this research study, the capability of the farmers does not solely depend on individual knowledge, education, training and skills, but also on useful behavioural habits and one's level of energy and social position in the scheme. The knowledge, education and habits of farmers and IMC members enhance transparency, efficiency, monitoring and evaluation of smallholder irrigation schemes. These governance indicators have the capacity to augment adherence of the IMC to the scheme constitution and instil a sense of ownership, responsibility and accountability among scheme members, all of which contribute to the performance and viability of the scheme.

Although a higher degree of alignment with the scheme's constitution can be the basis for resolving collective problems as confirmed by Ozerol (2013), the human capital element augmented by useful behavioural habits of farmers are the backbone of the viability and sustainability of smallholder irrigation schemes. The importance of the lack of mechanisms to monitor the operations of irrigation associations was demonstrated in Harrain plain in Sanliurfa province of Turkey, where there was water logging and soil salinity problems requiring collective solutions (Ozerol, 2013). Thus, there was an inadequacy of human capital to ensure viability and sustainability. The prevalence of good governance in Mashoko and Shereni demonstrates the role that human capital can play in promoting the viability and sustainability of smallholder irrigation schemes.

### *Social capital*

Social capital constitutes the stock of trust, mutual understanding, shared values and socially held knowledge that facilitates the social coordination of an economic activity. Viability and sustainability is achieved by the prevalence of social capital. This type of capital includes social coherence that may bring cooperation among farmers and IMC members. Social coherence has two extreme ends, namely social cohesion and social dissonance. In smallholder irrigation schemes in Bikita, social cohesion is aided by bureaucratic rules and norms that are conducive to enhanced performance. Productivity can only occur when there are shared values and mutual understanding among farmers. The success of smallholder irrigation schemes is determined by trust amongst farmers. Government, donors and irrigation authorities need to recognise the role that IMCs can play in conflict resolution. However, they should also realize that trust and mutual understanding bring social cohesion within irrigation communities, resulting in better accountability amongst scheme members. Failure to address collective problems therefore aggravates social dissonance and undermines the viability and sustainability of smallholder irrigation schemes.

### *Financial capital*

Financial capital is stock invested in some activities that produce something for its owner, especially more money. Viability and sustainability is influenced by the capabilities of farmers in smallholder irrigation schemes to perform operations such as budgeting, auditing and financial reporting. Skills and knowledge to perform the aforementioned operations are the determinant of viability and sustainability in any smallholder irrigation scheme. These factors have been overlooked in the past. The four schemes, Mashoko, Chinyamatumwa, Shereni and Rozva, had limited capabilities in financial management while most of their plot holders were poor. The greater the capacity to adopt sound financial management practices by farmers, the greater the chances of attaining viability and sustainability. However, viability and sustainability are not only influenced by the aforementioned practices, but also by farmers' savings, remittances, pensions and access to credits. As shown in Chapter 4, variations in the level of access to remittances, pensions and savings by farmers determine the variations in the levels of viability and sustainability of individual farmers within the four smallholder irrigation schemes.

### *Natural capital*

Viability and sustainability is not determined by the resource flows and services offered only but also by natural resource stocks from which services and resources flow for livelihood construction. As demonstrated in Chapter 4, availability and adequacy of natural capital such as water supply is a basic requirement for the viability and sustainability of smallholder irrigation schemes. It has been shown in the preceding chapter that the quantity of water available determines patterns of water rationing and crop scheduling in schemes, both of which are essential for the successful operations of an irrigation scheme. The capability of farmers to manage available water resources, scheduling of crops and pay water bills influences the viability of a smallholder irrigation schemes, depending on the availability of other forms of natural capital, including soil type.

### *Physical capital*

Basic infrastructure and producer goods such as canals, toilets, vehicles and storage tanks are examples of forms of physical capital that are needed to make smallholder irrigation schemes viable and sustainable. In addition, without adequate access to services such as water, energy, toilets and water pumps, human health deteriorates and long periods are spent in non-productive activities. The cost associated with poor infrastructure can affect productivity. Without vehicles, essential fertilizers cannot be acquired and distributed effectively and produce may not be sold timeously. Consequently, agricultural yields will remain low while losses of perishable products like vegetables will remain high, since produce cannot be transported to the market in time.

However, viability and sustainability of smallholder irrigation schemes cannot be achieved by assets utilization alone, but by their positive interaction with institutions, organizations, policies and legislation that shape smallholder irrigation schemes. A negative interaction between assets and institutions, organization and processes yields a vulnerability context that undermines viability in smallholder irrigation schemes. Variations in interactions between assets and institutions, organizations, policies and legislation in smallholder irrigation schemes determine the variations in the conditions characterising viability and sustainability. The failure by smallholder irrigation schemes to manage assets (i.e. the different forms of capital stated above) has a negative impact on the individual farmer who needs human, social, physical and natural

capital to become productive and viable. In terms of the Viability System-Based Theory, evidence from the results of this research indicates that the farmer is part of a subsystem. The negative effect on individual farmers has an effect on the subsystem for which he/she is a constituent component. This creates a chain reaction that undermines the whole supra-system. Therefore, viability and sustainability of smallholder irrigation schemes can only be attained if the capacity of the individual farmer, an important pillar of the scheme, is maintained through improved access to the forms of capital noted above.

Overall, this study has revealed that the state of viability and sustainability of smallholder irrigation schemes can be understood better through the application of the SLF and Systems Based Theory. However, one should take cognisance of the institutional structures and processes prevailing both within and around the schemes, since they have the potential to either offset or contribute positively to the viability and sustainability of the schemes. These are the endogenous and exogenous drivers or factors that were discussed in preceding chapters.

#### **5.4 CHAPTER SUMMARY**

The foregoing discussion is based on indicators reflecting the viability and performance of the subsystems of smallholder irrigation schemes as supra-systems. Indicators act as a barometer for measuring the state of these supra-systems. The viability of farmers as individuals contributes to the viability of WUAs and other committees of farmers in the schemes, which ultimately contribute to the viability of the whole irrigation scheme. However, it is important to note that if the indicators of any one component of a smallholder irrigation scheme are in an unsatisfactory state then the viability and sustainability of the whole scheme might be under threat. The more a scheme adopts indicators to assess its progress, the greater the likelihood of the scheme to develop the capacity to monitor the performance of its operations and become more viable and sustainable. The use of viability and sustainability indicators to assess the performance of smallholder irrigation schemes is closely linked to different forms of capitals and a number of livelihood outcomes. In smallholder irrigation schemes, a variation in institutions, structures and processes determines variability in livelihood outcomes, as shown by the complementarity between the SLF and System-Based Theory. The next chapter will focus on the conclusions,

lessons, policy implications and recommendations of the study, as well as areas that require further research regarding the viability and sustainability of smallholder irrigation agriculture.

## **CHAPTER 6 CONCLUSIONS, LESSONS, POLICY IMPLICATIONS AND RECOMMENDATIONS**

### **6.1 INTRODUCTION**

*Assumptions made by engineers and planners, social and economic realities about the likely performance of systems reflect a limited perspective on landscapes and livelihoods, which is often at odds with local realities – Guijt and Thompson (1994:307).*

For scholars studying sustainable development, the subject of sustainability is challenging, especially when working towards the development and implementation of sustainable policies (Pfahl, 2005). Since their recommendation by the United Nations Commission on Sustainable Development in 1995, institutional dimensions of sustainable development have been the basis for assessing progress in implementing Agenda 21. Accordingly, there is a need to assess conditions characterizing the viability and sustainability of the smallholder irrigation agriculture in line with the recommendations of Agenda 21. Thus, there is need to review the progress made in smallholder irrigation schemes, using a Sustainable Livelihood Framework and Viability System Based approaches as tools for assessing conditions characterizing the viability and sustainability of the schemes. This study assessed conditions characterizing the viability and sustainability of smallholder irrigation agriculture in four schemes in the Bikita District in the Masvingo Province of Zimbabwe. Conclusions and recommendations have been drawn, based on the key indicators used in the assessment. These indicators are critical factors that influence the performance of the schemes, namely governance and social coherence, technical and water resources management, and financial management and productivity levels.

### **6.2 CHAPTER SUMMARIES**

The aim of this research study was to assess conditions characterizing the viability and sustainability of smallholder irrigation agriculture in four schemes in the Bikita District. The objectives of the study were:

- To identify the key indicators that can be used to characterize the viability and sustainability of smallholder irrigation schemes in Bikita.

- To assess the viability and sustainability of smallholder irrigation schemes in Bikita.
- To determine the critical factors, which influence the performance and viability of smallholder, irrigation schemes in Bikita?
- To draw up recommendations that can guide the planning of smallholder irrigation schemes in Bikita.

This research was prompted by the need to establish the extent to which smallholder irrigation schemes in Zimbabwe can remain viable as farmer-managed schemes, following the withdrawal of government and donor support. As noted in Chapter 2, the existing literature does not shed much light on conditions characterizing the viability and sustainability of smallholder irrigation agriculture. The viability and sustainability of smallholder irrigation schemes have not received direct research attention in the past; neither has the nexus between the two phenomena been theorized in Zimbabwe. This assessment provides a first theoretical response, based on the Sustainable Livelihood Framework and the Viability System Based Theory to investigate the challenges that smallholder irrigation schemes in Zimbabwe face.

Chapter 3 covered the description of the study area and the research methodology, which employed a mixed-methods approach, applying both random and purposive sampling methodologies. Questionnaires were used to capture responses from irrigators, some of which were based on a five-point Likert Scale questions. Qualitative data was collected through FGDs, interviews and field observations. Quantitative analysis of the collected data was done using descriptive statistics in SPSS, augmented by Excel, to perform ANOVA in order to determine the factors that affect crop yields in smallholder irrigation schemes. It measures how statistically different are the scheme performances in the district. Qualitatively, the thematic analysis and constant comparative methods were done to validate the findings. The thematic analysis entails data display after collection; reflections are done followed by coding. Data is distilled (reduction), and generation of themes follows. However, one should note that reflection, coding and data distillation is done iteratively and simultaneously to monitor the process. From theme generation, story interpretation or discussions are done to reach a research conclusion (Creswell, 2008; Chinyoka, 2012).

Chapter 4 presents the results of the study, focusing on indicators used in assessing viability and sustainability and factors influencing viability and performance of the four schemes. The results of the analysis revealed that the Mashoko and Shereni irrigation schemes are viable, while Chinyamatumwa and Rozva are not. The results also revealed that the level of viability and sustainability of the schemes is determined by a combination of endogenous (social coherence, technical and water resources management skills, and financial management and productivity) and exogenous factors like political stalemate and macro-economic challenges prevailing in Zimbabwe, as shown in Figure 6.1.

Chapter 5 details the discussion of the results of this research. It depicts the complementarity between the Viability System-Based Theory and Sustainable Livelihood Framework in exploring the viability and sustainability of smallholder irrigation schemes. The last chapter contains the main findings and conclusions drawn and summarized under the four objectives of the study noted above.

### 6.2.1 Smallholder Irrigation Viability-Sustainability Model

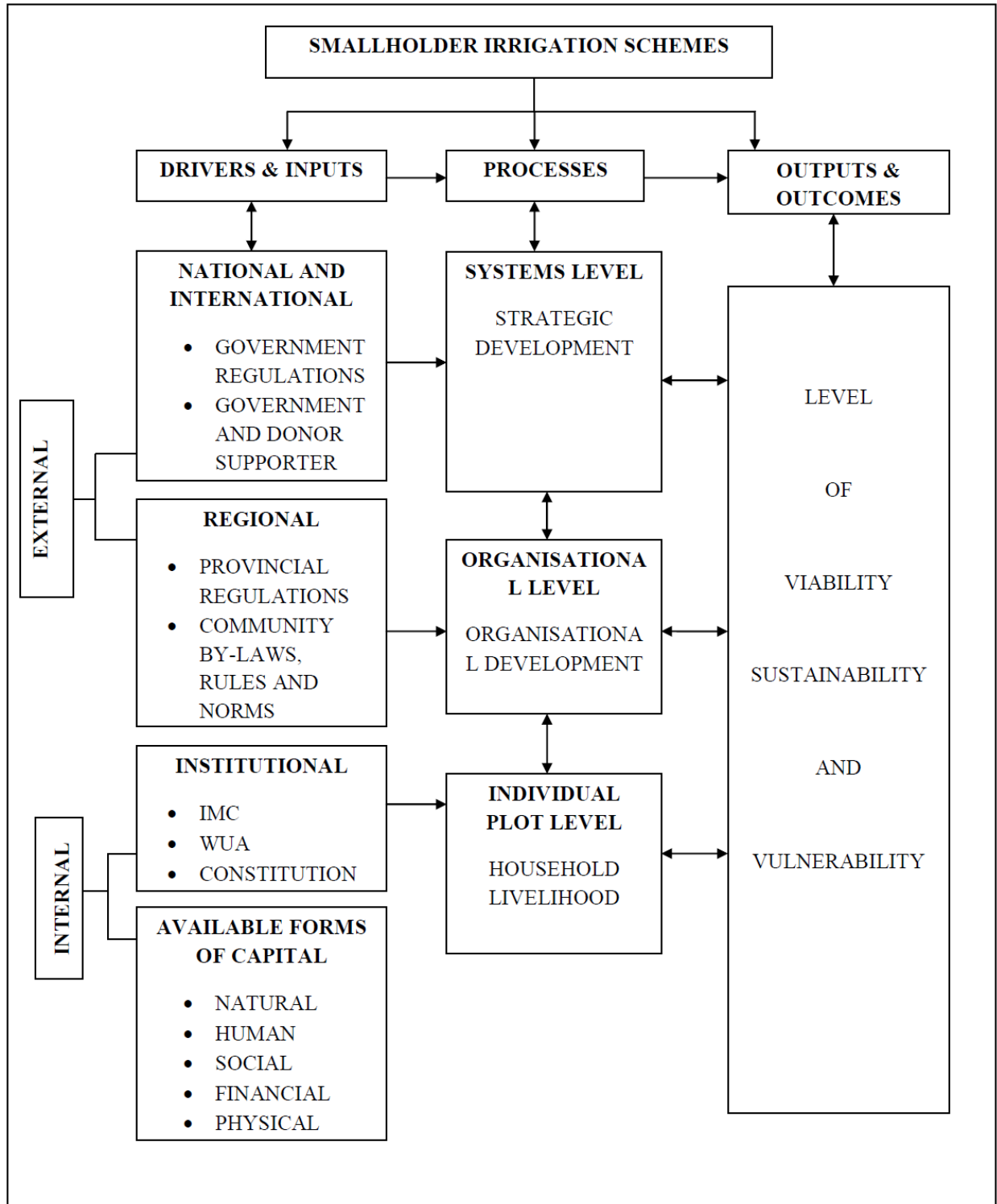


Figure 6.1: Smallholder Irrigation Viability-Sustainability Model

### 6.3 SUMMARY OF RESULTS

Chapter One presents the background of smallholder irrigation agriculture as a livelihood strategy to cope better with climate change and developmental challenges experienced by resource-poor and food-insecure farmers, who have been bypassed by the green revolution. These farmers remain worse off due to their failure to realize conditions required for attaining the viability and sustainability of smallholder irrigation agriculture. The significance of the study, a definition of key terms in the study, and the limitations and organisation of the thesis were presented.

The analysis of the results of this study presented in Chapter Four is summarized in Figure 6.1. As shown in Figure 6.1, there are two categories of drivers and inputs that influence the organisational and operational processes that characterize smallholder irrigation schemes, namely external (exogenous) and internal (endogenous) drivers. These drivers are hierarchical in nature, ranging from available forms of capital at the local level to national and international support from government and international donor organisations. There are three categories of external drivers, namely regional, national and international drivers, whose inputs can play an important role in strategic development within a smallholder irrigation scheme. Regional drivers include provincial planning regulations and the community bylaws, rules and norms, which should not be violated. These factors play an important role in organisational development. At national level, there are government regulations and laws, as well as government support through the provision of infrastructure, extension services and credit institutions, including those that finance intermediaries and contract farming. Thus, at the broader scale, external support is needed in order for smallholder irrigation schemes to be viable and sustainable.

Endogenous drivers are institutional level variables and the available forms of capital. Institutional forces are composed of the IMC, WUA and scheme constitutions. The constitutions and committees in a scheme govern the operations of households in the scheme. Forms of capital determine the viability and sustainability of schemes and constitute the basis for livelihood. They also determine the extent to which households are vulnerable to environmental stressors, like drought and depressed market prices and the macro-economic challenges facing Zimbabwe. As shown in Figure 6.1, the three levels of organization that define the operations of the scheme are

interlinked. This enables input at one level to filter to the other two levels. For instance, poor access to any form of capital at household level might deprive the organizational level of development viability, and eventually make it impossible for strategic development to take place, suggesting that the linkages between the three levels are synergistic. Without players at the local level, none of the best policies that government can draw up will make strategic development in the smallholder irrigation sector successful. Similarly, no amount of donor support can substitute the role of local players in any development setting. The implication of this reality is that there is a need to find ways through which farmers and other local players in smallholder irrigation schemes can succeed in maintaining their operations without external support. If such ways could be found, they would help to unlock the sustainability of the schemes. Farming organizations, including smallholder irrigation schemes, should be built by empowered farmers and other local players. It should be noted that a scheme has both internal and external forces. The ability of farmers to organize themselves or to organise their operations depends on internal factors like competency of the IMC, WUA, efficient operational systems, and access to training and sound financial systems. The ability of the farmers to relate to external stakeholders such as donors, credit institutions, government policy, farmers' coops, markets and competitors is also critical for mapping the viability and sustainability of the schemes.

The Viability-Sustainability Model derived from this research study could be useful in smallholder irrigation policy planning in Zimbabwe. The systems approach employed, with inputs, processes and outputs defined, reveals a complete network of activities that contribute to level of viability, sustainability and vulnerability of schemes. On the other hand the Sustainable Livelihood Framework revealed linkages between forms of capital and how they contribute to the viability and sustainability of smallholder irrigation schemes, as well as the vulnerability of the farmers in these schemes.

Based on this analysis, it can be concluded that in all the four smallholder irrigation schemes, viability is a function of governance and coherence, financial management capability and technical, and water resources management capability, as well as a variety of forms of capital, all of which are interconnected into a single system. Under these circumstances, in order to enhance the viability and sustainability of smallholder irrigation schemes some policy changes might be necessary.

A close analyzes of the data through qualitative and quantitative approaches reflects a strong link with the SLF as various forms of capital are positively contributing to an increased number of plot holders producing yields above scheme average, which is an indication of a positive livelihood outcome.

#### **6.4 POLICY RECOMMENDATIONS**

A number of policy recommendations relating to the strengthening of viability and sustainability of smallholder irrigation schemes can be drawn from this study. These include among other things:

- Farmer empowerment by AGRITEX through training on the management of social, financial and physical capital is advisable so that farmers will become more efficient and more productive as well as more self-reliant, and become less dependent on external support. This will also enable the farmers to cope better with the hostile climatic conditions that prevail in the agro-ecological environment where are based, particularly those related to scarcity of water.
- Farmers should be organized into co-operatives to ensure strategic development of the schemes. Strategic development would link community rules and regulations to official agencies like chiefs, headman and councillors with the scheme constitutions. This linkage enhances coherence among farmers, and between farmers and their social environment.
- There should be a comprehensive network linking individual farmers, organizations and system levels that creates downward, upward and horizontal linkages within smallholder irrigation schemes. Horizontal, internal and external forces should have a positive influence on farmers at an organization and system level, as shown in Figure 6.1.
- The Smallholder Irrigation Viability-Sustainability Model should be considered for use in current and future irrigation schemes in Zimbabwe for sustainability and sustainable development.

## 6.5 AREAS FOR FURTHER STUDY

Whereas the results of this research have revealed the conditions that characterize the viability and sustainability of smallholder irrigation schemes in Bikita District, there are still a number of issues that need to be investigated regarding the viability and sustainability of smallholder irrigation agriculture in Zimbabwe.

- This study provided a comparative analysis of qualitative indicators affecting viability and sustainability of smallholder irrigation schemes. Only productivity under financial management and productivity dimension was quantitatively measured. Therefore, future studies may go a step further and examine the effects of quantitative variables such as quantity of fertilizer, land size and access to credit facilities by farmers on viability and sustainability.
- The study also assessed how financial management practices like ability to save money, budgeting, accounting for resources and reporting are central to the operations of farmers in the schemes. Inflows of different forms of capital have never been weighed against the outflows of the schemes. Future studies providing detailed cost-benefit analyses and how they relate to viability and sustainability of smallholder irrigation schemes should be undertaken.
- In the face of climate change within the study area, which falls in semi-arid agro-ecological region four, availability of water is a critical factor, affecting viability and sustainability of smallholder irrigation. Only farmers' perceptions on water conveyance efficiency were assessed in this study and no measurements were carried out to determine its contribution to viability and sustainability. Therefore, future studies need to focus on the quantitative analysis of water conveyance efficiency on the viability and sustainability of smallholder irrigation schemes.
- Appreciation of product marketing in smallholder irrigation schemes is in its infant stage. The predominance of intermediaries overrides farmers' initiatives in the trading of agricultural produce. Therefore, future studies need to focus in greater detail on the comparative analysis of middlemen-led, farmer-led produce marketing,

and their contribution to the viability and sustainability of smallholder irrigation schemes.

- Lastly, with the challenges that farmers experience in marketing their produce, especially perishable products, the post-harvesting techniques used to preserve unsold produce in smallholder irrigation schemes need to be fully investigated. Consequently, future research needs to be done to assess the potential contribution of post-harvesting techniques of perishable produce towards the profitability, viability and sustainability of smallholder irrigation schemes.

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7. How useful are your institutions in the management of the scheme?-----  
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-----  
-----  
-----

8. Is your scheme viable and sustainable?            Yes            No

8b. Justify your answer above:

**C. METHODS OF EVALUATIONS**

9. Do you have the indicators that you are familiar with in assessing viability and sustainability?

Yes             No

10. If yes, state the indicators that you are familiar in assessing viability and sustainability in your scheme.

11. Among the indicator categories below, tick whether you are familiar with the criteria or not in your scheme.

Technical capacity	<input type="checkbox"/>	financial management	<input type="checkbox"/>
Governance	<input type="checkbox"/>	farm profitability	<input type="checkbox"/>
Water resources management	<input type="checkbox"/>		
Social coherence	<input type="checkbox"/>		

11b. To what extent have they been familiar in your in schemes?-----  
-----  
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12. Below is a marked semantic differential scale (sustainability test)

The assessment takes 12 dimensions into consideration, and the score should reflect the level of agreement with the statement. The following scores should be applied: 1=unsatisfactory to 5=excellent. **Please note that the scores may only be regarded as a tentative indication, not as an exact measurement. Any attempt to calculate average values, etc., will be misleading and should be avoided.**

**Dimension of Viability and Sustainability Assessment**

**SCORE**

		1	2	3	4	5	Comments
<b>1</b>	<b>ORGANISATIONAL STRATEGY</b>						
	<ul style="list-style-type: none"> <li>Those responsible for institution have a clear idea of its role and purpose.</li> </ul>						
	<ul style="list-style-type: none"> <li>The institution has a set of goals that are relevant to country needs</li> </ul>						
	<ul style="list-style-type: none"> <li>Has a realistic set of goals and level of ambition</li> </ul>						
	<ul style="list-style-type: none"> <li>Goals and strategies are clear to all staff</li> </ul>						
	<ul style="list-style-type: none"> <li>Institution has freedom of action to change and adapt to new demands</li> </ul>						
<b>2</b>	<b>ORGANISATIONAL MANAGEMENT</b>						
	<ul style="list-style-type: none"> <li>Capability of executive bodies</li> </ul>						
	<ul style="list-style-type: none"> <li>Systems and procedures</li> </ul>						
	<ul style="list-style-type: none"> <li>Organisational structure</li> </ul>						

3	<b>FINANCIAL RESOURCES MANAGEMENT</b>						
	<ul style="list-style-type: none"> <li>level of external support</li> </ul>						
	<ul style="list-style-type: none"> <li>Accounting &amp; Financial reporting</li> </ul>						
	<ul style="list-style-type: none"> <li>Savings</li> </ul>						
	<ul style="list-style-type: none"> <li>Auditing of resources</li> </ul>						
	<ul style="list-style-type: none"> <li>Input costs and product prices</li> </ul>						
4	<b>INFRASTRUCTURE</b>						
	<b>Technical infrastructure maintenance</b>						
	<ul style="list-style-type: none"> <li>Storage tanks</li> </ul>						
	<ul style="list-style-type: none"> <li>Pipe</li> </ul>						
	<ul style="list-style-type: none"> <li>Hydrant</li> </ul>						
	<ul style="list-style-type: none"> <li>Scheme gate</li> </ul>						
	<ul style="list-style-type: none"> <li>Ablution bock</li> </ul>						
	<ul style="list-style-type: none"> <li>Security fence</li> </ul>						
	<b>Administrative services</b>						
	<ul style="list-style-type: none"> <li>Water conveyance efficiency</li> </ul>						
<ul style="list-style-type: none"> <li>Water rationing</li> </ul>							
<ul style="list-style-type: none"> <li>Crop scheduling</li> </ul>							

	<ul style="list-style-type: none"> <li>• Technical extension services</li> </ul>						
5	<b>PERFORMANCE</b> <ul style="list-style-type: none"> <li>• Performance and productivity(CBA)</li> </ul>						
	<ul style="list-style-type: none"> <li>• Performance demands and control</li> </ul>						
6	<b>COMPETENCE</b> <ul style="list-style-type: none"> <li>• Institutional competence</li> </ul>						
7	<b>PERSONNEL</b> <ul style="list-style-type: none"> <li>• Technical personnel</li> </ul>						
	<ul style="list-style-type: none"> <li>• Managerial and administrative personnel</li> </ul>						
	<ul style="list-style-type: none"> <li>• Personnel policies, incentives and compensation</li> </ul>						
8	<b>CULTURE AND COMMUNICATION</b> <ul style="list-style-type: none"> <li>• Culture</li> </ul>						
	<ul style="list-style-type: none"> <li>• Communication, cooperation and authority</li> </ul>						
9	<b>LINKAGES /NETWORKS</b> <ul style="list-style-type: none"> <li>• Alliances and connections</li> </ul>						
	<ul style="list-style-type: none"> <li>• Competitors and rivals</li> </ul>						
	<ul style="list-style-type: none"> <li>• Relations to donors</li> </ul>						

10	<b>LEGAL AND POLITICAL FRAMEWORKS</b>						
	<ul style="list-style-type: none"> <li>• Legal basis and constraints</li> </ul>						
11	<b>ACCOUNTABILITY</b>						
	<b>ASSUMPTIONS ATTRIBUTION</b>						
	<ul style="list-style-type: none"> <li>• Scotch cat</li> <li>• Livestock</li> <li>• School fees</li> </ul>						
	<ul style="list-style-type: none"> <li>• Feedstock</li> </ul>						
12	<b>GOVERNANCE</b>						
	<ul style="list-style-type: none"> <li>• participation and legitimacy</li> </ul>						
	<ul style="list-style-type: none"> <li>• Local ownership and participation</li> </ul>						
	<ul style="list-style-type: none"> <li>• Legitimacy and trust in community</li> </ul>						
	<ul style="list-style-type: none"> <li>• Transparency</li> </ul>						
	<ul style="list-style-type: none"> <li>• Alignment with constitution</li> </ul>						
	<ul style="list-style-type: none"> <li>• Capacity of the IMC</li> </ul>						

Key: 1-unsatisfactory; 2-fair; 3- satisfactory; 4- good; 5-excellent

**13. Five-point Likert Scale perception tool on viability and sustainability evaluation framework for factors affecting scheme performance:**

**Table 2: Checklist: A tool for the assessment of viability and sustainability**

DIMENSION OF ASSESSMENT		SCORE					Comments
		1	2	3	4	5	
<b>1</b>	<b>Governance strategy</b>						
	<ul style="list-style-type: none"> <li>• Capacity of the IMC</li> </ul>						
	<ul style="list-style-type: none"> <li>• Level of alignment with the constitution</li> </ul>						
	<ul style="list-style-type: none"> <li>• M &amp;E</li> </ul>						
	<ul style="list-style-type: none"> <li>• Participation of actors</li> </ul>						
	<ul style="list-style-type: none"> <li>• Level of transparency in their operation</li> </ul>						
	<ul style="list-style-type: none"> <li>• Local ownership and participation</li> </ul>						
	<ul style="list-style-type: none"> <li>• Legitimacy and trust in community</li> </ul>						
	<ul style="list-style-type: none"> <li>•</li> <li>• Legal basis and constraints</li> <li>• Political support</li> </ul>						
<b>2</b>	<b>Technical capacity &amp; water resources management</b>						
	<ul style="list-style-type: none"> <li>• Level of operation and maintenance</li> </ul>						

	<ul style="list-style-type: none"> <li>•</li> <li>• Water rationing</li> </ul>						
	<ul style="list-style-type: none"> <li>• Crop scheduling</li> </ul>						
	<ul style="list-style-type: none"> <li>• Technical human resources</li> </ul>						
	<ul style="list-style-type: none"> <li>• Adequacy of water source</li> </ul>						
	<ul style="list-style-type: none"> <li>• Adequacy of integrated water resources management</li> <li>• Payment of water bills water</li> </ul>						
	<ul style="list-style-type: none"> <li>• conveyance efficiency</li> </ul>						
<b>3</b>	<b>Financial management &amp; productivity</b>						
	<ul style="list-style-type: none"> <li>• Use of budgets in programming</li> </ul>						
	<ul style="list-style-type: none"> <li>• Application of accounting systems</li> </ul>						
	<ul style="list-style-type: none"> <li>• Auditing</li> </ul>						
	<ul style="list-style-type: none"> <li>• Productivity of the scheme</li> </ul>						
	<ul style="list-style-type: none"> <li>• Quality standard of produce</li> </ul>						
	<ul style="list-style-type: none"> <li>• Ability to meet set targets</li> </ul>						
	<ul style="list-style-type: none"> <li>• Variability of crop outputs</li> </ul>						
<b>4</b>	<b>Social coherence</b>						
	<ul style="list-style-type: none"> <li>• Bureaucratic rules and norms conducive for performance</li> </ul>						
	<ul style="list-style-type: none"> <li>• Scheme ethnic conflict management</li> </ul>						
	<ul style="list-style-type: none"> <li>• Accountability</li> </ul>						

	• Attribution						
	• Assumption						
	• Alliances and connections						
	• Competitors and rivals						
	• Relations to donors						
	Totals						

Key: 1-unsatisfactory; 2-fair; 3- satisfactory; 4- good; 5-excellent

Adopted and modified from Oslo, 2000:27

13. a how effective are the use of indicators in schemes in achieving viability and sustainability.

---

13.b. What role do state and non state actors play in ensuring viability and sustainability of schemes?-----

13.c. What benefits are attributed to smallholder irrigation schemes?-----  
-----

13d. What are the production levels of the schemes per hectare per season?-----  
-----

13e. How profitable is your business in the market?-----  
-----

14. Since the official opening of this irrigation scheme, are there factors influencing viability and performance of the schemes.

Yes  No

15. If you say yes, what are the factors influencing viability and sustainability in your scheme?

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16. What would you suggest to guide the planning of smallholder irrigation schemes in Bikita?

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The end

## Appendix 2: Interview guide

- Identify the indicators currently used to assess viability and sustainability in smallholder irrigation agriculture.
- Determine the indicators of assessing viability and sustainability.
- To what extent have they been familiar with plot holders in schemes?
- How viable are the smallholder irrigation schemes in Bikita?
- How effective are the use of indicators in schemes in achieving viability and sustainability.

- 
- What role do state and non-state actors play in ensuring viability and sustainability of schemes?-----  
-----
  - What benefits are attributed to smallholder irrigation schemes?-----  
-----
  - What are the production levels of the schemes per hectare per season?-----  
-----
  - How profitable is plot holders' business in the market?-----  
-----
  - Determine the factors the influence viability, performance and sustainability the schemes.
  - What would you suggest to guide the viability and performance planning of smallholder irrigation schemes in Bikita?

-----  
The end

**Appendix 3: Focus-group discussion guide**

1 Do you have indicators that you are familiar with in assessing viability and sustainability in your scheme?

Yes  No

If no, how about the following:

-----

If yes, state the indicators that you are familiar with, in assessing viability, performance and sustainability effectiveness.-----

-----

-----

----

2. To what extent are plot holders familiar with the indicators in the schemes? -----

-----

-----

3. Comment on the statement below:

**ORGANISATIONAL STRATEGY**

- Those responsible for institution have a clear idea of its role and purpose.
- The institution has a set of goals that are relevant to country needs
- Has a realistic set of goals and level of ambition
- Goals and strategies are clear to all staff
- Institution has freedom of action to change and

adapt to new demands

## **ORGANISATIONAL MANAGEMENT**

- Capability of executive bodies
- Systems and procedures
- Organisational structure

## **FINANCIAL RESOURCES MANAGEMENT**

- Level of external support
- Accounting & Financial reporting
- Savings
- Auditing of resources
- Input costs and product prices
- Economic independence

## **INFRASTRUCTURE**

### **Technical infrastructure maintenance**

- Storage tanks
- Pipe
- Hydrant

- Scheme gate
- Ablution bock
- Security fence

#### **Administrative services**

- Water conveyance efficiency
- Water rationing
- Crop scheduling
- Technical extension services

#### **PERSONNEL**

- Technical personnel
- Managerial and administrative personnel
- Personnel policies, incentives and compensation

#### **CULTURE AND COMMUNICATION**

- Culture
- Communication, cooperation and authority

#### **LINKAGES/NETWORKS**

- Alliances and connections

- Competitors and rivals
- Relations to donors

## **LEGAL AND POLITICAL FRAMEWORKS**

- Legal basis and constraints
- Political support

### **Accountability**

### **Assumptions**

## **ATTRIBUTION**

- Scotch cat
- Livestock
- School fees
- Food stocks
- Linkages with stakeholders

## **Governance**

- participation and legitimacy
- Local ownership and participation
- Legitimacy and trust in community

- Transparency
- Alignment with constitution
- Capacity of the IMC

5a. a how effective are the use of indicators in schemes in achieving viability and sustainability.

---

5b. What role does state and non-state actors play in ensuring viability and sustainability of schemes? -----

5c. What benefits are attributed to smallholder irrigation schemes?-----  
-----

5d. What are the production levels of the schemes per hectare per season?-----  
-----

5e. How profitable is your business in the market. -----

6. What are the factors that influence viability and performance of smallholder irrigation schemes in Bikita?

-----  
-----  
-----  
-----

7. What would you suggest to guide the planning of smallholder irrigation schemes in Bikita?

-----  
-----  
-----  
-----

The end

#### Appendix 4: Computer-generated random number tables

Rozva		Mashoko		Chinyamatumwa		Shereni
76		125		16		12
32		111		117		18
62		33		49		24
4		9		31		19
70		113		121		26
90		64		65		28
90		11		74		17
81		30		1		5
52		38		21		2
72		127		30		18
61		51		88		5
42		50		90		43
58		10		35		22
1		55		136		41
9		65		58		2
55		4		50		27
43		24		39		41
42		127		25		24
23		55		4		18
15		70		49		41
30		108		29		8
95		32		8		33
47		79		107		36
28		115		48		13
68		56		118		32
81		31		35		8
36		93		122		28
54		93		75		41
86		71		41		37
16		95		90		36

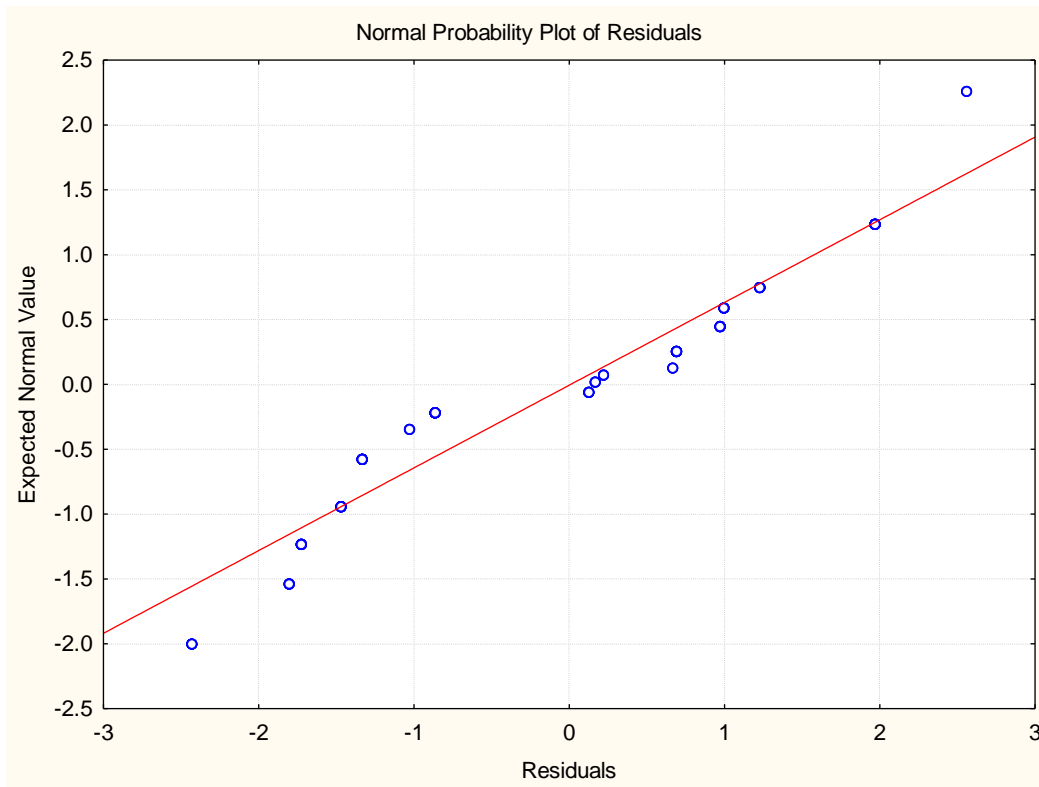
27		66		134		30
21		73		56		36
82		110		58		40
67		23		9		5
3		120		74		28
62		115		109		34
83		6		129		8
29		96		113		38
44		18		122		36
55		71		113		15
34		53		118		4
44		72		66		11
91		8		34		29
34		5		109		
52		51		98		
13		73		21		
38		58		12		
8		122		41		
59		52		136		
16		33		19		
46		31		2		
87		65		42		
65		46		70		
1		117		70		
18		93		56		
46		79		25		
38		35		78		
69		59		93		
34		27		65		
59		54		115		
69		21		86		
52		7		38		
91		62		104		

5		30		91		
75		121		67		
74		123		124		
67		110		78		
56		103		80		
35		21		25		
23		91		112		
63		120		63		
64		109		136		
22		90		101		
11		66		73		
79		14		23		
16		92		115		
72		32		124		
13		52		89		
31		111		63		
6		118		54		
71		28		54		
69		93		100		
78		119		37		
39		113		134		
21		119		3		
95		93		28		
14		17		57		
13		123		131		
64		5		50		
55		55		14		
61		49		24		
26		57		69		
36		96		20		
42		99		129		
22		70		4		
		25		107		

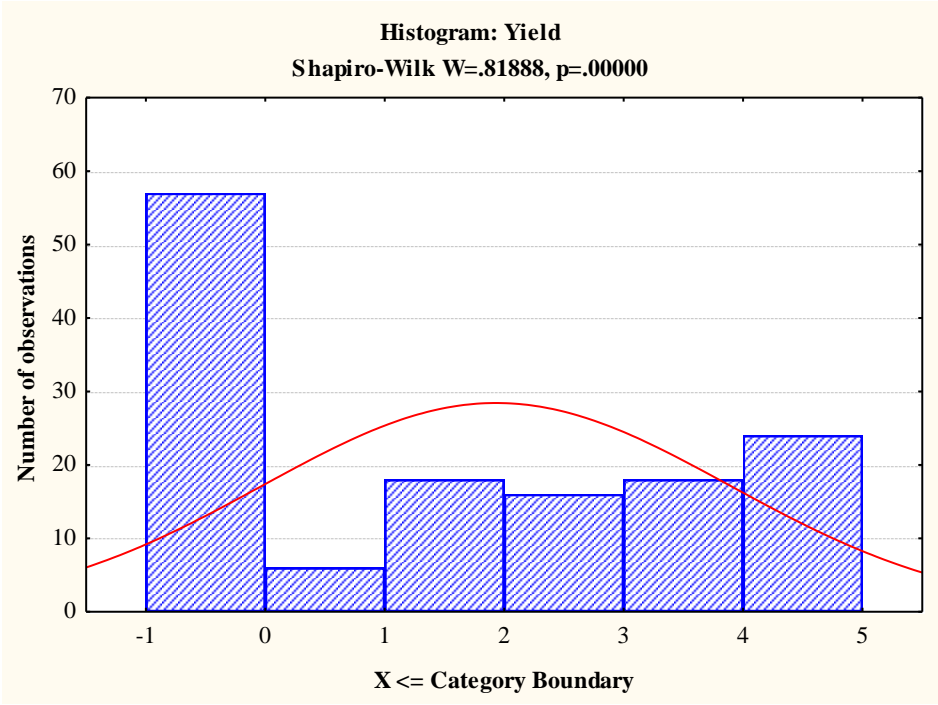
		55		116		
		89		21		
		80		74		
		7		124		
		37		121		
		127		123		
		31		90		
		97		5		
		44		88		
		26		30		
		91		68		
		87		44		
		86		20		
		124		87		
		99		11		
		32		95		
		86		15		
		116		89		
		65		58		
		78		98		
		74		99		
		8		31		
		45		111		
		21		31		
		54		130		
		29		19		
		85		79		
		39		77		
		9		122		
		102		73		
		53		22		
		89		136		
				81		

				68		
				118		
				11		
				82		
				10		
				28		
				104		

**Appendix 5: Normality plot for residuals for maize output**



**Appendix 6: Test for normality histogram (maize output)**



**Appendix 7: plates 4.1 to 4.11**



**Plates 4.1 Unprotected and subserviced storage water reservoir (Shereni)**



**Plates 4.2** : Poorly maintained, unprotected and exposed hydrants (Shereni)



**Plate 4.3: Subserviced canals with cracks and weeds growing inside (Shereni)**



**Plate 4.4: Poorly maintained broken and leaking pipes (Rozva)**



**Plate 4.5: Poorly maintained broken and leaking pipes (Rozva) with Hiscyth, showing that it has been like that for some time**



**Plate 4.6: Untreated wooden posts prone to termites attack and susceptible to elements of weather (Chinyamatumba)**



**Plate: 4.7: Widely spaced posts without fireguards (Shereni)**



**Plate 4.8: Poorly maintained gate exposing crops to attacks by domestic and wild animals (Rozva)**



**Plate 4.9: Insufficient and risk toilet for farmers and insensitive to gender (Rozva)**



**Plate 4.10: The same type and variety of crops has different colours and quality to show unreliability of extension worker to farmers resulting in unsustainability of the scheme (Mashoko)**



**Plate 4.11: No close monitoring over their farmers; thus poor spacing between maize and vegetables grown at the same time in the field (Mashoko)**



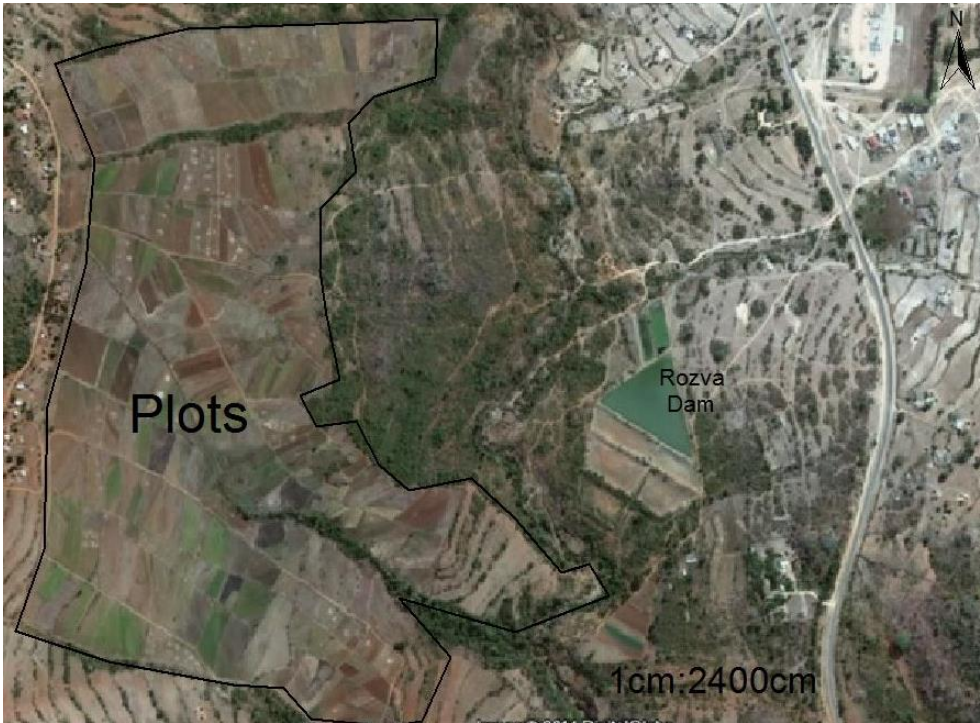
**Scale: 1:2400**

**Figure 4.3: Google Image of Mashoko Dam and the Scheme Plots (25 October, 2014)**



**Scale: 1: 2400**

**Figure: 4.4 Google Image of Shereni Dam and the Scheme Plots (25 October, 2014)**



**Scale: 1:2400**

**Figure 4.5: Google Images of Rozva Dam and the Scheme (25 October, 2014)**

## Appendix 8: Statistical table used in the study

### t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
<b>Z</b>	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	<b>Confidence Level</b>										

## Appendix 9: AGRITEX Data for Maize Production

MASHOKO			
Year	1st quater	2nd quarte	3rd quarter
Year1	5	3	1
Year2	4.5	5	1
Year3	4	4	4
Year4	7	6	2
Year5	8	5	2

ROZVA			
Year1	10	3	2
Year2	2	1.8	1
Year3	0.5	0.7	0.6
Year4	3.3	4	1.1
Year5	2	2.7	1.3

SHERENI			
Year1	4	2	0
year2	1.5	1.5	1.5
year3	2	2	2
year4	5	2.5	0

**maize**

## Appendix 10: AGRITEX data for wheat production

MASHOKO			
Year	1st quater	2nd quarte	3rd quarter
Year1	1	1	1
Year2	1	2	0
Year3	1.2	1.8	0.6
Year4	1.1	0.05	0.1

SHERENI			
Year	1st quater	2nd quarte	3rd quarter
Year1	2	1	0
Year2	1	1	1
Year3	1.5	0.8	0.7

ROZVA			
Year	1st quater	2nd quarte	3rd quarter
Year1	4	1	1
Year2	1	0.6	0.2
Year3	0.1	0.05	0

**wheat**

## Appendix 11: Influence of socio-demographic conditions on maize and wheat yields

Table 13: Influence of socio-demographic conditions on maize and wheat yields

Name of Scheme	Socio-demographic characteristics		Total No of plot holders (%)	Level of productivity			
	Variable	Category		Proportion of plot holders with yields exceeding scheme average (%)		Proportion of plot holders with yields below average (%)	
				maize	wheat	maize	wheat
	Age	0-15	-	-		-	
		16-25					
		26-35	20.45	0	0	100	100
		36-45	59.09	65.38	65.38	34.62	34.62
		>46	20.45	0	0	100	100
	Gender	Male	80	73	48.57	27	51.43
		Female	20	0	0	100	100
	Marital status	Single					
		Married	100	38.64	38.64	38.64	38.64

Mashoko		Divorced					
	Level of education	Primary or less					
		Form 2					
		Ordinary level					
		Advanced level					
		Tertiary	100	38.64	38.64	61.36	61.36
Rozva	Age	0-15					
		16-25					
		26-35					
		36-45	78.79	50	46.15	50	53.85
		>46	21.21	0	14.29	100	85.71
	Gender	Male	63.64	33.3	33.3	66.7	66.7
		Female	36.36	50	50	50	50
	Marital status	Single					
		Married	100	39.39	39.39	60.61	60.61
		Divorced					
		widowed					

	Level of education	Primary or less					
		Form 2	21.21	0	14.29	100	85.75
		Ordinary level	36.36	50	50	50	50
		Advanced level					
		Tertiary	42.42	50	42.86	50	57.14
Shereni	Age	0-15					
		16-25					
		26-35	60	66.66	22.22	33.33	77.78
		36-45	20	100	33	0	67
		>46	20	100	100	0	0
	Gender	Male	80	75	25	25	75
		Female	20	100	100	0	0
	Marital status	Single	20	100	33.3	0	66.7
		Married	60	66.7	22.22	33.3	77.78
		Divorced					
		widowed	20	100	100	0	0
	Level of education	Primary or less	20	100	100	0	0

		Form 2					
		Ordinary level					
		Advanced level					
		Tertiary	80	75	25.05	25	74.95

NB: Scheme average yields (t/ha): Mashoko: maize (4.07) wheat (1, 01), Rozva: maize (2.04), wheat (1.03), Shereni: maize (2), wheat (1.16)

## Appendix 12: Socio-demographic data with calculated scheme average yields

age	scheme	sex	qualificat	marital	stat	position	int	ViabilitySu	maizeyield	wheat	average/sc
3	4	1	6	2	3	1	2	1	2	1	0
3	4	1	6	2	3	1	1.5	0	1	1	0
5	4	2	2	4	2	2	2	1	1.5	1	1
3	4	1	6	1	2	1	2.5	1	1.2	1	1
4	4	1	6	2	3	1	2	1	1	1	0
3	4	1	6	2	3	1	2	1	1	1	0
3	4	1	6	2	3	1	1.5	0	1.5	1	1
5	4	2	2	4	2	2	2	1	1.2	1	1
3	4	1	6	1	2	1	2.5	1	1	1	0
3	4	1	6	2	3	1	2	1	1	1	0
3	4	1	6	2	3	1	1.5	0	1	1	0
5	4	2	2	4	2	2	2	1	1.5	1	1
3	4	1	6	1	2	1	2.5	1	1	1	0
4	4	1	6	2	3	1	2	1	1.5	1	1
4	4	1	6	2	3	1	2	1	1	1	0
									2	1.16	
4	3	1	6	2	3	1	5	1	2		
5	3	1	3	2	2	2	1.6	0	0.6		
4	3	1	6	2	2	1	0.6	0	0.05		
4	3	2	4	2	6	2	2.8	1	2		
4	3	2	4	2	6	1	0	0	0.6		
4	3	1	6	2	3	1	5	1	2		
5	3	1	3	2	2	2	1.6	0	0.6		
4	3	1	6	2	2	1	0.6	0	0.05		
4	3	2	4	2	6	2	2.8	1	2		
4	3	2	4	2	6	1	0	0	0.6		
4	3	1	6	2	3	1	5	1	0.05		
5	3	1	3	2	2	2	1.6	0	0.6		
4	3	2	4	2	6	1	0	0	0.6		
4	3	2	4	2	6	2	2.8	1	2		
4	3	1	6	2	3	1	5	1	2		
5	3	1	3	2	2	2	1.6	0	0.6		
4	3	1	6	2	2	1	0.6	0	0.05		
5	3	1	3	2	2	2	1.6	0	0.6		
4	3	2	4	2	6	1	0	0	0.6		
4	3	2	4	2	6	2	2.8	1	2		
4	3	1	6	2	3	1	5	1	2		
4	3	1	6	2	2	1	0.6	0	0.05		
5	3	1	3	2	2	2	1.6	0	0.6		
4	3	2	4	2	6	1	0	0	0.6		
4	3	1	6	2	2	1	0.6	0	0.05		
5	3	1	3	2	2	2	1.6	0	0.6		
4	3	2	4	2	6	1	0	0	0.6		
4	3	1	6	2	2	1	0.6	0	0.6		
									2.036364	1.034848	
5	2	1	6	2	4	1	3	1	1		
3	2	2	6	2	3	1	3.5	1	1		
4	2	1	6	2	3	1	4	1	1.2		
4	2	1	6	2	3	1	5	1	0.7		
4	2	1	6	2	3	1	5	1	1.2		
5	2	1	6	2	4	1	3	1	1		
3	2	2	6	2	3	1	3.5	1	1		



