

Analysis of the constraints faced by small-scale irrigation farmers in achieving household food security: A case study of Masholomoshe and Makwe irrigation schemes in Gwanda District, Matabeleland South Province, Zimbabwe.

A mini-dissertation submitted by

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To the

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Declaration

I Ndlovu Langelihle hereby declare that this research mini-dissertation for Masters of Science in Agriculture Economics at the University of Venda hereby submitted by me, has not been submitted previously for a degree at this university or any other university, that it is my own work in design and in execution, and that all reference material contained therein has been duly acknowledged.

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Abstract

The study analysed the constraints faced by small-scale irrigation farmers on household food security in drought prone agro-ecological region 5, Gwanda district. The study conducted a case study of Masholomoshe and Makwe irrigation schemes in Gwanda district of Matabeleland south province in Zimbabwe. The main objective was to analyse the impact of the constraints faced by small-scale irrigation farmers on household food security. The study looked at the socio-economic factors, production levels, role of supporting institutions and the constraints faced by farmers. Primary data was collected using interview questionnaires with open and closed ended questions. Questionnaires were designed based on objectives and research questions. Key informant interviews were also carried out with the extension officers. The data was captured and analyzed using statistical package for social scientist (SPSS). Descriptive statistics, gross margin, multiple linear and binary logistic regression models were all used to analyse the data.

The study established the dominance of women and the elderly who are less educated farmers, use of rented land and farming as the main source of income. The study also revealed that farmers were not able to grow crops throughout the year and they obtained very small net farm incomes. The main supporting service that the farmers were getting was the assistance from the extension workers and their main constraints were high water costs, shortage of water, lack of access to credit, lack of inputs and output markets, lack of relevant training and information and damage to irrigation infrastructure. Inferential statistical analyses detected a negative impact of household size, area cultivated, total yield, and quantity sold to household food security while total income, land tenure, access to credit and extension services had a positive impact. Amongst others the study recommended financial assistance to farmers in form of subsidies on input prices, low interest loans, and skills transfers. Farmers could also be assisted to construct water storage facilities such as dams and water tanks.

encouragement, guys you were a perfect family to me.

Lastly but not least, I would like to thank God for all the guidance and protection, for with Him all things are possible!!

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ABDA	Agricultural and Rural Development Authority
AREX	Department of Research and Extension Services
CC	Chiefs' Councils
DDF	District Development Fund
FAO	Food and Agriculture Organisation
GOZ	Government of Zimbabwe
IFAD	International Fund for Agricultural Development
MARD	Ministry of Agriculture and Rural Development
NGO	Non-Governmental Organisation
ODI	Organization Development Institute
O&M	Operations and Management
PTO	Permission to occupy
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
SWAZI VAC	Swaziland Vulnerability Assessment Committee's survey
W&RP	World Bank's Rural Portfolio
WCD	World Commission on Dams
WFP	World Food Programme
WUA	Water User Association
ZAPF	Zimbabwe Agricultural Policy Framework
ZINWA	Zimbabwe National Water Authority

List of Acronyms

ARDA	Agricultural and Rural Development Authority
AREX	Department of Research and Extension Services
CC	Catchment Councils
DDF	District Development Fund
FAO	Food and Agriculture Organisation
GOZ	Government of Zimbabwe
IFAD	International Fund for Agricultural Development
MARD	Ministry of Agriculture and Rural Development
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SPSS	Statistical Package for Social Sciences
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WCD	World Commission on Dams
WFP	World Food Programme
WUA	Water User Association
ZAPF	Zimbabwe Agricultural Policy Framework
ZINWA	Zimbabwe National Water Authority

CHAPTER ONE

INTRODUCTION

1.1 Background

Irrigated agriculture is one of the critical components of world food production, which has contributed significantly to maintaining world food security and to the reduction of rural poverty (FAO, 2008). Empirical studies have shown that 17 percent of global agricultural land is irrigated and contributes about 40 percent of the global production of cereal crops (World Bank, 2009). Irrigation developments have been recommended as a powerful tool to enhance agricultural productivity and poverty reduction in dry areas (Miele, 2008).

However, in most developing countries, irrigation development fails to achieve the intended objective. Some studies point out that properly implemented smallholder irrigation, with appropriate technologies, may have a considerable potential in improving rural household food security, although the viability of such irrigation schemes becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Shah, 2007).

FAO (2008) pointed out that many Sub-Saharan countries have realized the critical role of irrigation in food production. However, a number of constraints, including the relatively high cost of irrigation development, inadequate physical infrastructure and markets, poor investments in irrigation, lack of access to improved irrigation technologies and lack of cheap and readily available water supplies, have been responsible for a relatively slow rate of irrigation development in this region. FAO (2008) identified further constraints that affect the capacity of farmers to invest and manage irrigation projects as the poor resource base for farmers, fragmented and the small size of land holdings, unsecured or lack of land titles, high interest rates and poor transportation and marketing facilities.

A number of evaluation studies suggest that formal smallholder irrigation schemes in Zimbabwe (either community- or government-managed) have poor performance records and are not sustainable (Chazovachii, 2012). Problems identified include poor water utilisation in terms of its timeliness and adequacy to the field, and poor water application to the field (Manzungu, 2007).

Crop yields in small scale irrigation farms have been low and way below those achieved in the commercial farming sector. Poor agricultural performance has translated into poor financial and economic viability, thereby necessitating heavy government subsidies of up to 75% in some cases. The problem, according to Rukuni and Eicher (2006), is the inappropriate conventional budgeting technique, which ignores the sub-sector's unique history. Meinen-Dick *et al.* (2007), however, emphasise that agro-economic performance of smallholder irrigation schemes depends on a number of factors such as plot size, level of education of plot holders, access to markets and management structure. It is important to highlight that the state continued the colonial practice of controlling all irrigated activities in the schemes. For example, farmers were required to follow set cropping programmes, and irrigation schedules (Manzungu, 2007).

The Government of Zimbabwe (GOZ) recognises the role of irrigation development as a key drought mitigation measure. Tremendous strides have been made by the government, the private sector and the donor community in the area of irrigation development since independence in 1980 (Rukuni *et al.*, 2006). However, smallholder farmers in Gwanda District in Zimbabwe face food insecurity on an annual basis due to a combination of erratic rainfall (180 - 850 mm/a over a 30 year time series) and insufficient production in irrigation schemes in the area. This impacts both on household livelihoods and national food security (Meinen-Dick *et al.*, 2007). Literature shows that little has been done in finding out the causes of this problem of food insecurity given many small-scale irrigation schemes found in the area. It is because of these concerns that a study should be carried out in the area to investigate the constraints that hinder small scale irrigation schemes from achieving household food security.

1.2 Problem statement

Irrigation is being used in many countries especially in most developing countries like Zimbabwe to address the problem of food insecurity. Many studies have proved that small-scale irrigation indeed plays a vital role in enhancing food security (Chazovachii, 2012). Policies on irrigation have been redesigned to increase food security and improve livelihood initiatives amongst farming communities in Zimbabwe. A significant amount of investment on irrigation development and rehabilitation has been done since the country's independence in 1980. Non-governmental organisations such as World Vision, CARE international and IFAD have also contributed by supporting these schemes in every way possible. Therefore, households on irrigation schemes should be among the better-off because there is so much effort and investment that have been put in rural water supply for irrigation purposes in order to improve rural household's food security through improved productivity (Assefa, 2008).

However, despite all these efforts and investments, tons of food aid flow into Gwanda District every year due to rising food insecurity that prevails in the area. On the ground, these irrigation schemes do not seem to be performing up to standard. Irrigation has been successful in many countries raising the question why Masholomoshe and Makwe small-scale irrigation schemes in Gwanda District are not performing up to expectations. The study will, therefore, focus on critical economic constraints that are faced by Masholomoshe and Makwe small-scale irrigation schemes, and their impact on household income and food security. However, farm income will be used as a proxy for household food security. Therefore, it is assumed that the larger the farm income a farmer obtains, the more access the farmer have to food hence food security.

1.3 Objectives of the study

1.3.1 Broad objective of the study

The main objective of the study is to determine the critical constraints faced by small scale irrigation schemes farmers and their impact in achieving household food security.

1.3.2 Specific objectives are to:

- Determine the socio-economic factors of small scale irrigation farmers in Masholomoshe and Makwe irrigation schemes that affect household food security;
- Determine and compare the farm incomes from food crops in Masholomoshe and Makwe small-scale irrigation schemes;
- Assess the role played by supporting institutions in helping farmers to achieve household food security
- Determine the major constraints faced by irrigators and their impact in achieving household food security and improved livelihoods.

1.4 Research questions

- What is the impact of the socio-economic factors of small-scale irrigation farmers on household food security?
- What is the difference in farm incomes from food crops between Masholomoshe and Makwe small-scale irrigation schemes;
- What is the role played by supporting institutions in helping irrigation farmers achieve household food security?
- What are the major constraints faced by irrigators and their impact in achieving household food security and improved livelihoods?

1.5 Research hypothesis

- There is no significant impact of socio-economic factors on household food security of small-scale irrigation farmers.
- There is no significance difference between farm incomes of Masholomoshe and Makwe Small-scale irrigation schemes
- Supporting institutions play a significant role in helping irrigation farmers achieve household food security
- There is no significant relationship between the constraints faced by the small-scale irrigation farmers and their household food security.

1.6 Conceptual framework

The Neo-classical theory of demand can be used to provide a framework for how a household uses irrigation water to maximise household food security. Treating the household as a profit maximising firm, a household will employ an input if the added benefit provided is greater than the added cost of the input. Effectively, this means that the level of input use will occur until the marginal benefit is equal to the marginal cost. Applying this concept to the small-scale irrigation households, the household will use irrigation up to the point where the cost of an additional unit of irrigation just equals the added value its use produces. However, in regions where there is no water market, there is no explicit price for irrigation water. In this situation, the cost of irrigation can be represented by the labor cost of irrigating. Furthermore, for rural households, labour markets are often missing or ineffective, forcing households to be self –dependent with regard to their labour supply (Namara *et al.* 2007).

Literature on agricultural technology adoption identifies a number of factors affecting the decision to participate in irrigation farming (FAO, 2009). These factors include the physical, natural, human, social, community and financial assets of the agricultural household. Characteristics of the household, especially those of the household head are major deciding factors on whether to participate in irrigation farming or not. In particular, the household head's age, gender, level of education and household size influences the attitude one may have towards irrigation farming, (Bishir, 2004). Household size is also essential for determining the availability of labor to the irrigating household (FAO, 2006).

Information plays an important role in the efficiency and decision-making in order to improve productivity through small-scale irrigation (Feder, Just and Zilberman, 2010). Information regarding the use, productivity and input use and management of small-scale irrigation schemes contributes to improving household food security. The extent of the farmer's information about irrigation production is proxied by the number of irrigation meetings, extension or agricultural fair events attended, as well as the resources at the farmer's disposal.

The quality and topography of land can also influence the productivity of irrigation schemes (Zhou, 2008). It is believed that the farmer is more likely to achieve household food security if his land is good enough to produce a good return. Land tenure also influences the level of productivity of small-scale irrigators. The security of land tenure also affects the expected returns from investments in the land. Similarly, secure land rights reduce the risk of losing one's investment in the land. This therefore, increases the willingness of the farmer to participate and increase production in irrigation farming (Feder *et al.*, 2010).

Substantial literature has shown the importance of irrigation as a major driving force behind the increase in rural household income and food security. These studies attest to irrigation expansion as the main policy intervention strategy for alleviating rural household food insecurity and poverty. Figure 2.1 below provides a summary of the above description.

1.7 Delimitation and limitation of the study

1.7.1 Delimitation of the study

Due to limited time and budget, the study focused on only two of the 8 irrigation schemes available in the district. Interviews were conducted with small-scale irrigators, key informants and service providers.

1.7.2 Limitation of the study

The possible threats for the study were that farmers would give biased information that would make them seem worse-off in anticipation of food aid or donor support. The key informants may also be biased when giving information to hide their inefficiencies.

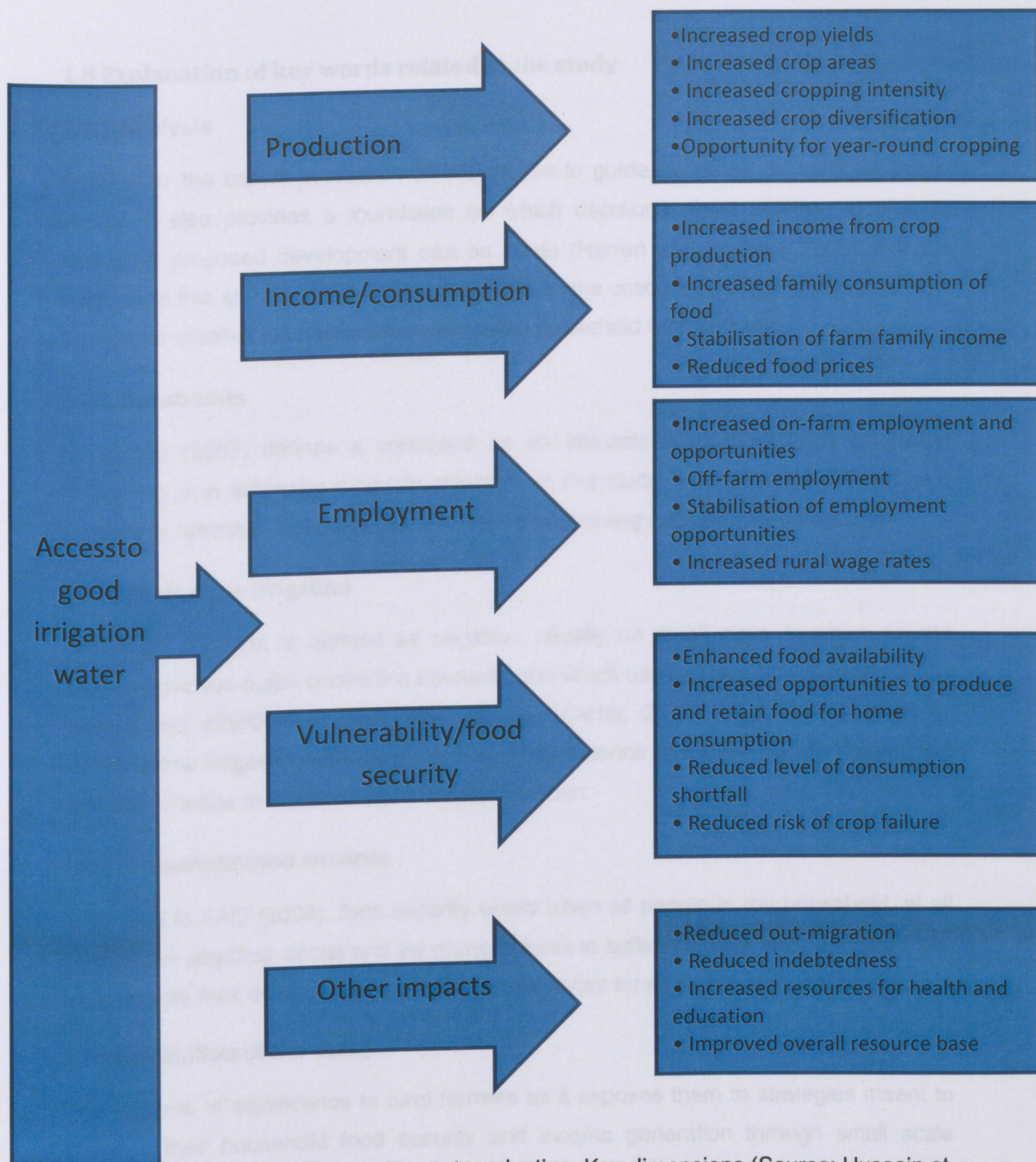


Figure 1 Agricultural water and poverty reduction: Key dimensions (Source: Hussain et al., 2004).

1.8 Explanation of key words related to the study

1.8.1 Analysis

Analysis is the critical evaluation of information to guide decisions on complex public issues. It also provides a foundation on which decisions about whether to alter or change a proposed development can be made (Herren and Watson, 2006). For the purpose of this study, analysis can be defined as the critical evaluation of the problems that hinder small-scale farmers from achieving household food security

1.8.2 Constraints

Manzungu (2007) defines a constraint as an obstacle or a difficulty in accessing something or in achieving a certain objective. In this study, a constraint is defined as a problem or hardship that prevents farmers from achieving household food security

1.8.3 Small-scale irrigation

Small-sale irrigation is defined as irrigation, usually on small plots, in which private farmers have the major controlling interests, and which uses a level of technology which farmers can effectively operate and maintain (Carter, 2008). Hecq and Dugauquier (2004) define irrigation agriculture as the art and science of harvesting and making the best use of water to increase agricultural production.

1.8.4 Household food security

According to FAO (2008), food security exists when all people in the household, at all times, have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences for an active and healthy life.

1.9 Justification of the study

This study is of significance to rural farmers as it exposes them to strategies meant to increase their household food security and income generation through small scale irrigation farming. The findings of this study are also expected to have major implications for policy-makers. It is expected that the research findings will assist the government in formulating relevant policies, and reviewing existing ones, while

developing support systems that will improve the productivity, profitability, sustainability and efficiency in the use of small holder irrigated agriculture in Zimbabwe. The research is also expected to help extension practitioners to develop technical, effective, realistic technologies, social, economic and sustainable interventions for the capacity building of small holder irrigation farmers. This will enable them to better manage their irrigation schemes so as to achieve food security, reduce poverty, sustain the environment, and create job opportunities for themselves and their families.

1.10 Proposed outline of the study

This chapter introduced the problem and gives a brief background to the study, define the objectives and specify the research questions. Chapter 2 presents relevant literature related to irrigation schemes in Zimbabwe and other parts of the world. Chapter 3 explains the methodology that was used for data collection, presentation and data analysis. It also discusses the model that was used to analyse data. Chapter 4 presents and discusses the findings of the study and chapter 5 provides summary, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Shuttleworth and Martyn (2009) define literature review as a critical and in-depth evaluation of previous research. It is a summary and synopsis of a particular area of research, allowing anybody reading the paper to establish why one is conducting the research. Goddard and Melville (2001) note that any investigation, whatever the scale, will involve reading what other people have written about one's area of study, gathering information to support or refute one's arguments and writing about one's arguments and findings. This chapter focuses on a broader understanding of the impact of the constraints faced in small scale irrigation schemes on household food security with reference to Swaziland, Ethiopia, Zambia, Ghana, South Africa and Zimbabwe.

2.2 Impact of socio-economic factors on household food security

Literature on small-scale irrigation shows that most of the farmers involved in farming activities on small-scale irrigation are mostly women. This is supported by a qualitative study conducted by Bishir (2004), in Ethiopia, in which it is concluded that women between the ages of 25 and 45 participate mostly in irrigation farming. He further notes that as much as this group constitutes the economical active, they lack powers to influence the management of the schemes as this is dominated by men. They also lack access to relevant and adequate information regarding the production and marketing of their produce, hence a negative impact on household food security.

Small-scale irrigation farmers' marketing capacity is limited by low production and productivity and a poor market information system (World Bank, 2008). However, Nekhavambe, Chauke and Pfumayaramba (2012) in a study of the assessment of factors that impact on income generation by smallholder irrigation famers in Limpopo, found out that males are the dominant gender (67.8%). Women, however, were found to be the main providers of farm labour. It has been shown by several studies that women participate in farming mainly to ensure family food security rather than for profit motives.

Nekhavambe *et al.* (2012) also revealed that 48.11% of smallholder irrigators had acquired secondary education with a substantial proportion (12.97%) reaching tertiary education. This is in line with Yokwe's (2009) findings in which he concluded that the level of education in most agricultural projects is medium to relatively high on average with secondary level being the most frequent level attained. Normally, farming investments are cross-subsidised by primary off-farm income, making the level of production and farming intensity higher.

The analysis conducted by Murray (2006) in which he regressed all the factors affecting small-scale irrigation farming, revealed that income, gender, access to market information and the health condition of households are important determinants for participating in small scale irrigation schemes. The analysis further revealed that irrigation participation, the family labour force, livestock ownership and access to market information and credit are positively and significantly associated with household income. Thus, improving rural farm households' access to market information and health services is likely to improve participation in irrigation schemes and also to improve small holder farmers' income and household food security.

According to Fiebig (2010), in Namibia, the age of the household head, level of education, agricultural knowledge, and the presence of friends or neighbours who already use micro-irrigation equipment are significant factors affecting household income and food security. He further highlights that these four factors exhibited a positive influence on household income. Results from the Heckman two-stage estimation conducted by Grimm (2007) in India indicate that secondary education, age, income sources and household size are the most significant factors on livelihoods. This corresponds with a qualitative study conducted by Aseyehgn (2012) in which he concludes that most of the small-scale irrigation farmers in developing countries have attained secondary education, that off-farm income sources enable farmers to purchase inputs and irrigation technology. Therefore off-farm income compliments on-farm income and consequently improves livelihood. He also indicates that household size is significant in determining farmers livelihood because the larger the household size, the more labour available for farming activities. Ayele (2005) concludes that the productivity

of labour and technology employed in agriculture is central to household livelihood and food security in developing countries.

A study conducted by Ohikere (2012) revealed that the average household size for the users of small-scale irrigation was six individuals in Nigeria. This result is statistically significant suggesting that labour availability is an important factor influencing households' decisions to participate in small-scale irrigation schemes. Aseyehgn (2012) also adds that, as active family labour or work force of a household in adult equivalent increases, the total income of the household increases. This in turn contributes to the improved well-being of farm households, further providing an evidence of the importance of labour in influencing the participation decision of households in small-scale irrigation.

2.3 Production and profitability of small-scale irrigation farmers

Literature on smallholder irrigation in sub-Saharan Africa (SSA) gives conflicting conclusions on the viability and sustainability of smallholder schemes (Teshome, 2008). The sustainability of the irrigation sector in Africa has been an issue of debate because of its disappointing performance in many cases. Because of the complex set of constraints facing smallholder producers, providing access to irrigation water by itself is not enough. Smallholders also require a broad range of support services (access to inputs, credit, and output markets), knowledge of farming and secure land tenure (Polak and Yoder, 2006). To achieve economic viability in small-scale irrigation schemes on a market-oriented basis requires access to support services and opportunities for producing high value crops (FAO, 2009).

2.3.1 Productivity of small-scale irrigation schemes

According to Owonubi *et al.* (2009), one of the possible causes of the decline in food production is the inefficient allocation of resources in agricultural production in Nigeria. Land, labour, capital and water resources are inefficiently allocated, thereby leading to a decrease in their productivity. However, Ojo *et al.* (2011) revealed that farmers in the Fadama irrigation scheme in Nigeria cultivate a total of six crops grown in four cropping patterns. Further analysis shows that Fadama farmers practiced both mixed sole

cropping – sole paddy rice, sole sugar cane, Tomato/pepper mixture and cassava/potato mixture. Sole paddy rice, (grown by 63.54% of all the respondents), was the most popular followed by sole sugar cane (15.63%), tomato/pepper mixture (12.50%) and cassava/sweet potato mixture (8.33%). These crops were grown in 44.76ha, 11.71ha and 6.44ha respectively. FAO (2009) concludes that farmers practice mixed cropping, in order to guard against the risk of failure of one crop and to diversify their production.

Furthermore, a study conducted by Gyasi *et al.* (2006) in Ghana, revealed that farmers produce more than one crop. The farm budgeting analysis conducted by DiGennaro (2010) shows that cultivation in small scale irrigation schemes in Zambia is profitable. Moreover Polak *et al.*, (2006) conducted a linear programming analysis and revealed that opportunities for increasing profit through resource re-organisation exist in small-scale irrigation schemes. Mupawose (2009) in Zimbabwe suggested that extension workers and private organisations should assist small-scale irrigation users in reducing post-harvest losses via the provision of processing and storage facilities.

In Ethiopia, descriptive statistics and Heckman's two-stage model estimation were used to estimate the determinants of small-scale irrigation production and household income (Teshome, 2008). The analysis revealed that income, gender, access to market information and the health condition of households are important determinants for producers in small scale irrigation schemes. The analysis further revealed that irrigation production, family labour force, livestock ownership and access to market information and credit are positively and significantly associated with household income and food security. Thus, improving rural farm households' access to market information and health services is likely to improve production in irrigation schemes as well as improve small holder farmers' income and household food security.

2.3.2 Profitability of small scale irrigation schemes

There is evidence emerging that irrigation has contributed significantly to increasing farm income and reducing income inequality and poverty in irrigated agriculture in Asia. For example, recent research led by IRRI in India (Bihar and Madhya Pradesh/

Chattisgarh regions), Philippines, Thailand and Vietnam suggests that the incidence, depth and severity of poverty is substantially lower in irrigated and agriculturally developed areas compared to un-irrigated and less-developed areas (Hussain, 2006). However, this is not the case in many developing countries in Africa as shown in Zambia by Digennaro (2010). He concludes that the average net profit for small-scale irrigation farmers is less than expected. He *et al.* (2006) add that the absent or unreliable supply of inputs and equipment, as well as insufficient transportation or infrastructure can also be major barriers to improved productivity and profitability in small-scale irrigation schemes in Zambia.

2.4 Operation and management systems for small -scale irrigation schemes

Poor design and management have contributed to few peasant irrigation systems in SSA countries (World Bank, 2008). According to Jorge (1993), the irrigation system falls in to two broad categories, namely those which the principal management responsibility is operated by government agencies with farmers playing a subsidiary role, and those in which most management activities are carried out and decisions made by the farmers themselves with the government providing periodic technical or logistical support.

The latter category in which farmers assume the dominant role is referred to as Farmer-Managed Irrigation Systems (FMIS). In general, an important characteristic of FMIS is that the farmers also control and manage the water abstraction from its source. Governments often classify these systems as “small-scale irrigation systems” or “minor irrigation systems,” FMIS are also known as traditional, indigenous, communal or people’s systems. The precise set of activities and functions that the farmers and their organisations perform varies from country to country and from system to system.

Bureau for Food and Agricultural Policy (BFAP) (2008) in a quantitative study on small-scale farmers’ macro-economic impacts on profitability provides evidence that farmer-controlled small-scale irrigation performs better than government-controlled small-scale farming systems. Murray (2006) adds that a substantial farmer-controlled small-scale irrigation sector that exists in many countries in Africa, often without government support, is economically viable. Areas under farmer-controlled small-scale irrigation

systems have grown rapidly over the past decades, and account for a large and growing share of irrigated areas in SSA (McCornicket *et al.*, 2003). For the most part, bypassed by the green revolution and other successful innovations in agriculture production, smallholders live at or below the poverty level and are highly averse to risk; therefore they focus on keeping the margin for error as small as possible.

Smallholders are capable of managing irrigation systems efficiently provided they have access to affordable technologies that are easy to operate, maintain and repair. Small-scale systems and technologies are attractive since they put the operation, maintenance and management of systems directly in the hands of the individual farmers, thus eliminating any need for centralized control of management (Jorma, 1999). In general, according to McCornick *et al.*, (2003) all small-scale systems may have advantages over large-scale systems. These advantages include small-scale technology which can be based on farmers' existing knowledge; local technical, managerial and entrepreneurial skills. Migration or resettlement of labour is not usually required; planning can be more flexible; social infrastructure requirements are reduced; and external input requirements are lower.

Small-scale irrigation schemes, compared with other irrigation strategies used in Africa, if properly implemented with appropriate technologies, may have considerable potential in improving rural livelihoods (FAO, 2009). However, the viability of such systems becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Kamara *et al.*, 2001). A qualitative study conducted by FAO (2008) proves that in many developing countries, government policy, institutional and legal supports are limited or that there is no priority given to irrigation development during national and local planning and budgeting. It also reveals that there are poor management structures in place to support farmers and promote irrigation development. For instance Tiwari and Dinar (2002) point out that the infrastructure to facilitate agricultural development is underdeveloped. They also add that land tenure system does not encourage farmers to invest in permanent improvements on their plots and make improvements which can be used to obtain credits for further development. This results in the poor management and

operation of the schemes, leading to a negative impact on household food security for the farmers. However, privately developed and managed (small-scale) irrigation schemes in most of the SSA countries show that there is business potential for private entrepreneur involvement in irrigation (FAO, 2009).

Fanadzo (2010) provides a scenario in the former homelands of South Africa, where the majority of small scale irrigation schemes (SIS) are situated. A number of SIS were planned and established following a centralised estate design in which control over farming activities and decision-making were strictly enforced by central management with little or no input from farmers. This created a high level of dependency among farmers in the schemes and poor performance when farmers were left to manage the schemes on their own. Experience elsewhere in SSA has shown that SIS can succeed if farmers participate in design and management (FAO, 2005). As a result of these positive African experiences, the South African government policy has gradually moved towards entrusting more responsibilities to smallholder farmers to manage SIS. Magingxa *et al.*, (2009) also recommend that the training of farmers and their collectives is needed in the domains of farm and scheme management.

2.4.1 Management systems

Denison and Manona (2007) indicate that the success and acceptability of irrigation schemes to participants seems to be closely related to the management system of the scheme. Smith and Laurence (2004) add that there is growing dissatisfaction amongst participants on irrigation schemes which are centrally (that is externally) managed, however noble the intentions of the developers and/or managers. Smith goes on to say that farmers have expressed very negative views on being deprived of decision-making powers, especially when they have no control over crop choice and production and marketing decisions. According to Teshome (2008), in Ethiopia, the worst scenario is where central management does not only take all decisions unilaterally on a "top-down" basis, but also conducts all on-farm operations. Transparency in financial matters and bookkeeping of centrally "top-down" managed irrigation schemes is often lacking. In some schemes, farmers are provided with financial statements in the form of computer printouts, but most find these incomprehensible. Paradoxically, the companies

managing irrigation schemes believe that they are acting in the best interests of the farmers, as advantage is being taken of the economy of scale and the farming the consolidated area, so that the farming enterprise should be more profitable (World Bank, 2008).

The management system of an irrigation scheme (project) is critically important and "Top-down", centrally (externally) managed systems are unacceptable in Ethiopia (Teshome, 2003). Farmers have made this very clear and experience in the rest of Africa confirms this. Bembridge (2000) points out that high political and social cost are involved when farmers play only a passive role in irrigation projects. In contrast, where farmers on schemes have been empowered with decision-making powers and freedom of choice in crop selection, irrigation and production practices and marketing, there is a high degree of personal satisfaction and a sense of belonging.

A greater number of male farmers work fulltime on such schemes, while a much smaller percentage is engaged in additional off-farm employment (Assefa, 2008). Gyasi *et al.*, (2006) adds that in Ghana, small-scale schemes rate much higher positive ratings with regards to socioeconomic parameters and socio- psychological variables than top-down managed schemes. They do not rate as well with regards to technical aspects due to lack of adequate support and advisory services, something that should be corrected by the state. In Nigeria, it is acknowledged by farmers that there are certain types of projects, for example, plantation projects, which should be centrally managed. In such cases, people should be employed as labourers, instead of creating false impressions that they are farmers (Ohikere, 2012).

2.4.2 Water supply management.

Water supply is the most important component of any irrigation scheme or project. Therefore, its management is a critical factor. According to WFP (2011), the sharing of a common water source by a group of farmers limits members' flexibility in terms of irrigation. The choice of suitable technology however, is important to ensure as much flexibility for each individual farmer as possible. Meizen-Dick *et al.*, (2007) add that irrigation technology in some centrally managed schemes in South Africa has been

adapted and/or expanded to increase flexibility and manageability by farmers. Meizen-Dick also concludes that a crucial element in the successful sharing of a water source is that the group of farmers be well organised and equipped (trained) to control, operate and maintain their infrastructure and manage their finances.

According to a qualitative study conducted by Aseyehegn (2012) in Ethiopia, legal system of land and water rights, support services (irrigation extension) and well-established water users associations through which purposes of irrigation are achieved are not adequately planned and put in place. Aseyehegn (2012) further adds that these shortcomings undermined irrigation management, ultimately risking the feasibility and sustainability of irrigated agriculture.

A comparative study conducted by Dejene, Teshome, Bekele and Prasad (2011) revealed that poor record of accomplishment, in spite of the difference between the two irrigation systems, in managing water distribution in terms of the three most important performance indicators, namely adequacy, reliability and equity in water distribution. Water related conflicts are rampant but not settled yet. Shah *et al.* (2007) adds that the main constraint in most small-scale irrigation schemes is scarcity and unreliability of water and management as well as socioeconomic problems.

Manzungu (2007) in Zimbabwe adds that these are, in turn, mediated by lack of, clearly defined and well-enforced institutions of land and water rights, technical problems in design and construction, inadequate institutional capacity of the local state irrigation agency to coordinate and support decentralised management of irrigation, policy related problems, inadequate organisation of users for self-management; and problematic social relations of power among water users. Dejene *et al.* (2011), concludes that farmers should be equipped with management knowledge and skills and also that there should be standardised water rights and maintenance teams in small scale irrigation schemes,

2.4.3 Support services

In most countries there is a serious lack of support services for small-scale irrigation farmers (BFAP, 2008). FAO (2008) adds that the most serious of these is a lack of specialised irrigation extension technicians, who can advise farmers on cropping aspects, as well as a lack of technical advice on engineering aspects. Maintenance support services are often also poor or non-existent. In Nigeria, Ojo *et al.* (2009) found that problems regarding the availability of inputs such as seed, fertilisers and pesticides are also encountered. Apart from the physical problem of procuring seed, fertilisers and pesticides, maintenance services and spare parts are seldom locally available. Specialised technical advice on cropping, irrigation management and equipment installation and operation is usually conspicuous by its absence (You, 2008).

DiGennaro (2010) argue that Zambia the suitability of an irrigation system is particularly related to the manageability of the system for a specific set of circumstances. The distance from the fields, the priority the irrigation farming enjoys in the life of the farmer and the size of the enterprise should all influence the recommendations.

According to FAO (2008) in Kenya, a rule that at least 70% of the farmers aspiring to participate in an irrigation scheme must attend all planning meetings applies. During these meetings, irrigation technologists share their knowledge on alternatives for irrigation technology with farmers. Farmers then take decisions on layout, technology, and technologists design the scheme accordingly. It is critically important that, in the identification, adaptation or development of appropriate technologies for specific situations, all relevant factors must be taken into account. Apart from the labour aspects already mentioned, women often have their labour burden increased by irrigation, which can seriously affect scheme productivity (FAO, 2008).

2.5 Major constraints faced by small-scale irrigators in achieving household food security

Irrigation development continues to expand. However, the pace is slowing down worldwide. In many countries, there are now challenges and constraints to irrigation development, particularly social and environmental concerns (Assefa, 2008). Low

productivity of many existing schemes has prompted a move in investment policies away from new infrastructure toward programmes that improve the performance of existing schemes (Water Sector Board, 2007). Jones (1995) indicates that there has been a sharp decline in World Bank lending for new irrigation schemes. Jones also states that funding for new irrigation construction has largely stopped and the emphasis is now on the sustainability and efficiency of existing systems.

In partial support of Jones, Thompson (2001) states that irrigation is still one of the core investment activities of the World Bank's Rural Portfolio (WBRP), though the number of irrigation schemes is expected to decrease. This, according to Thompson, is attributed to the fact that investments in irrigation systems are perceived to have failed to address the changing needs of irrigation services; Rehabilitation of existing schemes was mostly carried out to restore original project objectives as this did not take into account or ignored the desirable changes in cropping patterns and irrigation techniques, thus allowing low water-productivity practices. Thompson (2001) further states that cost and time overruns in irrigation projects have further eroded the confidence of funding agents in irrigation development.

Despite major breakthroughs in agricultural technologies such as drip irrigation, agricultural households in many parts of the world still struggle to produce enough to support themselves (FAO, 2008). Significant portions of the population in SSA are food insecure as measured by a variety of nutritional and caloric indicators (Smith *et al.*, 2006). With approximately 60% of the labour force employed in agriculture in Sub-Saharan Africa, the level and reliability of agricultural productivity is a critical element in food security.

As a result of low prices of staple crops coupled with poor yields and erratic rainfall, small-scale agriculture production is both risky and low-return (Lipton *et al.*, 2010). The problems of poor yields and erratic rainfall are expected to worsen in the future as a result of climate change (Lobell *et al.*, 2008). Small-scale irrigation is frequently cited as an innovation that can bolster rural livelihoods through climate adaptation, food security, and poverty reduction (World Development Report, 2008).

Ayele (2005) identified the following problems as the main constraints that prevent small-scale irrigators from achieving household food security in Ethiopia: lack of access to surface water; loss of water through seepage; problem of irrigation water distribution; lack of spare parts for water pumps; high costs of fuel for water pumps; lack of market transparency and marketing facilities; crop diseases; and the perceived high cost of inputs.

A number of potential barriers to the contribution of small-scale irrigation to household food security in Zambia have been identified (Feder *et al.*, 1985). Inadequate information, education, and training are significant barriers to attaining food security (Ayele, 2005). Uncertainty and risk, also associated with information about the technology, discourages adoption (Beshir, 2004). Lack of access to credit, especially when a significant expenditure is required to purchase equipment, prevents access to necessary inputs to produce at full capacity (Ayele, 2005). An absent or unreliable supply of equipment, and insufficient transportation or infrastructure can also be major barriers to improved productivity in small-scale irrigation schemes in Zambia (DiGennaro, 2010).

Although the irrigated area is increasing in Ethiopia, the growth rate is rather low. There are a number of constraints related to the slow rate of irrigation development, for example, weaknesses in management (O&M), equity issue, cost recovery and agricultural productivity (FAO, 2009). Social, economic, institutional and policy problems are general constraints for the efficiency of small-scale irrigation schemes (Teshome, 2008). Moreover, both technical and social factors constrain small-scale irrigation development in SSA, and, among them, institutional and management problems tend to be most constraining (FAO, 2008). Small-scale irrigation schemes in Ethiopia are generally characterised by Low efficiency, lack of finance, inadequate marketing and weak extension services (Teshome, 2008).

The major problems for many irrigation systems are free riding, rent seeking and corruption (Ostrom, 2001). Free riding evokes lack of trust between the actors. Potential rents stimulate efforts to influence public decision-making and evoke corruption. Free

riding can be overcome when farmers are convinced that the benefits exceed costs as well as by improving communication among them. The establishment of institutions that do not allow single officials to have full control over the resources can help to reduce corruption. The improvement of communication between farmers, irrigation schemes and state institutions could make the parties more aware of the problems and reduce both rent seeking and corruption (Polak, 2005).

To reduce the transaction costs of changing government policy, one of the key steps is to reduce the expenses of organisation and involve the stakeholders in specific water management reforms (Polak, 2005). Some specific tasks that will be added to the transaction costs of water reform include designing regulations for allocating water in an open and transparent manner, developing water delivery schedules in conjunction with stakeholders, enacting water-use rights and procedures, and resolving disputes over water allocation (Polak, 2005).

In Ghana, Gyasi *et al.* (2006) looked at the determinants of the success of community-based institutions for irrigation management. The assumption that communities and user groups will manage the systems sustainably may not hold in all cases. Evidence of success, especially in the context of small scale irrigation systems, is limited. Indeed, previous experiences with community managed irrigation schemes in northern Ghana have not always been positive in the past. Many schemes severely deteriorated or broke down completely due to insufficient maintenance. Gyasi *et al.* (2006) also note that market integration generates exit options as maintenance schedules that coincide with market days would receive very poor response. Similarly, higher wages (and, in general, exit options) outside the schemes increase the opportunity cost of labour and reduce the incentive for households to participate in the maintenance of the irrigation schemes. Transparent and accountable leadership is also shown to be an important concern that affects the incentives for households to contribute to the maintenance of the schemes. Lack of transparency, accountability and incidents of rent-seeking reduce trust and confidence in leadership, and ultimately undermine management efficiency. Leaders perceived to be corrupt lose their moral authority to enforce rules and regulations (IFAD, 2009).

Denison *et al.*, (2007) states that despite the South African government pouring millions of Rands into smallholder irrigation schemes, many of these have collapsed or remained under-utilised. Denison *et al.* (2007) concludes that infrastructure development alone is unlikely to succeed. Rather, comprehensive strategies which consider all the activities that make up an irrigation enterprise, such as markets, finance, inputs, institution-building and crop production information, are needed for success. A report by FAO (2008) identified constraints that have slowed irrigation investments as the relatively high cost of irrigation development, inadequate physical infrastructure and markets, poor investments in irrigation, lack of access to improved irrigation technologies, and lack of cheap and a readily available water supply.

However, recent research has indicated that low yield levels caused by poor crop and water management practices by the farmers are probably the main reason for the failure of many SIS in South Africa (Fanadzo *et al.*, 2010). At the same time, limited knowledge of crop production among farmers has been identified as one constraint to improved crop productivity in SIS (Machethe *et al.*, 2004). Among the primary constraints identified by extension officers on 164 of the 302 irrigation schemes in South Africa, poor management topped the list (50% of the cases). This was followed by infrastructural problems (15%); water inadequacies (13%); conflict (12%) and theft (7%) (Van Averbeké *et al.*, 2011). This suggests that human (capacity) and social (institutional) resource problems are at the heart of the poor performance of SIS in South Africa. These were identified by nearly all assessments that were made (Van Averbeké *et al.*, 2011). In this regard, Denison *et al.* (2007) recommends that crop production approaches and farmer training should be considered alongside all other issues.

Chazovachii (2012) conducted a qualitative and quantitative assessment of the impact of irrigation on livelihood in Zimbabwe and the results revealed that the irrigation scheme has brought some benefits to the community. However, the yields produced have not yet addressed the food security situation of plot holders. This is attributed to prohibitive water pricing and transport costs, which negatively affected their desire to produce at maximum capacity. Chazovachii (2012) further recommends the

intervention by interested stakeholders such as non-governmental organisations and the Zimbabwe National Water Authority (ZINWA). He also recommends economic recovery programmes such as farm mechanisation to ensure the viability and sustainability of irrigation on rural livelihoods and household food security.

Mupawose (2009) questioned the economic viability of smallholder irrigation schemes in Zimbabwe and pointed out that certain smallholder schemes have failed and are under-utilised due to poor management, lack of inputs and irrigation experience by farmers. In the same report, Mupawose advocated for the reduction of subsidies on smallholder irrigation schemes and indicated that irrigation development has become expensive. He suggested that some form of cost recovery should be employed in these schemes. However, FAO (2009) concluded that cost recovery from poor farmers for the operation and maintenance of irrigation systems is controversial, as subsidising these services and providing irrigation water far below cost is financially unsustainable. Monitoring the efficiency of water use in agriculture for many small farmers, each using a small amount of water is expensive. However, providing irrigation water below cost contributes to water wasting.

Irrigation is expensive and the profitability of irrigated production is critical in justifying both short-term and long term viability of an enterprise. Thus strong management is needed to enhance efficiency, cost recovery and to sustain the whole system (Rukuni, 2006). Development costs for small-scale irrigable schemes continue to rise due to several factors, with the development of a hectare of land estimated to be between US\$2,000 to US\$3,000 for engineering work yet Zimbabwe is faced with an acute shortage of foreign currency. This has affected the costs of raw materials that are procured from outside the country (Chazovachii, 2012).

2.6 Summary

Literature reveals that despite several interventions by government and NGOs in most developing countries, the contribution of small scale irrigated agriculture to food security is very minimal. This can be attributed to a number of factors which include the lack of policy in many countries to streamline agriculture, in particular irrigated agriculture. The

development of irrigation infrastructure is very slow, irrigation technology is not adapted to small scale irrigation and productivity and profitability of the schemes is questionable. Crop and vegetable production under irrigation is sometimes taken as part-time occupation resulting in farmers putting less time in it. Farmers often lack commitment and ownership of communal schemes. This may be so because sometimes they do not take an active role in the design, planning and implementation of the schemes. Farmers lack management skills, both financial and agriculture. The lack of production planning and poor market orientation results in over production of some crops by farmers, leading to oversupply in the market. Very few farmers keep records on yields and sale of their products, and thus they fail to achieve household food security.

The farmers targeted by the research are smallholder farmers in Gwanda District of Matabeland South Province involved in crop production using small-scale irrigation. The rainfall is between 450 - 600 mm rainfall per year and this is subject to frequent seasonal droughts (GeoHive, 2012). Gwanda, because of its semi-aridity, is flooded by numerous irrigation schemes so as to overcome the effects of seasonal droughts and ensure food security. Gwanda district has a population of about 654 878 people (GeoHive, 2012). The district falls under the country's agro-ecological region 3, which receives very little and erratic rainfall. It is mainly suitable for livestock production. Crop production mainly includes the production of maize, millet and sorghum, which are drought resistant crops. The district has been frequently hit by food shortages and hunger, which have led to intervention by non-governmental organisations such as World Vision, which provides food and other basic necessities for the people in the area. Gwanda District is shown on the map below

3.2.1 Masholomoshu Irrigation Scheme

Masholomoshu irrigation scheme, established in 1969, is one of the major schemes developed before the independence of Zimbabwe in 1980. The scheme is located in Ward 1, 20km East of Gwanda District. Masholomoshu uses a surface irrigation system with a command area of 38,8ha. Plot sizes range from 0.3 to 0.5ha with a total of 131 beneficiaries. Challenges cited in literature for the poor performance of Masholomoshu include a complicated land tenure system, poor management of the scheme, and political conflicts, lack of credit and poor market opportunities.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that was used in the study. This includes data collection, sampling procedures, how the data was analysed and presented, as well as the limitations of the study.

3.2 Description of the study area

The farmers targeted by the research are smallholder farmers in Gwanda District of Matabeleland South Province involved in crop production using small-scale irrigation. The rainfall is between 450 - 600 mm rainfall per year and this is subject to frequent seasonal droughts (GeoHive, 2012). Gwanda, because of its semi-aridity, is flooded by numerous irrigation schemes so as to overcome the effects of seasonal droughts and ensure food security. Gwanda district has a population of about 654 879 people (GeoHive, 2012). The district falls under the country's agro-ecological region 5, which receives very little and erratic rainfall. It is mainly suitable for livestock production. Crop production mainly includes the production of maize, millet and sorghum, which are drought resistant crops. The district has been frequently hit by food shortages and hunger, which have led to intervention by non-governmental organisations such as World Vision, which provides food and other basic necessities for the people in the area. Gwanda District is shown on the map below.

3.2.1 Masholomoshe Irrigation Scheme

Masholomoshe Irrigation scheme, established in 1969, is one of the major schemes developed before the independence of Zimbabwe in 1980. The scheme is located in Ward 1, 20km East of Gwanda District. Masholomoshe uses a surface irrigation system with a command area of 38,8ha. Plot sizes range from 0.3 to 0.5ha with a total of 131 beneficiaries. Challenges cited in literature for the poor performance of Masholomoshe include a complicated land tenure system, poor maintenance of infrastructure, local and political conflicts, lack of credit and poor market opportunities.

The water for the scheme comes from Masholomoshe Dam. Water for irrigation is distributed through a conveyance canal to the field edge. Crops mainly grown include maize and wheat. However, in most cases, farmers fail to do winter cropping due to low water levels in the dam.



Figure 3.1. Gwanda district on Zimbabwean Map (source: Agritex, 2012)

3.2.2 Makwe irrigation scheme

Makwe irrigation scheme is situated in Gwanda District, 30km west of Gwanda town, along the Gwanda-Kezi road. The project, which comprises 229ha, started operating in 1966. The source of water is Tuli-Makwe dam, an arched concrete dam with a capacity of 6 113 000m³. Water for the irrigation is pumped into a conveyance canal by electric powered pumps. The pump house has 4 pumps, which frequently break down. The winding channel is about 5km long and discharges into a 2km long inverted siphon to take the water across the Mtshелеle River. This pipe line (500mm) crossing the Mtshелеle River is the weakest link in the chain as frequent pipe bursts have occurred in the recent past. The conveyance channel is in fairly good condition, although some seepage occurs at various places and all expansion joints need sealing with bitumen putty.



Fig 3.2 Makwe irrigation and dam overview (source: AgriTex, 2012)

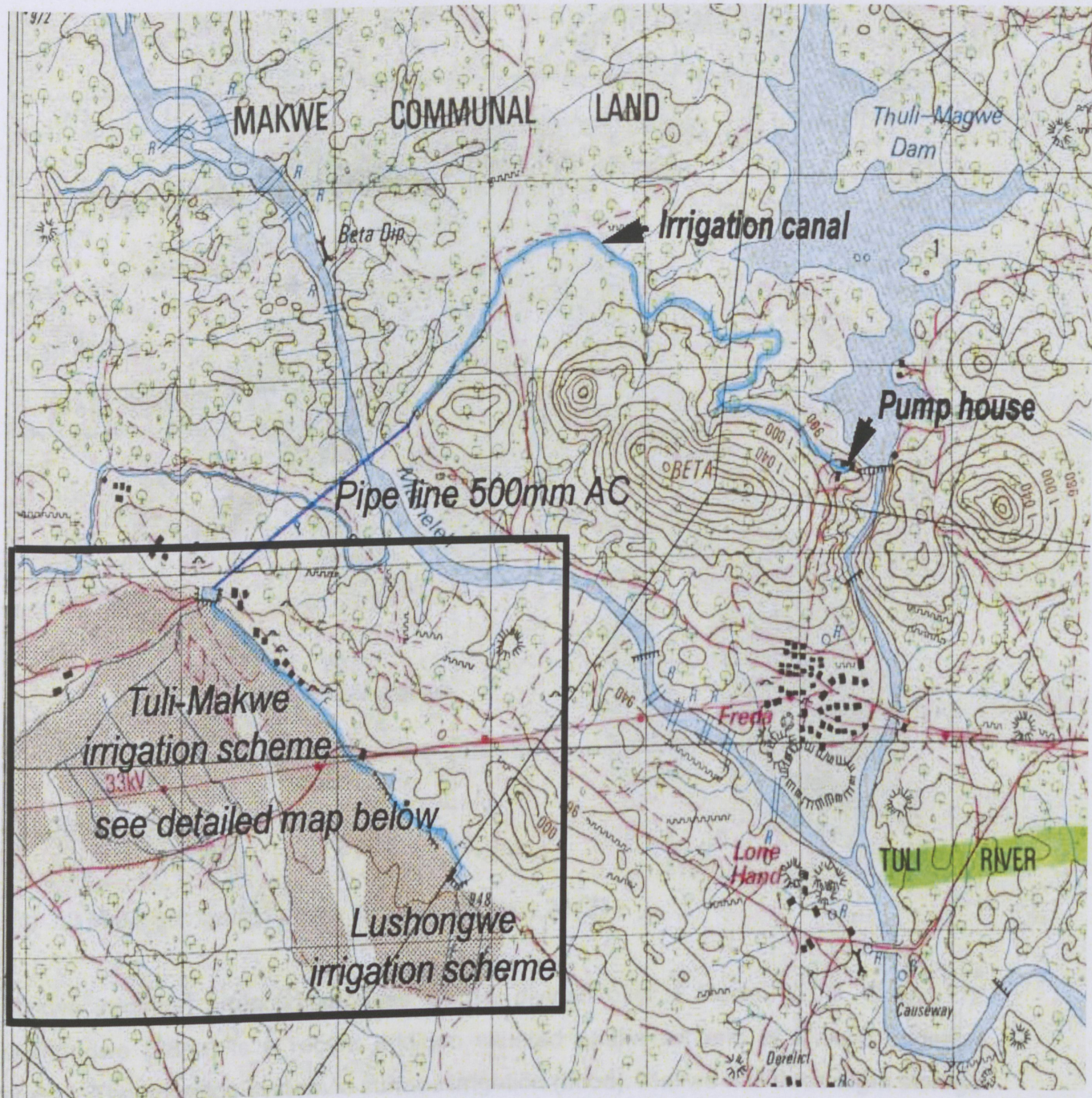


Fig 3.2 Makwe irrigation and dam overview (source: Agritex, 2012)

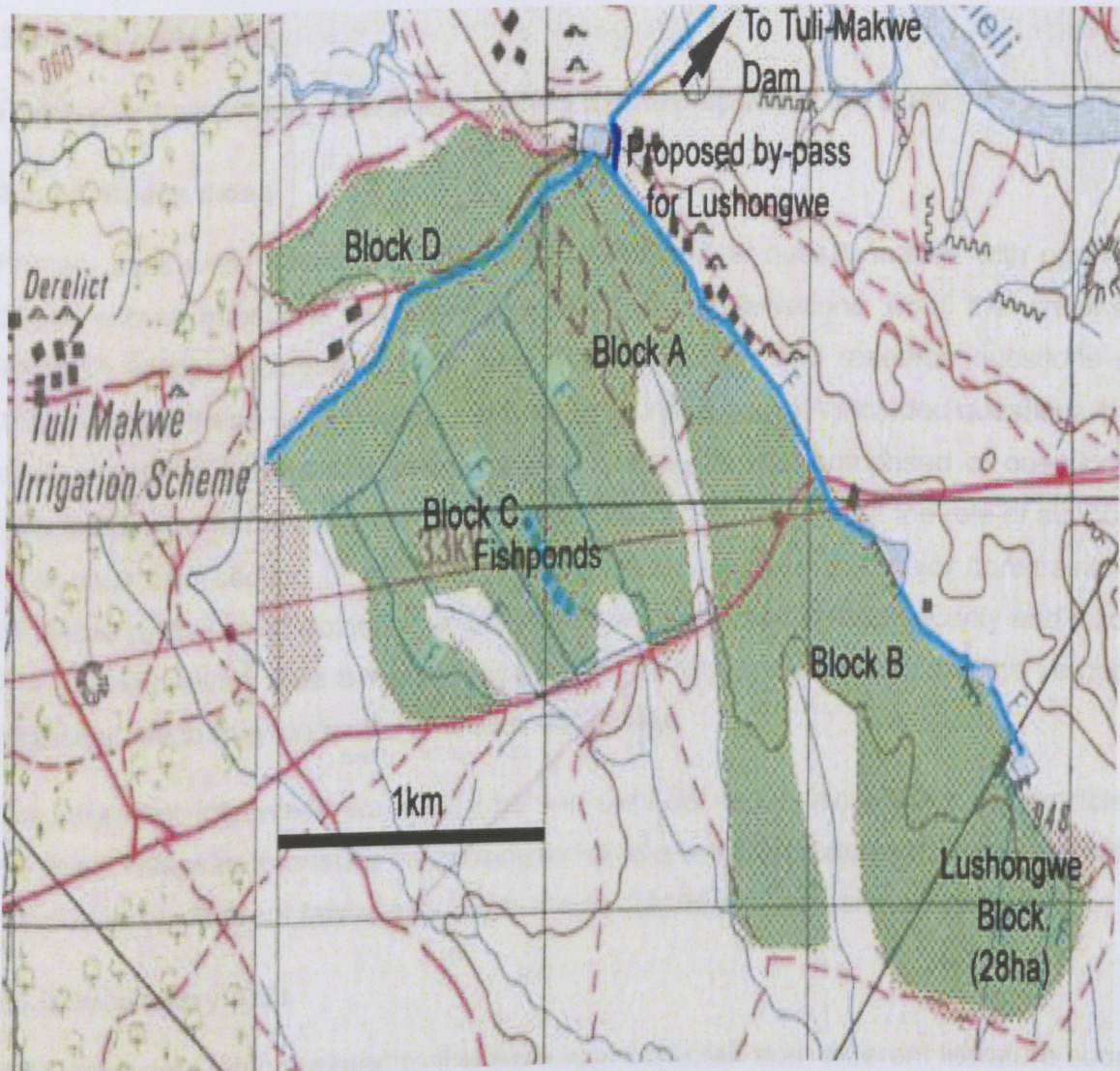


Fig 3.3 Makwe irrigation units (source: Agritex, 2012)

Makwe irrigation project comprises 201ha, divided over 4 blocks (A, B, C and D). Lushongwe (28ha) is a recent addition situated at the tail end of Makwe irrigation project. The irrigation system is surface irrigation (flood). Makwe has three night storage dams. Makwe currently has 500 member farmers, although the official number of plots is 425. The standard plot size is 0.5ha, but some members have sublet parts of their plots, while others are using more than one plot. The actual plot size, therefore, varies from 0.1 to 1.0 ha. Recent crops grown are mainly maize and wheat. Most of the irrigable land is fallow.

3.3 Data collection

Primary and secondary data was collected for the purpose of the study.

3.3.1 Primary data

Primary data were collected using structured interview questionnaires with open- and closed-ended questions supported by personal observations from the small-scale irrigation farmers. Questionnaires based on objectives and research questions were designed and these were divided into four sections. Section A included questions on the socio-economic factors that affect farmers, section B was comprised of questions on yield levels and farm income for each farmer, section C was about the role of supporting institutions and section D was comprised of information on the major constraints that are faced by the small-scale irrigators in achieving household food security and income. The questionnaires were written in English but farmers were asked in the vernacular language which they understand, that is IsiNdebele

Key informant interviews were also carried out with extension officers responsible for the area. This was to ensure that more primary data on agricultural activities carried out in the area by different farmers to improve household food security are gathered.

3.3.2 Secondary data

Secondary data which related to the topic was collected from different literature sources such as previous studies carried out in the area and reports on the performance of small-scale farmers in the area.

3.4 Research design

Both qualitative and quantitative methods were used in this study to mitigate the shortfalls of either of the methods and combine the advantages that each method brings and thus better understand the problems faced by small scale irrigation farmers in rural areas. The advantages of quantitative methods include providing a basis for comparing one result with a result from another source (Goddard and Melville, 2001). Quantitative methods can be subjected to mathematical bodies of data and statistical techniques permit hypotheses to be rigorously tested (Dawson, 2006). The advantages of

qualitative research methods include enabling researchers to study human experience in a great deal of depth (Dane, 1990).

3.5 Populations and sampling

3.5.1 Population

For the purpose of this study, population refers to all the farmers who are involved in irrigation farming in Masholomoshe and Makwe irrigation schemes. There are 135 farmers in Masholomoshe irrigation scheme and 480 farmers in Makwe irrigation scheme. Therefore, the total population for the study was 615 farmers.

3.5.2 Sample

A total sample of 150 small-scale irrigation farmers was used to carry out the study. A proportional sample of 30 (22% of the total population) irrigation farmers was selected from the entire population (135) of Masholomoshe irrigation scheme and 120 (25%) from the entire population (205) of Makwe irrigation scheme.

3.5.3 Sampling technique

In an attempt to survey all members of the population, a sample of 150 farmers from a population of 340 farmers from both schemes was used to represent the population. In order for a sample to reflect the characteristics of the population from which it is drawn, stratified random sampling was used to identify Masholomoshe and Makwe irrigators. A simple random sampling method was then conducted from each strata or group of farmers. A register was used where each individual was assigned a number and then a computer was used to compute random numbers giving each individual an equal chance to be selected for inclusion in the study. In this manner, a sufficiently random sample of the general population becomes representative of the larger whole. The sample was tested at 1%, 5% and 10% confidence intervals.

Table 3.1 Sampling technique table

Scheme	population	Sample
Masholomoshe	135	30
Makwe	205	120
Total sample	150	

3.6 Questionnaire design

An interview questionnaire was designed for the purpose of data collection. The questionnaire was divided into four sections with the first section including questions seeking the demographic information of the population. The second section was comprised of information on productivity and farm incomes and the third section was comprised of the information on the role played by supporting institutions while the last section was comprised of information on the major constraints that prevent farmers from achieving household food security. Interview questionnaires were conducted with irrigation farm households and key informants.

3.7 Reliability and Validity

The interview questionnaires were taken to an authority in the field to be validated. After this a pilot study was conducted on five farmers who were not the target participants in the study. This was done to ensure reliability and validity of the research instruments.

3.8 Data capturing, processing and analysis

Data capturing was done using SPSS and descriptive statistics were used to analyse the data. An inferential test where the multiple linear and logistic regression analysis were used to assess the impact of challenges on household food security was conducted. Gross margin analysis and independent t-test were also conducted to analyse the average farm incomes between the two schemes. Data was presented in the form of cross tabulations.

3.9 Primary data collection

3.9.1 To assess the impact of socio-economic factors that affect small-scale irrigator households in achieving household food security

This information was provided by the farmers who practice small-scale irrigation in the selected schemes. These farmers were randomly selected from a population and a sample of 150 households. A structured questionnaire was used to collect information. This was done in the form of face to face interview questioning. The data that was collected include gender, age, and level of education, marital status and household size. This data was analysed using descriptive statistics and the multiple linear regression model.

3.9.2 To assess the farm incomes from food crops for small-scale irrigator households

This information was provided by heads of households that is those who are responsible and involved in crop production. Extension officers and government officials also provide information. A questionnaire was used to collect this information from the selected sample. Data that was collected included crop type, area cultivated, total cost of inputs, total yields, quantity consumed, and quantity sold, unit price of the products, and total farm income. The data was analysed using descriptive statistics, multiple linear regression model and gross margin. An independent t-test was done on SPSS to test if there was a statistical significant difference between the average gross margins of the two schemes.

3.9.3 To determine the role played supporting institutions in helping farmers achieve household food security

This information was collected mainly from extension officers and irrigation farmers. An interview guide and questionnaire were used to collect information from the extension officers and farmers respectively. Data that was collected included information on input markets, extension services, credit facilities, training and information providers, output markets, farmer organisations. The data was analysed using logistic regression model.

3.9.4 To assess the major constraints faced by farmers and their impact in achieving household food security

This information was collected from the irrigation households, extension officers and government officials. An interview questionnaire was used to collect this data. Information that was required was related to the challenges faced by farmers in production, marketing of their products and general challenges in the scheme. The data run on SPSS was analysed using descriptive statistics.

3.10 Model specification

3.10.1 Multiple Linear Regression

Multiple linear regression attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data. Every value of the independent variable x is associated with a value of the dependent variable y .

Typically, the model for multiple linear regression, given n observations, is

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \dots + b_n + \hat{e}$$

Where;

Y is the dependent variable

b_0 is the intercept or the constant

$b_1, b_2, b_3, \dots, b_n$ are regression coefficients

$X_1, X_2, X_3, \dots, X_n$ are independent variables

$\hat{e}$ is the error term

Expressed in terms of the variables that were used in the model, the multiple linear regression equation is as follows: independent variables represent the constraints that the farmers are likely to face in their irrigation schemes.

$$\text{Household income per capita} = b_0 + b_1(\text{age}) + b_2(\text{hsize}) + b_3(\text{acult}) + b_4(\text{incost}) + b_5(\text{yields}) + b_6(\text{price}) + b_7(\text{qtysold}) + b_8(\text{tffi}) + \hat{e}$$

where;

household income per capita was used as a proxy for household food security and was the dependent variable

$b_1, b_2, b_3, \dots, b_n$ are regression coefficients

age - the age of the respondents at the time of interview in years

hsize - number of people in the household

acult - the size of land used for production per hectare

incost - the total cost of inputs used in production in US dollars

yields - total harvest per crop in kg/year

Price - the price of food crops in US dollars

Qtysold - quantity of the yields sold

Tffi - total farm income

3.10.2 Binary logistic regression model

In logistic regression, the dependent variable is binary or dichotomous, i.e. it only contains data coded as 1 or 0. For the purpose of the study, number of meals a farm household have a day was used as a proxy for household food security and as a dependent variable.

The prediction equation was

$$p(Y = 1) = \frac{e^{\beta x}}{1 + e^{\beta x}} \quad (1)$$

$$p(Y = 0) = 1 - \frac{e^{\beta x}}{1 + e^{\beta x}} = \frac{1}{1 + e^{\beta x}} \quad (2)$$

$$\text{logit}[\theta(x)] = \log \left[\frac{\theta(x)}{1 - \theta(x)} \right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_i X_i + \epsilon \quad (3)$$

Equation 3 is the natural logarithm of the modelled variables. The equation allows the researcher to run a linear estimation of the model where the following definitions apply:

θ = the logit transformation of the odds ratio,

α = intercept of the model,

β = the regression coefficient or slope of individual predictor variable modelled,

X_i = the predictor variable and

ε , is the error term.

Expressed in terms of the variables that were used in the model, the logistic regression equation was as follows

$$\text{Log}(p/1-p) = \beta_0 + \beta_1 \text{gen} + \beta_2 \text{edu} + \beta_3 \text{insoc} + \beta_4 \text{tenure} + \beta_5 \text{ext} + \beta_6 \text{credit} + \beta_7 \text{tranif} + \beta_8 \text{outmkt}$$

Where;

$(P/1-p)$ = probability of the farm household having 3 or more meals a day (yes= 1, no= 0)

β_0 to β_{12} = co-efficient of independent variables

gen - the gender of the respondents (female= 0, male=1)

edu – level of education of farmers (primary= 0, secondary=, high school= 2)

insoc - income sources (farming= 0, non-farm income= 1)

tenure - land ownership system (PTO= 0, tittle deeds= 1, rented= 2)

ext - availability of extension services (no= 0, yes= 1)

cred - access to credit (no= 0, yes= 1)

tranif - access to farmer training and information (no= 0, yes= 1)

outmkt - availability of output markets (no=0, yes= 1)

Table 3.2 Expected signs of coefficients for the variables

Variables	Expected sign
Farm income (dependant variable)	
age	-
Hsize	-
acult	+
incost	-
Yields	+
Price	+
Qtysold	+
Tfi	+
gen	+
Edu	+
insoc	+
Tenure	+
Ext	+
Cred	+
tranif	+
outmkt	+

The variables were tested at 95% confidence interval. Household food security is influenced by physical, natural, human, social, community and financial assets of the agricultural household, therefore all the independent variables are expected to be positive (FAO, 2009). Characteristics of the household, especially those of the household head are major deciding factors on whether to participate in irrigation farming or not. In particular, the household head's age, gender, level of education and household size influences the attitude one may have towards irrigation farming,

therefore the more educated a farmer is, the more likely to have household food security (Bishir, 2004). Household size is also essential for determining the availability of labor to the irrigating household (FAO, 2006). Information regarding markets, credit and the resources at the farmer's disposal play an important role in the efficiency and decision-making in order to improve productivity through small-scale irrigation (Feder, Just and Zilberman, 2010). The quality and topography of land can also influence the productivity of irrigation schemes (Zhou, 2008). It is believed that the farmer is more likely to achieve household food security if his land is good and big enough to produce a good return (Feder *et al.*, 2010).

3.10.2 Justification of the econometric model

The Multiple Linear Regression model (also known as the Ordinary Least Squares Regression (OLS) is the most widely used modelling method for data analysis, and it has been successfully applied in most studies (Montshwe, 2006). Gujarati (2003) pointed out that the method is useful in analysing data with a quantitative (numerical) dependent variable as in this study that is household income per capita. Moreover, multiple linear regression analysis is more statistically robust in practice, and is easier to use and understand than other methods. Binary logistic regression will also be used in this study to analyse qualitative data because it is feasible where there is a categorical dependent variable. Logit model assumes that the probability has to lie between 0 and 1. Therefore it is also suitable for this study as the study also have a categorical dependable variable that is the household eats three times a day or not (Dougherty, 2004).

3.11 Ethical considerations

In an endeavour to abide to the code of ethics in research, the researcher obtained an informed consent from the participants before the research began. Participants were enlightened on the aims and objectives of the research and the benefits that the study has to them and the procedures to be used. Participants were assured of the absence of physical or emotional harm. The researcher also undertook to offer answers to questions about any research procedure and indicated to participants that they had the

right to withdraw from the research at any stage. Participants were also assured that personal information would be kept as confidential as possible and that the study would not be used for commercial purposes but for the advancement of the discipline of agricultural studies and the quality of people's lives.

3.12 Summary

In this chapter, the methods that were used to analyse data were reviewed. Data was collected from 150 small-scale irrigators in Gwanda District. The research focused mainly on the farmers who were involved in irrigation. Stratified random sampling was applied, in order to select a sample from smallholder farmers involved in farming. To collect the data, a questionnaire was administered to the respondents through face-to-face interviews. To analyse data, the multiple linear and binary logistic regression models were chosen and its advantages have been highlighted. The results of the research will be presented in chapter

Table 3.3 Summary of objectives, research questions, hypothesis, data required and analytical tools

Research objectives	Research question	Research hypothesis	Data requirement	Analytical tools
To determine the impact of socio-economic factors of the irrigators on household food security	What is the impact of socio-economic factors on household food security?	There is no significant impact of socio-economic factors on household food security of small-scale irrigators	Gender of farmers Age of farmers Level of education Household size Household income sources Per capita income Land ownership	Descriptive statistics Multiple Linear regression model
To determine and compare the farm incomes of food crops for irrigation households from Masholomose and Makwe small-scale irrigation schemes	What is the difference between the farm incomes from food crops in Masholomose and Makwe irrigation schemes?	There is no significance difference between farm incomes of Masholomose and Makwe Small-scale irrigation schemes	Types of crops grown Size of the farm used for production Levels of yields produced Prices of food crops Input costs Quantity sold Total farm income	Descriptive statistics Gross margin analysis
To assess the role played by supporting institutions in helping farmers to achieve household food security	What is the role played by supporting institutions in helping irrigation farmers achieve household food security?	Supporting institutions play a significant role in helping irrigation farmers achieve household food security	Input markets Extension services Credit facilities Training and information providers Transport to markets Output Markets	Descriptive statistics Logistic regression model
To determine the major constraints faced by farmers in small-scale irrigation and provide recommendations	What are the major constraints faced by farmers in achieving household food security	There is no significant relationship between the constraints faced by the small-scale irrigation farmers and their household food security.	Major problems faced by farmers in production Major constraints faced by farmers in marketing Ranking of problems faced by farmers in the scheme.	Descriptive analysis

Table 4.1 Descriptive Statistics of age and household size

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents survey results of Masholomoshe and Makwe small-scale irrigation schemes. The findings are part of the study aimed at analysing the impact of the constraints faced by small-scale irrigation farmers in achieving household food security. The analysis was done using descriptive analysis, multiple linear and logistic regression models.

4.2 Descriptive statistical analyses

4.2.1 Socio-economic characteristics of small-scale irrigation farmers

4.2.1.1 Age and household size

The results in Table 4.1 shows that the age of the household heads of sampled respondents in Masholomoshe scheme ranged between 28 and 77, with an average age of 60 years and standard deviation of 13.67. The age of respondents in Makwe scheme ranged between 23 and 80 years with mean age of 65.62 and standard deviation of 15.39 years. The age difference between the two groups is not significant and the overall average age was 63 years. This suggests that most small-scale irrigation farmers are old people who have retired from their formal jobs.

Table 4.1 Descriptive Statistics of age and household size

Variable	N	Minimum	Maximum	Mean	Overall mean	Std. Deviation
Age of respondents						
Masholomoshe	30	28	77	60	63	13.67
Makwe	120	23	80	65.62		15.391
Household size						
Masholomoshe	30	3.00	12.00	6.3333	6	2.873
Makwe	120	2.00	12.00	5.7667		2.55783
Valid N (listwise)	150					

(Source: study survey, 2013)

4.2.1.4 Household size

The average household size for Masholomoshe farmers was 6.33 with standard deviation of 2.87 and that of Makwe was 5.77 with a standard deviation of 2.56 as indicated in Table 4.1. The household size has an overall impact on labour availability for any activities at the scheme ranging from irrigation maintenance, repairs to crop production activities.

4.2.1.2 Gender

On average, there were more female than male farmers in the small-scale irrigation schemes. As shown in Table 4.2, the results of the study shows that from the sample selected in Masholomoshe scheme, most (60%) of the farmers were females. The results for Makwe scheme also revealed the dominance of females (67%). Interviews with the farmers indicated that there are more females in the schemes because males work in towns and also prefer to do gold panning to compliment farm incomes. Females are based at the schemes and tend to oversee all the irrigation works at the farm. This implies that all decisions pertaining to any irrigation developments are made by women in the absence of their male counterparts.

Table 4.2 Descriptive Statistics of gender, level of education, income sources and ownership system

Variable	Scheme				Total percentage
	Masholomoshe (n=30)		Makwe (n=120)		30+120=150
	Frequency	Percentage	Frequency	percentage	
Gender					
Female	18	60	80	67	65
Male	12	40	40	33	35
Level of education					
Primary (grade 1-7)	13	43	54	45	45
Secondary (form 1-4)	12	40	49	41	41
High school (form 5-6)	3	10	11	9	9
Tertiary	2	7	6	5	5
Income sources					
Farming	11	37	63	53	48
Employment	3	10	33	27	24
Contribution	9	30	19	16	20
mix	7	23	5	4	8
ownership					
PTO	8	27	17	14	20
Tittle deeds	13	43	30	25	34
Rented	9	30	73	61	46
Total					

(Source: study survey, 2013)

4.2.1.3 Level of education

The descriptive statistics in Table 4.2 indicate a low level of education among the farmers, a majority of whom had primary education. From Masholomoshe scheme 43% of the respondents had primary education, 40% had secondary, and 10% and 7% had attained high school and tertiary education respectively. From Makwe scheme, 45% of respondents had attained primary education, 41% secondary while 9% and 5% had attained high school and tertiary education respectively. Generally most farmers from both schemes have primary education followed by secondary education whilst only a few farmers have attained tertiary education. The prevalence of individuals with only primary education is a result of the fact that most farmers in the schemes are old people who did not have the opportunities to continue with education during their active days. Those with tertiary education prefer to go to the cities in search of white collar jobs than to work in the irrigation schemes.

4.2.1.5 Household income sources between irrigation schemes

The sources of household income were divided into two broad categories of farm and non-farm sources. Farm incomes included income derived from the sale of farm produce and non-farm sources included pensions, remittance, wages and salaries and other sources. Most respondents from the study sample revealed that farming is their main source of income with 37% and 53% from Masholomoshe and Makwe irrigation schemes relying on farming for their household income respectively. Only 10% and 27% of the respondents from Masholomoshe and Makwe, respectively, relied on employment from other sectors, mainly mining and self-employment. On the other hand, 30% and 16% from Masholomoshe and Makwe schemes, respectively, rely on contributions from relatives and other family members, mainly children who have migrated to South Africa for better job opportunities. The farmers were quick to state that farm income alone is not enough to sustain the household for the whole year. Therefore, they supplemented it with incomes from other off-farm activities such as gold panning.

4.2.1.6 Land ownership system

The inadequate quantity of land available per household was the biggest constraint to production for irrigation farmers to achieve household food security. The issue was also complicated by the land tenure arrangements which indicate that 27% and 14% of the sample farmers from Masholomoshe and Makwe schemes, respectively, currently producing (mostly women) have the PTOs (permission to occupy) registered in their husbands or family names. The situation where women are the actual farmers but title deeds are mostly in the names of men may also be creating disincentives to farming. In the Makwe scheme, most farmers (61%) producing in the scheme are renting the land from owners who failed to grow crops due to high water charges. By contrast only 30% of the farmers had title deeds. In Masholomoshe, 30% of the farmers rented the land whilst 43% have title deeds to the land.

4.2.2 Comparisons of farm incomes between irrigation schemes

Table 4.3 Production information

<i>Scheme</i>	<i>Crop grown</i>	<i>Average area cultivated (ha)</i>	<i>Number of farmers</i>	<i>Average yields (kgs)</i>	<i>Average revenue (US\$)</i>	<i>Average total costs (US\$)</i>
Masholomoshe	Maize	0.3	30	380	285	121
Makwe	Maize	0.2	53	400	300	147
	Beans	0.2	28	250	373	98
	Wheat	0.2	10	300	375	188
	Cabbage	0.1	14	103	103	126
	Tomatoes	0.2	15	18	270	130

(Source: study survey, 2013)

4.3.1 Types of crops grown

Farmers in Masholomoshe scheme only managed to grow maize during the cropping season 2012/2013. Due to water shortages, farmers were quick to say that yields were not enough to sustain them for the whole year and they had to employ other food shortage mechanisms such as contributions from relatives and buying maize meal from shops. In contrast, farmers from Makwe irrigation scheme grew a variety of crops. They practice what they call a block system whereby the scheme is divided into sections of different crops. Farmers are required to pay a certain water charge every time they need to irrigate depending on the size of the land that they want to cultivate. This means that farmers have to choose the crop they want to produce and the size of the area. This has resulted in some farmers withdrawing from irrigation activities because they could not afford the charges. Those who decided to produce opted to produce one crop because the more one produces the higher the water charges. From the study sample, the majority (58%) of farmers had decided to produce maize because it is easy to produce and it is also the staple food in the area. The average area cultivated for maize

was 0.3ha with average yields of 380kg per farmer. The maize farmers incurred average production costs of \$121 and obtained average revenue of \$285.

About 28 farmers from the sample chose to produce beans because they saw it as a cheaper alternative than producing any other crop. Farmers emphasised that beans are cheaper to produce because they do not require a lot of water. The average area cultivated for beans is 0.2ha and obtained an average yield of 250kg and average revenue of \$373. Table 4.4 shows that 10 farmers from the sample who chose to produce wheat incurred high cost of \$188 because wheat is labour and water intensive. The average area cultivated for wheat was 0.2ha with average yields of 300kg and average total revenue of \$375. Other farmers opted for vegetables such as cabbages and tomatoes. The table above shows that the average total costs for cabbages (\$126) was high than the average total revenue (\$103). The average area cultivated for cabbages was 0.1ha which might be the cause of low returns.

The difference in net farm income between farm types was calculated as shown in Table 4.4. The cost of inputs like fertilizers, pesticides, herbicides, seeds, labour and equipment were deducted from the gross farm income of each crop. The result revealed that the average gross margin of \$164 in Masholomoshe scheme was slightly higher than that of Makwe irrigation which was \$146.40. This is because Makwe irrigation farmers experience high irrigation water charges. This could be because the expenditure is very high and the income from the harvest is insufficient to support their household income. The average income per capita was \$59.

4.2.3 Role of supporting institutions

4.2.3.1 Input markets

Figure 4.1 shows that 20% of the sample respondents in Masholomoshe had access to input markets and 30% from Makwe had access to input market. Farmers pointed out that inputs such as seeds and pesticides are very expensive and only a few can afford them. They also emphasised that there was shortage of fertiliser in the markets and when available it is too expensive for the small-scale farmers to buy. Most farmers

Table 4.4 Difference between the gross margins of farmers in Masholomoshe Makwe irrigation schemes

<i>Scheme</i>	<i>Variable</i>	<i>Average Gross revenue (\$)</i>	<i>Average total costs(\$)</i>	<i>Average net farm income(\$)</i>
Masholomoshe	Maize	285	121	164
Makwe	Maize	300	147	153
	Beans	373	98	275
	Wheat	375	188	187
	Cabbage	103	126	-23
	Tomatoes	270	130	140
Total Makwe				146.40
Average income per capita/month				51.00
Average income per capita/day				1.70

(Source: study survey, 2013)

4.2.3 Role of supporting institutions

4.2.3.1 Input markets

Figure 4.1 shows that 20% of the sample respondents in Masholomoshe had access to input markets and 30% from Makwe had access to input market. Farmers pointed out that inputs such as seeds and pesticides are very expensive and only a few can afford them. They also emphasised that there was shortage of fertiliser in the markets and when available it is too expensive for the small-scale farmers to buy. Most farmers

resort to using untreated seeds from their previous harvest, especially those who produce maize, wheat and beans.

4.2.3.2 Extension services

The results on figure 4.2 reveal that the majority of the farmers have access to extension services. 73% and 87% farmers from Masholomoshe and Makwe, respectively, indicated that they had access to extension services. However, some farmers in Masholomoshe were not satisfied with these services. They pointed out that the extension agents are not always available for consultation whilst in Makwe farmers complained that extension agents are too busy with their own farms to provide farming advices to other farmers. They also complained that they still use old farming methods making it difficult to attain high levels of yields and quality crops.

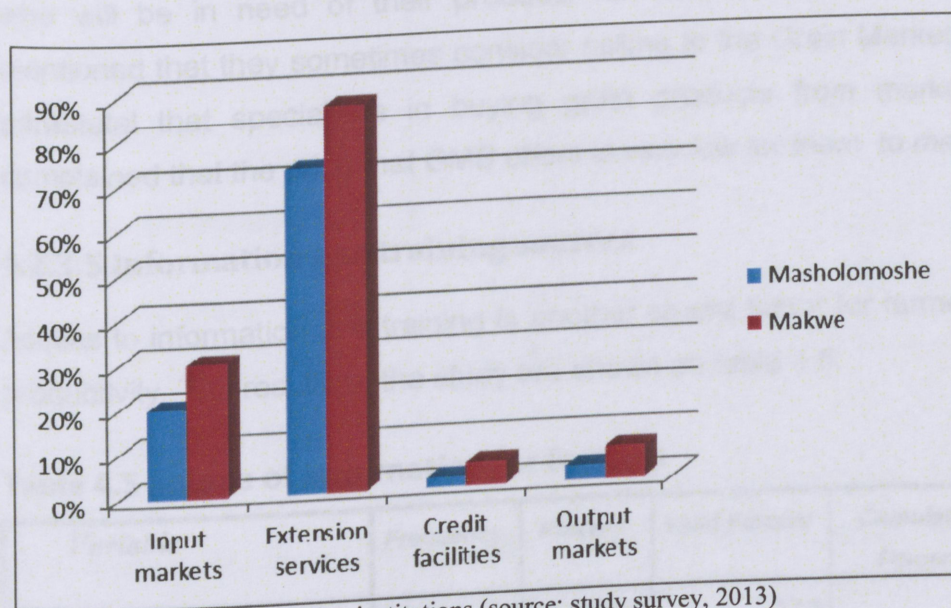


Figure 4.1 Access to supporting institutions (source: study survey, 2013)

4.2.3.3 Credit facilities

Access to credit was a big challenge to farmers as only a few farmers could acquire loans from the bank. The results on figure 4.1 show that 2% of the sample respondents in Masholomoshe had access to a bank loan from Agribank whilst only 5% of the respondents in Makwe scheme also had access to loans. Agribank is the only institution that provides loans to farmers in the area. However, farmers do not want to take loans

because the interest rate is very high. Further probing revealed that farmers also fear to take loans from the bank because yields are not guaranteed due to shortage of water in the schemes and others mentioned that for one to qualify for a bank loan he/she must produce a valid payslip as collateral. Since most farmers do not have formal jobs this means that they do not qualify for the bank loans.

4.2.3.4 Access to output markets

The study also revealed that most farmers did not have access to output markets where they can sell their produce. Only 3% and 5% of the sample respondents from Masholomoshe and Makwe schemes (figure 4.2) had access to output. Farmers from both schemes mentioned that they did not have stable markets therefore they had to search for markets for themselves. People who buy from them are usually individuals who will be in need of their products for subsistence. Maize and wheat farmers mentioned that they sometimes consider selling to the Grain Marketing Board (GMB), a parastatal that specialises in buying grain products from markets. However, they complained that the price that GMB offers is very low for them to make any profits.

4.2.3.5 Information and training sources

Access to information and training is another crucial factor for farmers to increase their productivity. The results of the study are shown on table 4.5.

Table 4.5 Source of information for farmers

<i>Variable</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
extension workers	116	77.3	77.3	77.3
NGOs	7	4.7	4.7	87.3
private organisations	4	2.7	2.7	90.0
Other	15	15.0	10.0	100.0
Total	150	100.0	100.0	

(Source: study survey, 2013)

The study revealed that extension workers were the main source of information for farmers, with 77% of farmers in both schemes relying on extension workers. Only 15%

rely on other sources such as their neighbours and other farmers from neighbouring schemes. On the other hand, a few farmers (4.7% and 2.7%) relied on NGOs and other private organisation, respectively.

4.2.4 Major constraints faced by farmers

4.2.4.1 Major problems in production

Table 4.6 reveal the major problems that scheme farmers face with 42% of the sample respondents from both schemes listing water as their main problem.

Table 4.6 Major production scheme problems

<i>Variable</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
Water	63	42.0	42.0	42.0
Management	6	4.0	4.0	46.0
Maintenance	7	4.7	4.7	50.7
Lack of inputs	29	19.3	19.3	70.0
Lack of supporting Institutions	6	4.0	4.0	74.0
Lack of markets	39	26.0	26.0	100.0
Total	150	100.0	100.0	

(Source: study survey, 2013)

Lack of markets and inputs was also a major problem in the schemes with 26% and 19%, respectively facing this problem. Other problems included the poor maintenance (4.7%) where damaged infrastructure takes long to be repaired. Other farmers (4%) also revealed that inefficient management of the scheme was a problem and another 4% of the respondents mentioned lack of supporting institution as another problem that hinders maximum productivity.

4.2.4.2 Major problems in produce marketing

Table 4.7 reveals the major problems faced by farmers in marketing their products per crop. Most farmers (48%) faced a problem of high transport cost while about 33% of the

farmers faced the problem of not having transport to take their products to the market and 14% of the farmers faced a problem of inadequate transport.

Table 4.7 Major marketing problems

variable	Frequency	Percent	Valid Percent	Cumulative Percent
small size transport	22	14.7	14.7	14.7
lack of transport	49	32.7	32.7	47.3
high transport cost	72	48.0	48.0	95.3
other costs	7	4.7	4.7	100.0
Total	150	100.0	100.0	

(Source: study survey, 2013)

4.2.4.3 Challenges ranked according to severity

Farmers were asked to rank the constraints that they face in production that hinder them from achieving household food security according to severity. The results are as shown in table 4.8.

Table 4.8 Major challenges faced by farmers ranked according to priority

Major constraints	Makwe	Masholomoshe
high water cost	97%	34%
shortage of water	53%	83%
lack of credit	81%	46%
lack of inputs	56%	63%
lack of output markets	69%	71%
lack of relevant training and information	19%	22%
damaged irrigation infrastructure	66%	51%

(Source: study survey, 2013)

97% of Makwe farmers ranked high water cost as their number one problem that hinders them from achieving household food security. Lack of credit to buy inputs and labour was ranked second by 81% of the sample farmers. Lack of output market (69%) and damage to equipment and infrastructure (66%) such as the engine pump, canals and fences were ranked third and fourth, respectively. In Masholomoshe scheme, 83% of farmers ranked shortage of water as their main problem, and 71% listed lack of

output market as their second major problem whilst 63% of farmers listed lack of inputs third biggest problem.

4.3 Econometric analysis of results

4.3.1 Linear regression analysis of results

Results of inferential statistical analyses are shown in Table 4.9 which shows the impact of various variables on farm household income per capita generation by smallholder farmers. The household income per capita was obtained by dividing farm income by the size of the household. The table shows that out of the eight variables, five were significant, three at 1% (household size, total yields for maize and total farm income), one at the 5% level (area cultivated) and the last at the 10% level (price of the product)

Table 4.9 Coefficients of variables in linear regression model

Variables	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	39.269	11.716		3.352	.001**
age of respondents	.212	.135	.042	1.569	.119
household size	-9.407	.823	-.340	-11.424	.000*
area cultivated	-72.369	28.633	-.098	-2.528	.013**
input cost	.034	.053	.025	.632	.529
total yields(maize)	.060	.017	.340	3.468	.001*
quantity sold (maize)	-.038	.025	-.167	-1.514	.132
price of the product	-.589	.349	-.048	-1.687	.094***
total farm income	.231	.019	.713	12.271	.000*
R Square = 0.950	Adjusted R Square = 0.898	Std. Error of the Estimate = 21.54428			

Source: study results; Dependent Variable: income per capita; n = 150; * = 1% ** = 5%; *** = 10%

The negative coefficients for household size of a farm household and the area cultivated reflect that both variables have negative impacts on household food security of a small-scale irrigation farm household. This means that as the household size increases, it becomes less likely that the farm household will have a high per capita income which

translates to household food security. Also as the area cultivated increases, it becomes less likely that the household will achieve a high per capita income. The last finding is however unexpected and will further be explained in the discussion of results.

Total yields, and total farm income have a positive impact on income generation as was expected as shown in Table 4.9. This means that these variables are important determinants of small-scale irrigation farm household income and food security. If the total yields of farm household increases by 100kg, the household per capita income will increase by \$34, hence household food security. As the total farm income increases by \$100, the household will obtain per capita income of \$71, 30 which adds to household food availability. The price of the product revealed a negative impact on household food security with the p-value of 0.094. The R^2 of the model was 0.903 with an adjusted R^2 of 0.898 as shown in table 4.9. R^2 measures how well the model fits the data and the higher the R^2 the better the model fits the data. Therefore, the results show that the model was a good fit.

4.3.1.2 Correlation between the variables

The results of a 2-tailed Pearson correlation test which measures the relationship or association between variables is given in Table 4.10. This measures the strength and direction of the relationship between the variables.

Table 4.10 Correlation matrix table

Pearson Correlations Matrix									
Variables	income per capita	age of respondent	household size	area cultivated	input cost	total yields	quantity sold	price	total farm income
income per capita	1.000	.046	-.625	.812	.079	.800	.842	-.527	.885
age of respondents	.046	1.000	.002	-.016	-.118	-.007	.022	.051	.026
household size	-.625	.002	1.000	-.020	.106	-.063	-.186	-.009	-.534
area cultivated	.812	-.016	-.020	1.000	.713	.662	.796	-.111	.722
input cost	.079	-.118	.106	.713	1.000	.181	.195	-.245	.172
total yields	.800	-.007	-.063	.662	.181	1.000	.952	.036	.855
quantity sold	.842	.022	-.186	.796	.195	.952	1.000	-.046	.888
price of the product	-.527	.051	-.009	-.111	-.245	.036	-.046	1.000	-.809
total farm income	.885	.026	-.534	.722	.172	.855	.888	-.809	1.000

Source: study results.

The results on the correlation matrix show that there was a significant association between most of the variables that were used in the study with the dependent variable. Household size and the price of the product had a negative relationship with the income per capita whilst size of the area cultivated, total yields, quantity sold and total farm income indicated a positive relationship with the dependent variable.

4.3.2 Binary logistic regression analysis

The results of the binary logistic regression model are shown in Table 4.11 which shows the impact of various variables on number of meals a household have a day which was used as a proxy for household food security. After elimination of many non-significant variables, only 4 variables were significant where rented land and availability of

extension services are significant at 1% while PTO and access to credit are significant at 5%.

Table 4.11 Binary logistic regression results

Variables	B	Exp(B)	Sig
PTO			0.063***
Title Deeds	1.22	3.414	0.022**
Rented	0.027	1.028	0.004**
CRDT(1)	0.110	.895	0.012**
EXT(1)	0.816	.442	0.004**
Constant	0.023	1.225	0.083***

Source: study results; n = 150; Dependent Variable: household have 3 or more meals a day; n = 150; **= 5%;

***= 10%

The model used the number of meals a household have a day as a proxy for household food security. The dependent variable was whether the household eats three or more times a day or not with those who have 3 or more meals a day regarded as food secure. This was regressed against three predictor variables that is, land tenure (TENURE), access to credit (CRDT), and access to extension services (EXT) following the elimination of some highly insignificant variables, that is PTO, having title deeds and rented the land. The results show that tenure system has a positive effect on the number of meals a household have per day with p-values of 0.063, 0.022, and 0.004 for those with PTOS, title deeds and those who had rented the land, respectively, and all had positive coefficients. Access to credit and extension services show a positive relationship with the number of meals a household have a day as was expected. This means that for every extra \$1 a farmer gets in loan, it is 0.110 more likely that the farm

household will achieve food security and for every extra service a farmer gets from extension workers, the odds of achieving household food security increase from 0 to 0.442.

4.3.2.1 Model predictability and Hosmer and Lemeshow Test

The model predictability level is shown in Table 4.12 which classifies the variables that were entered in the model. The model correctly predicted 65% of the cases entered in the model as correct.

Table 4.12 Classification Table

Observed	Predicted		
	household eats 3 or more times a day		Percentage Correct
	household 3 or more times a day	household eats less than 3 times a day	
household eats 3 or more times a day	42	25	62.7
household eats less than 3 times a day	27	56	67.5
Overall Percentage			65.3
Hosmer and Lemeshow Test Chi-square =5.7 P-value = 0.68			

Source: Study Results

The Hosmer and Lemeshow test produced a chi squared value of 5.70 with a p-value of 0.68, indicating that the model's predicted estimates did not differ significantly from the observed data and thus an indication of an acceptable goodness of fit which means that the model was fit for the analysis.

4.4 Discussion of the results

This study revealed descriptive and inferential statistical results related to small-scale farmers at the Masholomoshe and Makwe irrigation schemes. From the former, it could be established that most small-scale irrigation farmers are old people who have retired

from their formal jobs. This finding has a significant impact on the sustainability of irrigation farming. In a study conducted by Fiebig (2010) in Namibia, the age of the household head was found to be a significant factor in affecting household income and food security. Regarding the gender spread of small-scale irrigators, the finding of this study was that females were the most dominant. This is a positive outcome because women are regarded as pillars of ensuring household food security. A study by Nekhavambe et al (2012) uncovered the dominance of males in smallholder irrigation despite women being major providers of labour. The dominance of females in the two schemes that are the focus of this study is therefore a welcome trend.

Results also revealed that most farmers from the two schemes had primary education. This differed from the Heckman two-stage estimation conducted by Grimm (2007) in India that indicated that secondary education was the most significant factor on livelihoods. This corresponds with a qualitative study conducted by Aseyehgn (2012) in which he concludes that most of the small-scale irrigation farmers in developing countries have attained secondary education which enable farmers to have adequate farming knowledge. Farmers with secondary education were also able to calculate and apply required measurements such as plant spacing and fertiliser application. It can be concluded that farmers need to have higher levels of education to improve their household food security.

Farming was found to be the most important source of income for farmers and this confirms its importance as a contributor to household income and food security. However, off-farm income sources enable farmers to purchase inputs and irrigation technology. Therefore off-farm income compliments on-farm income and consequently improves livelihood and per capita income which determines the level of food security a household have with higher per capita income preferred than the lower one.

The results also indicated that household size was significant in determining farmers livelihood because the larger the household size, the more labour available for farming activities. Ayele (2005) concludes that the productivity of labour and technology employed in agriculture is central to household livelihood and food security in developing countries.

Results of the study reveal that most farmers in Makwe irrigation scheme had rented the land that they used followed by those who had title deeds for their land. A substantial number of farmers had Permission to Occupy (PTO). In Masholomoshe scheme most of the farmers had title deed, rented and only a few had PTOs. Shah *et al.* (2007) states that providing security of tenure to small-scale farmers is often seen as a pre-condition for intensifying agricultural production and is increasingly stressed as a prerequisite for better productivity and household income. However, with high percentage of rented land in Makwe, paid rent to the owners of the farms from the little income that they got from farming, farmers ended up with very little to sustain their families. Farmers with title deeds to their land indicated that these documents mean nothing to them because they still lack other resources such as seeds and financial capital to produce at full capacity. Therefore, land tenure status is considered to be an important factor in determining the productivity of small-scale irrigation farmers. In Ethiopia, Aseyehegn (2012) argues that legal system of land and water rights, support services and well-established water users associations through which purposes of irrigation are achieved are not adequately planned and put in place in most small-scale irrigation schemes in Africa. This, Aseyehegn concluded, impacts negatively on productivity and farm household food security.

Farmers in Masholomoshe and Makwe irrigation schemes only managed to grow one crop for the cropping season 2012/2013 due to shortage and high water cost. Most farmers chose to produce maize because it is a staple food in the country and is a significant contributor to food security. This is in contrast with Ojo *et al.* (2011) who attested that small-scale irrigation allows farmers to grow a variety of crops and produce crops throughout the year. According to a qualitative study conducted by Aseyehegn (2012) in Ethiopia, availability of water was the most important component of irrigation schemes to be sustainable and ensure household food security. Shah *et al.*, (2007) further added that shortage and high water cost undermined small-scale irrigation productivity, ultimately risking the feasibility and sustainability of small-scale irrigated agriculture.

The study also revealed that the area cultivated in the two schemes was very small. This in turn had a negative impact on the yields, quantity sold and total farm income. According to a study conducted by Murray (2006), the larger the area cultivated, the bigger the yields a farmer gets and this enables farmers to have enough for household consumption and a surplus for selling, hence improving household income. Therefore, it can be concluded that the area cultivated by farmers was very small and this had a negative impact on production, yields and total farm income and hence the low household food security.

The gross margin analysis revealed that there was no significant difference between the two schemes gross margins. The average per capita income per day (\$1.70) which was obtained by dividing the farm income by the household size was slightly higher than the poverty line critical value of \$1.25 per day (Geohive, 2012). According to the Geohive (2012) all households that rely on more than \$1.25 per capita income per day are regarded as food insecure because they live above the critical poverty line value. However, given the Zimbabwean situation with very high food prices, the average per capita income is not enough to sustain the households. Therefore, it can be concluded that the small-scale irrigation households from the two schemes are food insecure.

Regarding the role played by supporting institutions, the study revealed that farmers had poor access to input and output markets, credit facilities and information and training while extension agents were their main support system. This corresponds with BFAP (2008) who asserts that there is a serious lack of supporting services for small-scale irrigation farmers in most developing countries. Ojo *et al.* (2009) in Nigeria emphasises that access to input markets enables farmers to purchase seeds, fertilisers, pesticides and other inputs which aid production whilst access to credit provide farmers with capital to purchase these inputs. Output markets enable farmers to sell their produce to get income which then enables them to purchase other household necessities that improve their food security status. It can then be concluded that the availability of supporting institutions and services is crucial in the small-scale irrigation farming.

Provision of agricultural extension services, such as practical training and technical advice on improved production techniques help small-scale irrigation farmers increase their knowhow and access to information which in turn improves their production levels. Ayele (2005) revealed that inadequate information, education, and training are significant barriers to attaining food security. Therefore, the role of extension agents in providing improved varieties of crops and practical training to innovative farmers is crucial.

The study identified shortage of water and high cost of irrigation as the main challenges that are hampering irrigation production in Masholomoshe and Makwe irrigation schemes, respectively. The study revealed that Makwe scheme owed Zimbabwe national water Authority (ZINWA), the body regulating water usage in Zimbabwe, thousands of dollars in debt. The scheme is struggling to pay the required amount. In an attempt to raise the money to pay for water they came up with a method of farming called the Block system. The block system divides the scheme into different sections for different crops and only those who were willing to pay designated prices were allowed to grow certain crops. According to Nhundu *et.al.* (2010), insufficient water and high water cost in irrigation production and management have a negative impact on farmer household food security because these challenges impact on the efficiency and operation of irrigation schemes.

The study also revealed that shortage of credit is another major problem that farmers face. Farmers need financial capital to buy inputs such as fertilisers, seeds, pesticides and other farm inputs. This is in line with Machethe *et al.* (2004) who argue that one of the most critical problems threatening the viability of smallholder irrigation is the absence of credit. Access to credits need collateral mostly in the form of land right which some smallholder farmers do not possess. Credit is very important in that it helps farmers to acquire all the necessary inputs in right quantities and qualities at the right time. Adequate credit could help adopt new technologies. Ayele (2005) added that one way of overcoming financial constraints is improving access to credit. This is because credit access has a direct effect on investment in irrigation. For instance, credit access increases the capacity of irrigators to purchase agricultural inputs and mitigate risks of

crop failures. It serves as a crop insurance which helps farmers to be strongly engaged in such costly farming activities. Therefore, it provides start-up capital to begin more profitable business to generate higher income and ensure food security.

Damaged infrastructure is also among the major constraints that farmers face in their respective schemes. Farmers in Makwe pointed out that their main problem is the constant generator break down. Since the scheme suffers from financial crisis, it takes a long time for them to repair the engine. The generator is used to pump irrigation water from the dam to the scheme. Most farmers in Masholomoshe complained about the damage on water canals that are too old and are worn out. This means that the construction of new canals is necessary. Other problems they face include the worn out fences which allow animals such as goats to enter and graze on their crops. He *et al.* (2006) in a study conducted in Zambia concluded that the absence or unreliable supply of inputs and equipment, as well as insufficient transportation or infrastructure can also be major barriers to improved productivity and profitability in small-scale irrigation schemes.

The econometric results revealed that although household food security of a small-scale irrigation farm household is affected by many factors, only a few variables had a significant relationship to income per capita. In the study, household income per capita was used as a proxy for food security. The variables that proved to be significant on household food security using linear regression model were household size, area cultivated, quantity sold for maize and total farm income. Land tenure, access to credit and extension services were significant to household food security using a binary logistic regression model. However, an analysis conducted by Murray (2006) in which he regressed all the factors affecting small-scale irrigation farming, revealed that income, access to market information, land ownership and access to market information and credit were positively and significantly associated with household income. Thus, improving rural farm households' access to market information is likely to improve small holder farmers' income and household food security.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study revealed the following:

- Most small-scale irrigation farmers were old women with primary education.
- Farming was found to be the most important source of income for farmers and this confirms its importance as a contributor to household income and food security.
- Household size was significant in determining farmers livelihood because the larger the household size, the more labour available for farming activities.
- Most farmers in Makwe irrigation scheme had rented the land that they used followed by those with tittle deeds for their land whilst a substantial number had Permission to Occupy (PTO). In Masholomoshe scheme most of the farmers had tittle deed,
- Most farmers in the two schemes mostly grew maize for the cropping season 2012/2013 due to shortage and high water cost. Maize is considered to be the most important staple food in the region
- The area cultivated in the two schemes was relatively small, a factor that has had a negative impact on the yields, quantity sold and total farm income.
- The gross margin analysis revealed that the farmers from the two schemes obtained very little profit (there was no significant difference between the two schemes' gross margins).

- Farmers had poor access to input and output markets, credit facilities, information and training while extension agents were their main support system.
- Shortage of water and high cost of irrigation were the main challenges that hampered irrigation production in Masholomoshe and Makwe irrigation schemes respectively. Shortage of markets, credit and damaged infrastructure, the constant engine break downs and broken fences were other constraints in the schemes.
- Lack of transport and stable markets, and high transport costs were the major challenges faced by farmers in marketing their produce.
- The econometric results revealed that, household size, area cultivated, quantity sold for maize and total farm income regressed on linear model had a significant relationship with household food security. Land tenure, access to credit and extension were significant to household food security using a binary logistic regression model.

5.2 Conclusion

- The first hypothesis of the study was that there was no significant impact of socio-economic factors on household food security of small-scale irrigation farmers. The finding that most farmers were elderly women translates into production and productivity challenges as depicted by descriptive statistical analyses. Despite the low gross margins for example, inferential statistical analyses have shown that if the total yields of farm households were to increase by 1kg, the probability that a given household could have high per capita income was more than 34%, and thus ensuring food security. The hypothesis as stated is therefore rejected.
- The second hypothesis was that there was no significant difference between farm incomes of Masholomoshe and Makwe small-scale irrigation schemes. The results on the gross margin analysis revealed that the net gross margins of the two schemes were very low with minimal difference between their net incomes.

This means that farmers from both schemes obtain almost the same average farm incomes regardless of the schemes. The hypothesis is therefore accepted.

- The third hypothesis stated that supporting institutions play a significant role in helping irrigation farmers to achieve household food security. The study found that farmers had challenges in accessing adequate supporting institutions which provide them with essential services such as markets to sell their produce, credit to buy inputs, farming information and training for them to increase production. This translated to constraints in increasing productivity in the schemes and in achieving household food security. For instance the inferential statistical analysis revealed that if a farmer could get an additional \$1 in credit, the probability of the household having 3 or more meals a day was about 90%. Therefore, the stated hypothesis is accepted.
- The last hypothesis was that there was no significant relationship between the constraints faced by the small-scale irrigation farmers and their household food security. The findings that farmers from both schemes faced many constraints in farming which included high cost and shortage of water, lack of credit to buy inputs, lack of production information and training and damaged infrastructure in the schemes resulting in low yields and gross margins, shows that there is a relationship between the constraints faced by farmers and their household food security. Therefore the stated hypothesis is rejected.

5.3 Recommendations

- This study has noted that most farmers are elderly and less productive, translating into challenges for food security despite the finding that increasing total yields of farm household could significantly increase per capita incomes. Strategies to counter this negative impact could include information sessions with youth at schools and institutions of higher learning to participate in farming ventures. Government could play a meaningful role of providing stipends that

could be allocated to small irrigation schemes at competitive market rates for placement of identified youth holding agricultural qualifications.

- The finding that the farmers from the two schemes obtained very low average net farm incomes can be countered by providing workshops that will teach farmers on how to manage their farm incomes. The government could also assist by giving small-scale irrigation schemes some funds as a start-up capital. This would enable them to buy adequate production inputs and increase their productivity and hence farm income.
- The study also revealed that farmers lacked access to supporting services such as markets, loans, farming information and training. Stakeholders could counter these problems by searching for output markets before production of a certain crop begins. The state could also establish institutions that could be specifically designed to help small-scale irrigation farmers with funds, information and skills transfers. Low interest loans could also be provided to farmers.
- Strategies to counter production challenges could include water price subsidies. The farmers could also be assisted to construct water storage facilities such as dams and water tanks.

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736191759 or by email. langza@electonmail.co.za

Signature: Respondent

Date:

Appendix A: Consent Form

Good day, my name is Ndlovu Langelihle (BN565990) from the University of Venda. I am conducting a research on the analysis of the constraints faced by small scale irrigation farmers in achieving household food security. This is in partial fulfillment of the degree masters of Science in Agricultural Economics (MSCAEC). This research is meant to identify the constraints faced by small scale irrigation farmers in achieving household food security.

I have randomly selected you to participate in this study. i would like you to respond to the questions. If possible, I would like to talk to the principal owner of the plot/farm. i have randomly selected you within this scheme as one of other small –scale irrigation farmers in this area to be interviewed.

Please understand that participation in this study is voluntary and you may decide to discontinue completing the questionnaire at any time. However, i would really appreciate it if you do share your thoughts with me. If you choose not to take part in answering these questions, you will not be affected in any way whatsoever. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this, there will also be no penalties and you will NOT be prejudiced in ANY way. When it comes to answering questions there are no right and wrong answers.

The study will hold no risks for you or to any other member of your community. Although you will not personally benefit from this study, i will do my best to make sure that people in irrigation scheme benefit from this study. All information that you give will be kept confidential and you will not be identified by name or address in any of the reports that will be written.

If you would like some more information about this study please feel free to contact me on 0027-736191759 or by email, langa@classicmail.co.za

Signature: Respondent

Date.....

DECLARATION BY FIELDWORKER

DECLARATION BY FIELDWORKER

I hereby declare that I explained to the respondent that he or she is participating freely in this research. I also explained to the respondent that he or she may stop this interview at any point and that such a decision would not in any way affect them negatively. I explained to the respondent that this is a research project whose purpose is not necessarily to benefit him or her personally. I explained to the respondent that the answers he or she will provide during the interview would remain confidential.

Male

1

Signature of enumerator

Date:

A.3 level of education

Primary	0
Secondary	1
High school	2
Tertiary	3

A.4 numbers of people in household

A.5 income sources

Farming	0
Employment	1
Contributions	2
Other	3

A.6 Please indicate the type of land you own

Freehold	0
Leasehold	1
Rented	2
Other (please state)	3

Appendix B: Interview Questionnaire

This questionnaire will be directed to small-scale irrigation farmers.

NB: TICK THE APPROPRIATE ANSWER WHERE ANSWERS ARE PROVIDED

SECTION A: BIOGRAPHICAL INFORMATION

A1 Genders of respondents

Female	0
Male	1

A2 Ages of respondents

.....

A3 level of education

Primary	0
Secondary	1
High school	2
Tertiary	3

A.4 numbers of people in household

.....

A.5 income sources

Farming	0
Employment	1
Contributions	2
Other	3

A.6. Please indicate ownership of your plot (Tenure Status)	
PTO	0
Title Deed	1
Rented	2
Other (please state)	3

SECTION B: FARM INCOMES FROM FOOD CROPS

B1. Crop and area cultivated, yields, quantity consumed and sold

Crop type	Area cultivated during production season (ha)	Total value of all inputs used for the crop during season (\$)	Total Yields for the crop (kg)	Quantity consumed (kg)	Quantity sold (kg)	unit price (\$/kg)	Total income for the crop (\$)

B2. Why do you select the above type of crops for your irrigation farming?	
0 = Better price	0
1 = Good production	1
2 = High disease tolerance	2
3 = Easiest to cultivate	3
4 = Seed availability	4
5 = Other (specify)	5

B3 Do you cultivate the total area of your irrigable land every season?

0 = No

1 = Yes

B4. If your answer to question 3 is No, what are the reasons? (Circle the answers)

Shortage of family labour	0
Lack of seed	1
Lack of oxen	2
insufficient irrigation water	3
Lack of credit	4
Other (specify)	5

B5 Are the yields enough to sustain the household throughout the year?

0= yes

1= no

B6 If No for how long does agricultural yield sustain the household per year?

B7 When do you experience food shortages?

B8 How many times do the household eat a day?.....

B9 What are your food shortage coping mechanisms?

SECTION C SUPPORTING INSTITUTIONS

C1. Where do you get the production inputs that you use?

0= buy

1= provided by the government

2= provided by the private organisations

3= other (specify)

C2. If you buy which inputs do you buy and how much? List in the table below

Production input amount per ha	Cost of input per ha (\$)
Treated Seeds	

Fertilizer	
Pesticides	
Insecticides	
Other (<i>Specify</i>)	
Total cost of inputs	

C3 How do you cultivate your land? (Tick as appropriate) and indicate the costs

Own	Borrowed	Hired	Cost (\$)
Tractor			
Animal drawn			
Hand			
Other (<i>Specify</i>)			

C4 What help do you need from the government or any organization on your irrigation farming

0=seeds

1= fertiliser

2= markets

3= transport

4= loans

5=other

C5 Do you have adequate infrastructure and irrigation equipment in the scheme?

0= Yes

1= No

C6 Did you ask or apply for a loan from any of the following:	
Family members and friends	01
Neighbours	02
Local dealer / shop	03
Stokvel	04
Money lender (<i>mashonisa</i>)	05
Employer	06
Church	07
Other (<i>Specify</i>)	08
No Response	09

C7 What kind of security (collateral) did you provide?	
None	01
Land	02
House and homestead improvements	03
Equipment	04
Livestock	05
Crops	06
Bank card	07
ID book	08
Television / fridge	09
Other (<i>Specify</i>)	10
No Response	11

C8 What was the loan used for	
Buy food	01
Pay medical expenses	02
Pay school fees	03
Pay for funeral	04
Buy furniture	05
To pay off debt	06
Purchase inputs and services (For business or farm)	07
Working capital (For business or farm)	08
Purchase land/Equipment/Buildings (For business or farm)	09
Other (<i>Specify</i>)	10
No Response	11

C9 Why did you not apply for a loan or for credit from a formal credit institution?	
High interest rate	01
Could not offer security	02
Did not need loan	03
Did not think I would get one	04
Lack information on credit institutions	05
Afraid of debt	06
Other (Specify)	07
No Response	08

C10 Do you receive any sort of extension services available in your locality?

0 = No

1 = Yes

C11 do you receive farming training from any organisation?

0= no

1= yes

2= sometimes

C12 .Do you get market information about prices and demand conditions of agricultural inputs and out puts?

0 = No

1 = Yes,

C13. Where do you get the information?

0 = extension workers

1 = government agencies

2 = NGOs

3 = private organisations

4 = other (specify)

C14. Are you a member of any farmer organisation?

0= NO

1= yes

C15. If yes how do they help you in production?

C16. Are you satisfied with the operation and management of the scheme?

0=Yes

1= No

C17. If no what do you suggest should be done to improve the operation and maintenance of infrastructure and equipment in the scheme

C18 Is the scheme and equipment properly maintained?

0= YES

1= NO

C19. Does damaged equipment get repaired on time?

0= Yes

1= No

C20. If No how long does it take to be repaired and how does it affect your production

C21. Is the amount of water enough to irrigate your land every season?

0= Yes

1= No

C22. If your answer is no, what mechanisms do you suggest to solve the scarcity of water

SECTION D: MAJOR PROBLEMS FACED BY FARMERS IN THE SCHEME

D1. What general problem do you experience in moving your produce to the market? (Please tick)

Small size of transport
Lack of transport
High transport cost
cost Other (Specify)

D2. What are the major problems you face/observe in your irrigation farming?

0= water

1= management

2= maintenance of infrastructure

3= lack of inputs

4= lack of supporting institutions

5= other

D3. What actions do you take to solve the problem?

D4. What problems do you face interms of water allocation

0= insufficient water supply

1= high costs

2= unfairness

3= other

D5. What are the major problems in operation and management of the scheme? What is your opinion about the solution?

0= exclusion from decision making process

1= mismanagement of funds

2= damaged equipment

3= other (specify)

solutions.....

D6. List what you consider to be the major problems you face in production and marketing your farm products and in the scheme in general

D7. Suggest ways in which such problems can be addressed

Thank you!!!!

Appendix C: Extension worker interview guide

This questionnaire will be directed to the extension workers

1. Which irrigation method is used in the scheme?
2. Do you think it is the correct method suitable for the scheme?
3. Who manages the scheme?
4. Do you involve farmers in decision making of the scheme?
5. Do you have enough water supplies for the scheme throughout the year?
6. When do you usually experience water shortage in the scheme?
7. What types of crops are grown in the scheme?
8. Who decides on the crops to be grown?
9. Do you think farmers have enough knowledge and skill to produce those crops?
10. Do you think farmers produce enough for their household consumption and also for selling?
11. What assistance do you provide to the farmers to improve production?
12. Is the infrastructure and equipment in scheme enough for everyone and accessible to all farmers?
13. Do you think all farm households are food secure?
14. What are the main challenges that farmers face in production and in achieving food security?
15. What are the main challenges that the scheme that hinder farmers from improving production?

Appendix D: Work Plan

Date	Item	Activity	Responsibility
April – June 2013	Research proposal	Submission of final research proposal (Supervisor)	Student
		Questionnaire design	Student
	Research assistant	Submission of final research proposal (Higher Degrees Committee)	Supervisor
		Proof reading/Editing of the research proposal	Student
		Submission of final research proposal (SENEX)	Supervisor
July-September 2013	Data collection	Pretesting/ Pilot study	Student
		Refinement	Student
		Field data collection	Student
September-December 2013	Data analysis	Data coding and entry	Student
		Data cleaning	Student
	Final copy of research	Thesis write up	Student and supervisor
		Submission of first draft	
		Submission of second draft	
		Proof reading of thesis	
		Submission to external examiners	
		Corrections from external examiners	
		Binding	
		Final submission of the thesis	

Appendix E: Budget

Activities	Item	Quantity	Unit cost	Total
Travel	Travel to the research site ($\approx 650\text{km}$ / single journey)	4 trips	R3.16/km	R8 216
Accommodation	Accommodation at research site	5 days	R800	R4 000
Administration	Stationery :Bond papers	13 rims	R45	R 585
	Printing(drafts, questionnaires and final copies),	2000 pages	R2.50/copy	R5 000
Data Collection	Research assistants	3 assistants x 8hrs/ day for 10 days	R30/ hr.	R7 200
	Questionnaire pretesting		R1 500	R1 500
	Catering for researcher and assistance	3x 10 days	R120/ day	R3 600
Data analysis	Data cleaning, coding and capturing	3 assistants x 8hrs/day for 10days	R30/hr.	R7 200
	Statistical analysis	1	R3 500	R3 500
	Proof reading of final copy	1	R3 000/copy	R3 000
	Binding of final report	6	R250.00	R1 500
	Contingency	10% of estimated costs		R4 699
TOTAL				R50 000

Analysis of the constraints faced by small-scale irrigation farmers in achieving household food security: A case study of Masholomoshe and Makwe irrigation schemes in Gwanda District, Matabeleland South Province, Zimbabwe.

A mini-dissertation submitted by

Ndlovu Langelihle (11585391)

In partial fulfillment of the requirements for the degree Masters of Science in
Agricultural Economics (MSCAEC)

To the

Department of Agricultural Economics and Agribusiness, School of Agriculture,
University of Venda.



University of Venda

Supervisor:

Dr. P. K. Chauke

Co- Supervisor:

Mr. T. K. Pfumayaramba

November, 2013

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Declaration

I Ndlovu Langelihle hereby declare that this research mini-dissertation for Masters of Science in Agriculture Economics at the University of Venda hereby submitted by me, has not been submitted previously for a degree at this university or any other university, that it is my own work in design and in execution, and that all reference material contained therein has been duly acknowledged.

Signature.....*Ndlovu*.....

Date.....01-04-2014.....

Main supervisor: Dr P.K Chauke

Signature.....*PK Chauke*.....

Date.....2014-04-01.....

Co-Supervisor: Mr T.K Pfumayaramba

Signature.....*PK Chauke*.....

Date.....2014/04/01.....

Abstract

The study analysed the constraints faced by small-scale irrigation farmers on household food security in drought prone agro-ecological region 5, Gwanda district. The study conducted a case study of Masholomoshe and Makwe irrigation schemes in Gwanda district of Matabeleland south province in Zimbabwe. The main objective was to analyse the impact of the constraints faced by small-scale irrigation farmers on household food security. The study looked at the socio-economic factors, production levels, role of supporting institutions and the constraints faced by farmers. Primary data was collected using interview questionnaires with open and closed ended questions. Questionnaires were designed based on objectives and research questions. Key informant interviews were also carried out with the extension officers. The data was captured and analyzed using statistical package for social scientist (SPSS). Descriptive statistics, gross margin, multiple linear and binary logistic regression models were all used to analyse the data.

The study established the dominance of women and the elderly who are less educated farmers, use of rented land and farming as the main source of income. The study also revealed that farmers were not able to grow crops throughout the year and they obtained very small net farm incomes. The main supporting service that the farmers were getting was the assistance from the extension workers and their main constraints were high water costs, shortage of water, lack of access to credit, lack of inputs and output markets, lack of relevant training and information and damage to irrigation infrastructure. Inferential statistical analyses detected a negative impact of household size, area cultivated, total yield, and quantity sold to household food security while total income, land tenure, access to credit and extension services had a positive impact. Amongst others the study recommended financial assistance to farmers in form of subsidies on input prices, low interest loans, and skills transfers. Farmers could also be assisted to construct water storage facilities such as dams and water tanks.

encouragement, guys you were a perfect family to me.

Lastly but not least, I would like to thank God for all the guidance and protection, for with Him all things are possible!!

Acknowledgement

I would like to express my deep whole-hearted gratitude and indebtedness to my supervisor Dr P.K Chauke and co-supervisor Mr T.K Pfumayaramba for their skillful guidance and support throughout the course of this work. Their critical and valuable comments and suggestions are worthy enough to be mentioned here. Without their support and endless understanding, this mini-dissertation would not have had its present shape. Thus, they deserve special thanks.

I gratefully acknowledge the department of Agricultural Technical and Extension Services (AGRITEX) in Gwanda, Zimbabwe for all the help that I got from them with special thanks to Mr M.M Ndlovu and the irrigation engineer for the department Mr Mpotengwa. I also thank all the farmers in Makwe and Masholomoshe irrigation schemes that were part of this study, without them this project would not have been successful.

The understanding, support and encouragement that I have obtained from my family was a driving force throughout my study time, Mum, you have always been the pillar of my strength and for that I will always love you! To my uncle and Aunt Mr and Mrs B Khumalo, your love and support did not go unnoticed, you have both been there in every movement of my academic success ever since I was young, thank you very much and may the Lord continue to bless you .

I wish to thank all my friends at Univen for their constant support and encouragement. I would like to mention in particular Ndabezinhle, Buhle, Mavis and Cris who were there in every moment of my study. Timothy, the competition and motivation you gave me was worth it, thank you very much, special thanks also goes to the Univen Seventh Day Adventist Students Movement (SDASM) members for all the prayers and encouragement, guys you were a perfect family to me.

Lastly but not least, I would like to thank God for all the guidance and protection, for with Him all things are possible!!

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ABDA	Agricultural and Rural Development Authority
AREX	Department of Research and Extension Services
CC	Chiefs' Councils
DDF	District Development Fund
FAO	Food and Agriculture Organisation
GOZ	Government of Zimbabwe
IFAD	International Fund for Agricultural Development
MARD	Ministry of Agriculture and Rural Development
NGO	Non-Governmental Organisation
ODI	Organization Development Institute
O&M	Operations and Management
PTO	Permission to occupy
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
SWAZI VAC	Swaziland Vulnerability Assessment Committee's survey
W&RP	World Bank's Rural Portfolio
WCD	World Commission on Dams
WFP	World Food Programme
WUA	Water User Association
ZAPF	Zimbabwe Agricultural Policy Framework
ZINWA	Zimbabwe National Water Authority

List of Acronyms

ARDA	Agricultural and Rural Development Authority
AREX	Department of Research and Extension Services
CC	Catchment Councils
DDF	District Development Fund
FAO	Food and Agriculture Organisation
GOZ	Government of Zimbabwe
IFAD	International Fund for Agricultural Development
MARD	Ministry of Agriculture and Rural Development
NGO	Non-Governmental Organisation
ODI	Organization Development Institute
O&M	Operations and Management
PTO	Permission to occupy
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
SWAZI VAC	Swaziland Vulnerability Assessment Committee survey
WBRP	World Bank's Rural Portfolio
WCD	World Commission on Dams
WFP	World Food Programme
WUA	Water User Association
ZAPF	Zimbabwe Agricultural Policy Framework
ZINWA	Zimbabwe National Water Authority

CHAPTER ONE

INTRODUCTION

1.1 Background

Irrigated agriculture is one of the critical components of world food production, which has contributed significantly to maintaining world food security and to the reduction of rural poverty (FAO, 2008). Empirical studies have shown that 17 percent of global agricultural land is irrigated and contributes about 40 percent of the global production of cereal crops (World Bank, 2009). Irrigation developments have been recommended as a powerful tool to enhance agricultural productivity and poverty reduction in dry areas (Miele, 2008).

However, in most developing countries, irrigation development fails to achieve the intended objective. Some studies point out that properly implemented smallholder irrigation, with appropriate technologies, may have a considerable potential in improving rural household food security, although the viability of such irrigation schemes becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Shah, 2007).

FAO (2008) pointed out that many Sub-Saharan countries have realized the critical role of irrigation in food production. However, a number of constraints, including the relatively high cost of irrigation development, inadequate physical infrastructure and markets, poor investments in irrigation, lack of access to improved irrigation technologies and lack of cheap and readily available water supplies, have been responsible for a relatively slow rate of irrigation development in this region. FAO (2008) identified further constraints that affect the capacity of farmers to invest and manage irrigation projects as the poor resource base for farmers, fragmented and the small size of land holdings, unsecured or lack of land titles, high interest rates and poor transportation and marketing facilities.

A number of evaluation studies suggest that formal smallholder irrigation schemes in Zimbabwe (either community- or government-managed) have poor performance records and are not sustainable (Chazovachii, 2012). Problems identified include poor water utilisation in terms of its timeliness and adequacy to the field, and poor water application to the field (Manzungu, 2007).

Crop yields in small scale irrigation farms have been low and way below those achieved in the commercial farming sector. Poor agricultural performance has translated into poor financial and economic viability, thereby necessitating heavy government subsidies of up to 75% in some cases. The problem, according to Rukuni and Eicher (2006), is the inappropriate conventional budgeting technique, which ignores the sub-sector's unique history. Meinen-Dick *et al.* (2007), however, emphasise that agro-economic performance of smallholder irrigation schemes depends on a number of factors such as plot size, level of education of plot holders, access to markets and management structure. It is important to highlight that the state continued the colonial practice of controlling all irrigated activities in the schemes. For example, farmers were required to follow set cropping programmes, and irrigation schedules (Manzungu, 2007).

The Government of Zimbabwe (GOZ) recognises the role of irrigation development as a key drought mitigation measure. Tremendous strides have been made by the government, the private sector and the donor community in the area of irrigation development since independence in 1980 (Rukuni *et al.*, 2006). However, smallholder farmers in Gwanda District in Zimbabwe face food insecurity on an annual basis due to a combination of erratic rainfall (180 - 850 mm/a over a 30 year time series) and insufficient production in irrigation schemes in the area. This impacts both on household livelihoods and national food security (Meinen-Dick *et al.*, 2007). Literature shows that little has been done in finding out the causes of this problem of food insecurity given many small-scale irrigation schemes found in the area. It is because of these concerns that a study should be carried out in the area to investigate the constraints that hinder small scale irrigation schemes from achieving household food security.

1.2 Problem statement

Irrigation is being used in many countries especially in most developing countries like Zimbabwe to address the problem of food insecurity. Many studies have proved that small-scale irrigation indeed plays a vital role in enhancing food security (Chazovachii, 2012). Policies on irrigation have been redesigned to increase food security and improve livelihood initiatives amongst farming communities in Zimbabwe. A significant amount of investment on irrigation development and rehabilitation has been done since the country's independence in 1980. Non-governmental organisations such as World Vision, CARE international and IFAD have also contributed by supporting these schemes in every way possible. Therefore, households on irrigation schemes should be among the better-off because there is so much effort and investment that have been put in rural water supply for irrigation purposes in order to improve rural household's food security through improved productivity (Assefa, 2008).

However, despite all these efforts and investments, tons of food aid flow into Gwanda District every year due to rising food insecurity that prevails in the area. On the ground, these irrigation schemes do not seem to be performing up to standard. Irrigation has been successful in many countries raising the question why Masholomoshe and Makwe small-scale irrigation schemes in Gwanda District are not performing up to expectations. The study will, therefore, focus on critical economic constraints that are faced by Masholomoshe and Makwe small-scale irrigation schemes, and their impact on household income and food security. However, farm income will be used as a proxy for household food security. Therefore, it is assumed that the larger the farm income a farmer obtains, the more access the farmer have to food hence food security.

1.3 Objectives of the study

1.3.1 Broad objective of the study

The main objective of the study is to determine the critical constraints faced by small scale irrigation schemes farmers and their impact in achieving household food security.

1.3.2 Specific objectives are to:

- Determine the socio-economic factors of small scale irrigation farmers in Masholomoshe and Makwe irrigation schemes that affect household food security;
- Determine and compare the farm incomes from food crops in Masholomoshe and Makwe small-scale irrigation schemes;
- Assess the role played by supporting institutions in helping farmers to achieve household food security
- Determine the major constraints faced by irrigators and their impact in achieving household food security and improved livelihoods.

1.4 Research questions

- What is the impact of the socio-economic factors of small-scale irrigation farmers on household food security?
- What is the difference in farm incomes from food crops between Masholomoshe and Makwe small-scale irrigation schemes;
- What is the role played by supporting institutions in helping irrigation farmers achieve household food security?
- What are the major constraints faced by irrigators and their impact in achieving household food security and improved livelihoods?

1.5 Research hypothesis

- There is no significant impact of socio-economic factors on household food security of small-scale irrigation farmers.
- There is no significance difference between farm incomes of Masholomoshe and Makwe Small-scale irrigation schemes
- Supporting institutions play a significant role in helping irrigation farmers achieve household food security
- There is no significant relationship between the constraints faced by the small-scale irrigation farmers and their household food security.

1.6 Conceptual framework

The Neo-classical theory of demand can be used to provide a framework for how a household uses irrigation water to maximise household food security. Treating the household as a profit maximising firm, a household will employ an input if the added benefit provided is greater than the added cost of the input. Effectively, this means that the level of input use will occur until the marginal benefit is equal to the marginal cost. Applying this concept to the small-scale irrigation households, the household will use irrigation up to the point where the cost of an additional unit of irrigation just equals the added value its use produces. However, in regions where there is no water market, there is no explicit price for irrigation water. In this situation, the cost of irrigation can be represented by the labor cost of irrigating. Furthermore, for rural households, labour markets are often missing or ineffective, forcing households to be self –dependent with regard to their labour supply (Namara *et al.* 2007).

Literature on agricultural technology adoption identifies a number of factors affecting the decision to participate in irrigation farming (FAO, 2009). These factors include the physical, natural, human, social, community and financial assets of the agricultural household. Characteristics of the household, especially those of the household head are major deciding factors on whether to participate in irrigation farming or not. In particular, the household head's age, gender, level of education and household size influences the attitude one may have towards irrigation farming, (Bishir, 2004). Household size is also essential for determining the availability of labor to the irrigating household (FAO, 2006).

Information plays an important role in the efficiency and decision-making in order to improve productivity through small-scale irrigation (Feder, Just and Zilberman, 2010). Information regarding the use, productivity and input use and management of small-scale irrigation schemes contributes to improving household food security. The extent of the farmer's information about irrigation production is proxied by the number of irrigation meetings, extension or agricultural fair events attended, as well as the resources at the farmer's disposal.

The quality and topography of land can also influence the productivity of irrigation schemes (Zhou, 2008). It is believed that the farmer is more likely to achieve household food security if his land is good enough to produce a good return. Land tenure also influences the level of productivity of small-scale irrigators. The security of land tenure also affects the expected returns from investments in the land. Similarly, secure land rights reduce the risk of losing one's investment in the land. This therefore, increases the willingness of the farmer to participate and increase production in irrigation farming (Feder *et al.*, 2010).

Substantial literature has shown the importance of irrigation as a major driving force behind the increase in rural household income and food security. These studies attest to irrigation expansion as the main policy intervention strategy for alleviating rural household food insecurity and poverty. Figure 2.1 below provides a summary of the above description.

1.7 Delimitation and limitation of the study

1.7.1 Delimitation of the study

Due to limited time and budget, the study focused on only two of the 8 irrigation schemes available in the district. Interviews were conducted with small-scale irrigators, key informants and service providers.

1.7.2 Limitation of the study

The possible threats for the study were that farmers would give biased information that would make them seem worse-off in anticipation of food aid or donor support. The key informants may also be biased when giving information to hide their inefficiencies.

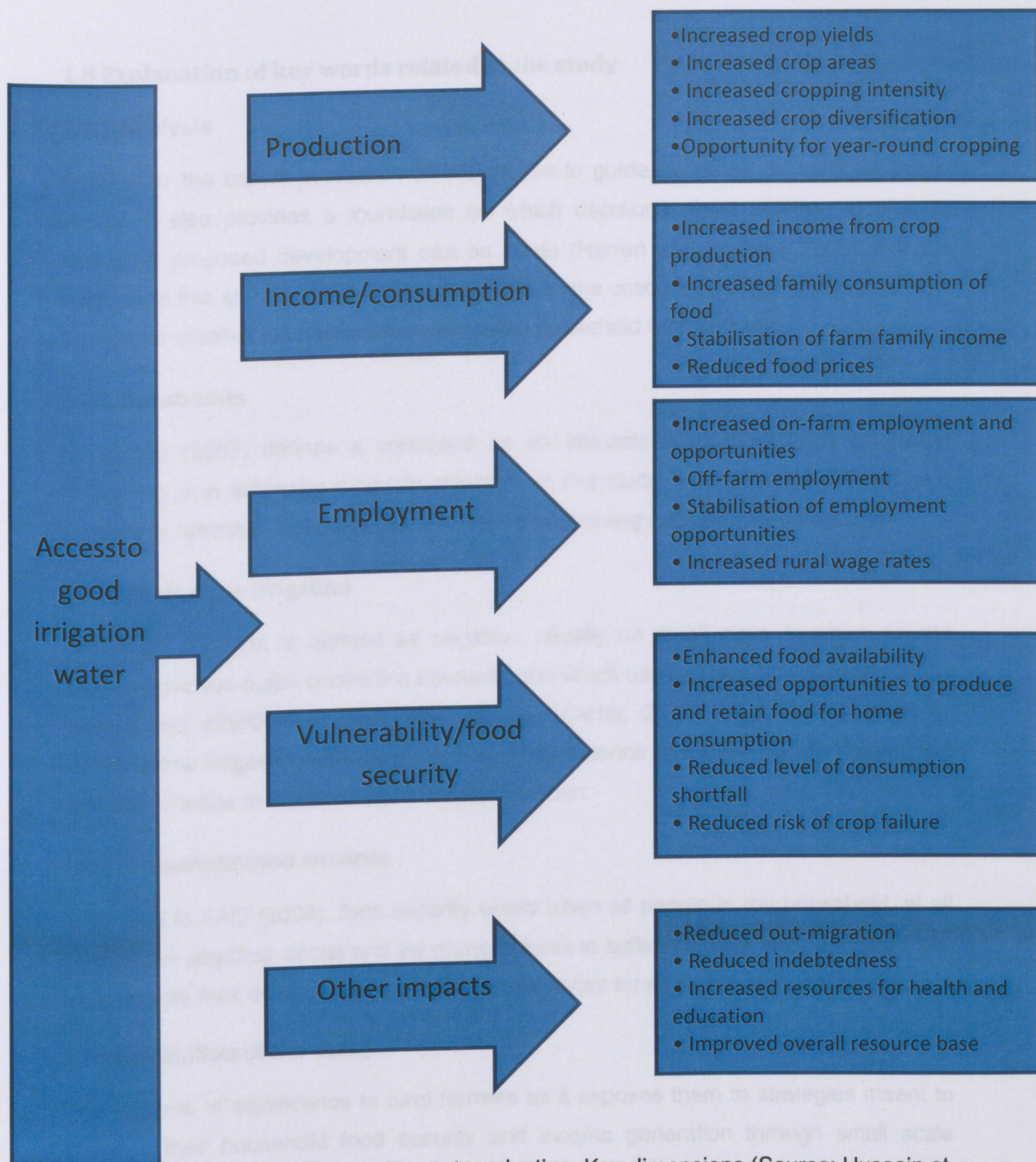


Figure 1 Agricultural water and poverty reduction: Key dimensions (Source: Hussain et al., 2004).

1.8 Explanation of key words related to the study

1.8.1 Analysis

Analysis is the critical evaluation of information to guide decisions on complex public issues. It also provides a foundation on which decisions about whether to alter or change a proposed development can be made (Herren and Watson, 2006). For the purpose of this study, analysis can be defined as the critical evaluation of the problems that hinder small-scale farmers from achieving household food security

1.8.2 Constraints

Manzungu (2007) defines a constraint as an obstacle or a difficulty in accessing something or in achieving a certain objective. In this study, a constraint is defined as a problem or hardship that prevents farmers from achieving household food security

1.8.3 Small-scale irrigation

Small-sale irrigation is defined as irrigation, usually on small plots, in which private farmers have the major controlling interests, and which uses a level of technology which farmers can effectively operate and maintain (Carter, 2008). Hecq and Dugauquier (2004) define irrigation agriculture as the art and science of harvesting and making the best use of water to increase agricultural production.

1.8.4 Household food security

According to FAO (2008), food security exists when all people in the household, at all times, have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences for an active and healthy life.

1.9 Justification of the study

This study is of significance to rural farmers as it exposes them to strategies meant to increase their household food security and income generation through small scale irrigation farming. The findings of this study are also expected to have major implications for policy-makers. It is expected that the research findings will assist the government in formulating relevant policies, and reviewing existing ones, while

developing support systems that will improve the productivity, profitability, sustainability and efficiency in the use of small holder irrigated agriculture in Zimbabwe. The research is also expected to help extension practitioners to develop technical, effective, realistic technologies, social, economic and sustainable interventions for the capacity building of small holder irrigation farmers. This will enable them to better manage their irrigation schemes so as to achieve food security, reduce poverty, sustain the environment, and create job opportunities for themselves and their families.

1.10 Proposed outline of the study

This chapter introduced the problem and gives a brief background to the study, define the objectives and specify the research questions. Chapter 2 presents relevant literature related to irrigation schemes in Zimbabwe and other parts of the world. Chapter 3 explains the methodology that was used for data collection, presentation and data analysis. It also discusses the model that was used to analyse data. Chapter 4 presents and discusses the findings of the study and chapter 5 provides summary, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Shuttleworth and Martyn (2009) define literature review as a critical and in-depth evaluation of previous research. It is a summary and synopsis of a particular area of research, allowing anybody reading the paper to establish why one is conducting the research. Goddard and Melville (2001) note that any investigation, whatever the scale, will involve reading what other people have written about one's area of study, gathering information to support or refute one's arguments and writing about one's arguments and findings. This chapter focuses on a broader understanding of the impact of the constraints faced in small scale irrigation schemes on household food security with reference to Swaziland, Ethiopia, Zambia, Ghana, South Africa and Zimbabwe.

2.2 Impact of socio-economic factors on household food security

Literature on small-scale irrigation shows that most of the farmers involved in farming activities on small-scale irrigation are mostly women. This is supported by a qualitative study conducted by Bishir (2004), in Ethiopia, in which it is concluded that women between the ages of 25 and 45 participate mostly in irrigation farming. He further notes that as much as this group constitutes the economical active, they lack powers to influence the management of the schemes as this is dominated by men. They also lack access to relevant and adequate information regarding the production and marketing of their produce, hence a negative impact on household food security.

Small-scale irrigation farmers' marketing capacity is limited by low production and productivity and a poor market information system (World Bank, 2008). However, Nekhavambe, Chauke and Pfumayaramba (2012) in a study of the assessment of factors that impact on income generation by smallholder irrigation famers in Limpopo, found out that males are the dominant gender (67.8%). Women, however, were found to be the main providers of farm labour. It has been shown by several studies that women participate in farming mainly to ensure family food security rather than for profit motives.

Nekhavambe *et al.* (2012) also revealed that 48.11% of smallholder irrigators had acquired secondary education with a substantial proportion (12.97%) reaching tertiary education. This is in line with Yokwe's (2009) findings in which he concluded that the level of education in most agricultural projects is medium to relatively high on average with secondary level being the most frequent level attained. Normally, farming investments are cross-subsidised by primary off-farm income, making the level of production and farming intensity higher.

The analysis conducted by Murray (2006) in which he regressed all the factors affecting small-scale irrigation farming, revealed that income, gender, access to market information and the health condition of households are important determinants for participating in small scale irrigation schemes. The analysis further revealed that irrigation participation, the family labour force, livestock ownership and access to market information and credit are positively and significantly associated with household income. Thus, improving rural farm households' access to market information and health services is likely to improve participation in irrigation schemes and also to improve small holder farmers' income and household food security.

According to Fiebig (2010), in Namibia, the age of the household head, level of education, agricultural knowledge, and the presence of friends or neighbours who already use micro-irrigation equipment are significant factors affecting household income and food security. He further highlights that these four factors exhibited a positive influence on household income. Results from the Heckman two-stage estimation conducted by Grimm (2007) in India indicate that secondary education, age, income sources and household size are the most significant factors on livelihoods. This corresponds with a qualitative study conducted by Aseyehgn (2012) in which he concludes that most of the small-scale irrigation farmers in developing countries have attained secondary education, that off-farm income sources enable farmers to purchase inputs and irrigation technology. Therefore off-farm income compliments on-farm income and consequently improves livelihood. He also indicates that household size is significant in determining farmers livelihood because the larger the household size, the more labour available for farming activities. Ayele (2005) concludes that the productivity

of labour and technology employed in agriculture is central to household livelihood and food security in developing countries.

A study conducted by Ohikere (2012) revealed that the average household size for the users of small-scale irrigation was six individuals in Nigeria. This result is statistically significant suggesting that labour availability is an important factor influencing households' decisions to participate in small-scale irrigation schemes. Aseyehegn (2012) also adds that, as active family labour or work force of a household in adult equivalent increases, the total income of the household increases. This in turn contributes to the improved well-being of farm households, further providing an evidence of the importance of labour in influencing the participation decision of households in small-scale irrigation.

2.3 Production and profitability of small-scale irrigation farmers

Literature on smallholder irrigation in sub-Saharan Africa (SSA) gives conflicting conclusions on the viability and sustainability of smallholder schemes (Teshome, 2008). The sustainability of the irrigation sector in Africa has been an issue of debate because of its disappointing performance in many cases. Because of the complex set of constraints facing smallholder producers, providing access to irrigation water by itself is not enough. Smallholders also require a broad range of support services (access to inputs, credit, and output markets), knowledge of farming and secure land tenure (Polak and Yoder, 2006). To achieve economic viability in small-scale irrigation schemes on a market-oriented basis requires access to support services and opportunities for producing high value crops (FAO, 2009).

2.3.1 Productivity of small-scale irrigation schemes

According to Owonubi *et al.* (2009), one of the possible causes of the decline in food production is the inefficient allocation of resources in agricultural production in Nigeria. Land, labour, capital and water resources are inefficiently allocated, thereby leading to a decrease in their productivity. However, Ojo *et al.* (2011) revealed that farmers in the Fadama irrigation scheme in Nigeria cultivate a total of six crops grown in four cropping patterns. Further analysis shows that Fadama farmers practiced both mixed sole

cropping – sole paddy rice, sole sugar cane, Tomato/pepper mixture and cassava/potato mixture. Sole paddy rice, (grown by 63.54% of all the respondents), was the most popular followed by sole sugar cane (15.63%), tomato/pepper mixture (12.50%) and cassava/sweet potato mixture (8.33%). These crops were grown in 44.76ha, 11.71ha and 6.44ha respectively. FAO (2009) concludes that farmers practice mixed cropping, in order to guard against the risk of failure of one crop and to diversify their production.

Furthermore, a study conducted by Gyasi *et al.* (2006) in Ghana, revealed that farmers produce more than one crop. The farm budgeting analysis conducted by DiGennaro (2010) shows that cultivation in small scale irrigation schemes in Zambia is profitable. Moreover Polak *et al.*, (2006) conducted a linear programming analysis and revealed that opportunities for increasing profit through resource re-organisation exist in small-scale irrigation schemes. Mupawose (2009) in Zimbabwe suggested that extension workers and private organisations should assist small-scale irrigation users in reducing post-harvest losses via the provision of processing and storage facilities.

In Ethiopia, descriptive statistics and Heckman's two-stage model estimation were used to estimate the determinants of small-scale irrigation production and household income (Teshome, 2008). The analysis revealed that income, gender, access to market information and the health condition of households are important determinants for producers in small scale irrigation schemes. The analysis further revealed that irrigation production, family labour force, livestock ownership and access to market information and credit are positively and significantly associated with household income and food security. Thus, improving rural farm households' access to market information and health services is likely to improve production in irrigation schemes as well as improve small holder farmers' income and household food security.

2.3.2 Profitability of small scale irrigation schemes

There is evidence emerging that irrigation has contributed significantly to increasing farm income and reducing income inequality and poverty in irrigated agriculture in Asia. For example, recent research led by IRRI in India (Bihar and Madhya Pradesh/

Chattisgarh regions), Philippines, Thailand and Vietnam suggests that the incidence, depth and severity of poverty is substantially lower in irrigated and agriculturally developed areas compared to un-irrigated and less-developed areas (Hussain, 2006). However, this is not the case in many developing countries in Africa as shown in Zambia by Digennaro (2010). He concludes that the average net profit for small-scale irrigation farmers is less than expected. He *et al.* (2006) add that the absent or unreliable supply of inputs and equipment, as well as insufficient transportation or infrastructure can also be major barriers to improved productivity and profitability in small-scale irrigation schemes in Zambia.

2.4 Operation and management systems for small -scale irrigation schemes

Poor design and management have contributed to few peasant irrigation systems in SSA countries (World Bank, 2008). According to Jorge (1993), the irrigation system falls in to two broad categories, namely those which the principal management responsibility is operated by government agencies with farmers playing a subsidiary role, and those in which most management activities are carried out and decisions made by the farmers themselves with the government providing periodic technical or logistical support.

The latter category in which farmers assume the dominant role is referred to as Farmer-Managed Irrigation Systems (FMIS). In general, an important characteristic of FMIS is that the farmers also control and manage the water abstraction from its source. Governments often classify these systems as “small-scale irrigation systems” or “minor irrigation systems,” FMIS are also known as traditional, indigenous, communal or people’s systems. The precise set of activities and functions that the farmers and their organisations perform varies from country to country and from system to system.

Bureau for Food and Agricultural Policy (BFAP) (2008) in a quantitative study on small-scale farmers’ macro-economic impacts on profitability provides evidence that farmer-controlled small-scale irrigation performs better than government-controlled small-scale farming systems. Murray (2006) adds that a substantial farmer-controlled small-scale irrigation sector that exists in many countries in Africa, often without government support, is economically viable. Areas under farmer-controlled small-scale irrigation

systems have grown rapidly over the past decades, and account for a large and growing share of irrigated areas in SSA (McCornicket *et al.*, 2003). For the most part, bypassed by the green revolution and other successful innovations in agriculture production, smallholders live at or below the poverty level and are highly averse to risk; therefore they focus on keeping the margin for error as small as possible.

Smallholders are capable of managing irrigation systems efficiently provided they have access to affordable technologies that are easy to operate, maintain and repair. Small-scale systems and technologies are attractive since they put the operation, maintenance and management of systems directly in the hands of the individual farmers, thus eliminating any need for centralized control of management (Jorma, 1999). In general, according to McCornick *et al.*, (2003) all small-scale systems may have advantages over large-scale systems. These advantages include small-scale technology which can be based on farmers' existing knowledge; local technical, managerial and entrepreneurial skills. Migration or resettlement of labour is not usually required; planning can be more flexible; social infrastructure requirements are reduced; and external input requirements are lower.

Small-scale irrigation schemes, compared with other irrigation strategies used in Africa, if properly implemented with appropriate technologies, may have considerable potential in improving rural livelihoods (FAO, 2009). However, the viability of such systems becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Kamara *et al.*, 2001). A qualitative study conducted by FAO (2008) proves that in many developing countries, government policy, institutional and legal supports are limited or that there is no priority given to irrigation development during national and local planning and budgeting. It also reveals that there are poor management structures in place to support farmers and promote irrigation development. For instance Tiwari and Dinar (2002) point out that the infrastructure to facilitate agricultural development is underdeveloped. They also add that land tenure system does not encourage farmers to invest in permanent improvements on their plots and make improvements which can be used to obtain credits for further development. This results in the poor management and

operation of the schemes, leading to a negative impact on household food security for the farmers. However, privately developed and managed (small-scale) irrigation schemes in most of the SSA countries show that there is business potential for private entrepreneur involvement in irrigation (FAO, 2009).

Fanadzo (2010) provides a scenario in the former homelands of South Africa, where the majority of small scale irrigation schemes (SIS) are situated. A number of SIS were planned and established following a centralised estate design in which control over farming activities and decision-making were strictly enforced by central management with little or no input from farmers. This created a high level of dependency among farmers in the schemes and poor performance when farmers were left to manage the schemes on their own. Experience elsewhere in SSA has shown that SIS can succeed if farmers participate in design and management (FAO, 2005). As a result of these positive African experiences, the South African government policy has gradually moved towards entrusting more responsibilities to smallholder farmers to manage SIS. Magingxa *et al.*, (2009) also recommend that the training of farmers and their collectives is needed in the domains of farm and scheme management.

2.4.1 Management systems

Denison and Manona (2007) indicate that the success and acceptability of irrigation schemes to participants seems to be closely related to the management system of the scheme. Smith and Laurence (2004) add that there is growing dissatisfaction amongst participants on irrigation schemes which are centrally (that is externally) managed, however noble the intentions of the developers and/or managers. Smith goes on to say that farmers have expressed very negative views on being deprived of decision-making powers, especially when they have no control over crop choice and production and marketing decisions. According to Teshome (2008), in Ethiopia, the worst scenario is where central management does not only take all decisions unilaterally on a "top-down" basis, but also conducts all on-farm operations. Transparency in financial matters and bookkeeping of centrally "top-down" managed irrigation schemes is often lacking. In some schemes, farmers are provided with financial statements in the form of computer printouts, but most find these incomprehensible. Paradoxically, the companies

managing irrigation schemes believe that they are acting in the best interests of the farmers, as advantage is being taken of the economy of scale and the farming the consolidated area, so that the farming enterprise should be more profitable (World Bank, 2008).

The management system of an irrigation scheme (project) is critically important and "Top-down", centrally (externally) managed systems are unacceptable in Ethiopia (Teshome, 2003). Farmers have made this very clear and experience in the rest of Africa confirms this. Bembridge (2000) points out that high political and social cost are involved when farmers play only a passive role in irrigation projects. In contrast, where farmers on schemes have been empowered with decision-making powers and freedom of choice in crop selection, irrigation and production practices and marketing, there is a high degree of personal satisfaction and a sense of belonging.

A greater number of male farmers work fulltime on such schemes, while a much smaller percentage is engaged in additional off-farm employment (Assefa, 2008). Gyasi *et al.*, (2006) adds that in Ghana, small-scale schemes rate much higher positive ratings with regards to socioeconomic parameters and socio- psychological variables than top-down managed schemes. They do not rate as well with regards to technical aspects due to lack of adequate support and advisory services, something that should be corrected by the state. In Nigeria, it is acknowledged by farmers that there are certain types of projects, for example, plantation projects, which should be centrally managed. In such cases, people should be employed as labourers, instead of creating false impressions that they are farmers (Ohikere, 2012).

2.4.2 Water supply management.

Water supply is the most important component of any irrigation scheme or project. Therefore, its management is a critical factor. According to WFP (2011), the sharing of a common water source by a group of farmers limits members' flexibility in terms of irrigation. The choice of suitable technology however, is important to ensure as much flexibility for each individual farmer as possible. Meizen-Dick *et al.*, (2007) add that irrigation technology in some centrally managed schemes in South Africa has been

adapted and/or expanded to increase flexibility and manageability by farmers. Meizen-Dick also concludes that a crucial element in the successful sharing of a water source is that the group of farmers be well organised and equipped (trained) to control, operate and maintain their infrastructure and manage their finances.

According to a qualitative study conducted by Aseyehegn (2012) in Ethiopia, legal system of land and water rights, support services (irrigation extension) and well-established water users associations through which purposes of irrigation are achieved are not adequately planned and put in place. Aseyehegn (2012) further adds that these shortcomings undermined irrigation management, ultimately risking the feasibility and sustainability of irrigated agriculture.

A comparative study conducted by Dejene, Teshome, Bekele and Prasad (2011) revealed that poor record of accomplishment, in spite of the difference between the two irrigation systems, in managing water distribution in terms of the three most important performance indicators, namely adequacy, reliability and equity in water distribution. Water related conflicts are rampant but not settled yet. Shah *et al.* (2007) adds that the main constraint in most small-scale irrigation schemes is scarcity and unreliability of water and management as well as socioeconomic problems.

Manzungu (2007) in Zimbabwe adds that these are, in turn, mediated by lack of, clearly defined and well-enforced institutions of land and water rights, technical problems in design and construction, inadequate institutional capacity of the local state irrigation agency to coordinate and support decentralised management of irrigation, policy related problems, inadequate organisation of users for self-management; and problematic social relations of power among water users. Dejene *et al.* (2011), concludes that farmers should be equipped with management knowledge and skills and also that there should be standardised water rights and maintenance teams in small scale irrigation schemes,

2.4.3 Support services

In most countries there is a serious lack of support services for small-scale irrigation farmers (BFAP, 2008). FAO (2008) adds that the most serious of these is a lack of specialised irrigation extension technicians, who can advise farmers on cropping aspects, as well as a lack of technical advice on engineering aspects. Maintenance support services are often also poor or non-existent. In Nigeria, Ojo *et al.* (2009) found that problems regarding the availability of inputs such as seed, fertilisers and pesticides are also encountered. Apart from the physical problem of procuring seed, fertilisers and pesticides, maintenance services and spare parts are seldom locally available. Specialised technical advice on cropping, irrigation management and equipment installation and operation is usually conspicuous by its absence (You, 2008).

DiGennaro (2010) argue that Zambia the suitability of an irrigation system is particularly related to the manageability of the system for a specific set of circumstances. The distance from the fields, the priority the irrigation farming enjoys in the life of the farmer and the size of the enterprise should all influence the recommendations.

According to FAO (2008) in Kenya, a rule that at least 70% of the farmers aspiring to participate in an irrigation scheme must attend all planning meetings applies. During these meetings, irrigation technologists share their knowledge on alternatives for irrigation technology with farmers. Farmers then take decisions on layout, technology, and technologists design the scheme accordingly. It is critically important that, in the identification, adaptation or development of appropriate technologies for specific situations, all relevant factors must be taken into account. Apart from the labour aspects already mentioned, women often have their labour burden increased by irrigation, which can seriously affect scheme productivity (FAO, 2008).

2.5 Major constraints faced by small-scale irrigators in achieving household food security

Irrigation development continues to expand. However, the pace is slowing down worldwide. In many countries, there are now challenges and constraints to irrigation development, particularly social and environmental concerns (Assefa, 2008). Low

productivity of many existing schemes has prompted a move in investment policies away from new infrastructure toward programmes that improve the performance of existing schemes (Water Sector Board, 2007). Jones (1995) indicates that there has been a sharp decline in World Bank lending for new irrigation schemes. Jones also states that funding for new irrigation construction has largely stopped and the emphasis is now on the sustainability and efficiency of existing systems.

In partial support of Jones, Thompson (2001) states that irrigation is still one of the core investment activities of the World Bank's Rural Portfolio (WBRP), though the number of irrigation schemes is expected to decrease. This, according to Thompson, is attributed to the fact that investments in irrigation systems are perceived to have failed to address the changing needs of irrigation services; Rehabilitation of existing schemes was mostly carried out to restore original project objectives as this did not take into account or ignored the desirable changes in cropping patterns and irrigation techniques, thus allowing low water-productivity practices. Thompson (2001) further states that cost and time overruns in irrigation projects have further eroded the confidence of funding agents in irrigation development.

Despite major breakthroughs in agricultural technologies such as drip irrigation, agricultural households in many parts of the world still struggle to produce enough to support themselves (FAO, 2008). Significant portions of the population in SSA are food insecure as measured by a variety of nutritional and caloric indicators (Smith *et al.*, 2006). With approximately 60% of the labour force employed in agriculture in Sub-Saharan Africa, the level and reliability of agricultural productivity is a critical element in food security.

As a result of low prices of staple crops coupled with poor yields and erratic rainfall, small-scale agriculture production is both risky and low-return (Lipton *et al.*, 2010). The problems of poor yields and erratic rainfall are expected to worsen in the future as a result of climate change (Lobell *et al.*, 2008). Small-scale irrigation is frequently cited as an innovation that can bolster rural livelihoods through climate adaptation, food security, and poverty reduction (World Development Report, 2008).

Ayele (2005) identified the following problems as the main constraints that prevent small-scale irrigators from achieving household food security in Ethiopia: lack of access to surface water; loss of water through seepage; problem of irrigation water distribution; lack of spare parts for water pumps; high costs of fuel for water pumps; lack of market transparency and marketing facilities; crop diseases; and the perceived high cost of inputs.

A number of potential barriers to the contribution of small-scale irrigation to household food security in Zambia have been identified (Feder *et al.*, 1985). Inadequate information, education, and training are significant barriers to attaining food security (Ayele, 2005). Uncertainty and risk, also associated with information about the technology, discourages adoption (Beshir, 2004). Lack of access to credit, especially when a significant expenditure is required to purchase equipment, prevents access to necessary inputs to produce at full capacity (Ayele, 2005). An absent or unreliable supply of equipment, and insufficient transportation or infrastructure can also be major barriers to improved productivity in small-scale irrigation schemes in Zambia (DiGennaro, 2010).

Although the irrigated area is increasing in Ethiopia, the growth rate is rather low. There are a number of constraints related to the slow rate of irrigation development, for example, weaknesses in management (O&M), equity issue, cost recovery and agricultural productivity (FAO, 2009). Social, economic, institutional and policy problems are general constraints for the efficiency of small-scale irrigation schemes (Teshome, 2008). Moreover, both technical and social factors constrain small-scale irrigation development in SSA, and, among them, institutional and management problems tend to be most constraining (FAO, 2008). Small-scale irrigation schemes in Ethiopia are generally characterised by Low efficiency, lack of finance, inadequate marketing and weak extension services (Teshome, 2008).

The major problems for many irrigation systems are free riding, rent seeking and corruption (Ostrom, 2001). Free riding evokes lack of trust between the actors. Potential rents stimulate efforts to influence public decision-making and evoke corruption. Free

riding can be overcome when farmers are convinced that the benefits exceed costs as well as by improving communication among them. The establishment of institutions that do not allow single officials to have full control over the resources can help to reduce corruption. The improvement of communication between farmers, irrigation schemes and state institutions could make the parties more aware of the problems and reduce both rent seeking and corruption (Polak, 2005).

To reduce the transaction costs of changing government policy, one of the key steps is to reduce the expenses of organisation and involve the stakeholders in specific water management reforms (Polak, 2005). Some specific tasks that will be added to the transaction costs of water reform include designing regulations for allocating water in an open and transparent manner, developing water delivery schedules in conjunction with stakeholders, enacting water-use rights and procedures, and resolving disputes over water allocation (Polak, 2005).

In Ghana, Gyasi *et al.* (2006) looked at the determinants of the success of community-based institutions for irrigation management. The assumption that communities and user groups will manage the systems sustainably may not hold in all cases. Evidence of success, especially in the context of small scale irrigation systems, is limited. Indeed, previous experiences with community managed irrigation schemes in northern Ghana have not always been positive in the past. Many schemes severely deteriorated or broke down completely due to insufficient maintenance. Gyasi *et al.* (2006) also note that market integration generates exit options as maintenance schedules that coincide with market days would receive very poor response. Similarly, higher wages (and, in general, exit options) outside the schemes increase the opportunity cost of labour and reduce the incentive for households to participate in the maintenance of the irrigation schemes. Transparent and accountable leadership is also shown to be an important concern that affects the incentives for households to contribute to the maintenance of the schemes. Lack of transparency, accountability and incidents of rent-seeking reduce trust and confidence in leadership, and ultimately undermine management efficiency. Leaders perceived to be corrupt lose their moral authority to enforce rules and regulations (IFAD, 2009).

Denison *et al.*, (2007) states that despite the South African government pouring millions of Rands into smallholder irrigation schemes, many of these have collapsed or remained under-utilised. Denison *et al.* (2007) concludes that infrastructure development alone is unlikely to succeed. Rather, comprehensive strategies which consider all the activities that make up an irrigation enterprise, such as markets, finance, inputs, institution-building and crop production information, are needed for success. A report by FAO (2008) identified constraints that have slowed irrigation investments as the relatively high cost of irrigation development, inadequate physical infrastructure and markets, poor investments in irrigation, lack of access to improved irrigation technologies, and lack of cheap and a readily available water supply.

However, recent research has indicated that low yield levels caused by poor crop and water management practices by the farmers are probably the main reason for the failure of many SIS in South Africa (Fanadzo *et al.*, 2010). At the same time, limited knowledge of crop production among farmers has been identified as one constraint to improved crop productivity in SIS (Machethe *et al.*, 2004). Among the primary constraints identified by extension officers on 164 of the 302 irrigation schemes in South Africa, poor management topped the list (50% of the cases). This was followed by infrastructural problems (15%); water inadequacies (13%); conflict (12%) and theft (7%) (Van Averbeké *et al.*, 2011). This suggests that human (capacity) and social (institutional) resource problems are at the heart of the poor performance of SIS in South Africa. These were identified by nearly all assessments that were made (Van Averbeké *et al.*, 2011). In this regard, Denison *et al.* (2007) recommends that crop production approaches and farmer training should be considered alongside all other issues.

Chazovachii (2012) conducted a qualitative and quantitative assessment of the impact of irrigation on livelihood in Zimbabwe and the results revealed that the irrigation scheme has brought some benefits to the community. However, the yields produced have not yet addressed the food security situation of plot holders. This is attributed to prohibitive water pricing and transport costs, which negatively affected their desire to produce at maximum capacity. Chazovachii (2012) further recommends the

intervention by interested stakeholders such as non-governmental organisations and the Zimbabwe National Water Authority (ZINWA). He also recommends economic recovery programmes such as farm mechanisation to ensure the viability and sustainability of irrigation on rural livelihoods and household food security.

Mupawose (2009) questioned the economic viability of smallholder irrigation schemes in Zimbabwe and pointed out that certain smallholder schemes have failed and are under-utilised due to poor management, lack of inputs and irrigation experience by farmers. In the same report, Mupawose advocated for the reduction of subsidies on smallholder irrigation schemes and indicated that irrigation development has become expensive. He suggested that some form of cost recovery should be employed in these schemes. However, FAO (2009) concluded that cost recovery from poor farmers for the operation and maintenance of irrigation systems is controversial, as subsidising these services and providing irrigation water far below cost is financially unsustainable. Monitoring the efficiency of water use in agriculture for many small farmers, each using a small amount of water is expensive. However, providing irrigation water below cost contributes to water wasting.

Irrigation is expensive and the profitability of irrigated production is critical in justifying both short-term and long term viability of an enterprise. Thus strong management is needed to enhance efficiency, cost recovery and to sustain the whole system (Rukuni, 2006). Development costs for small-scale irrigable schemes continue to rise due to several factors, with the development of a hectare of land estimated to be between US\$2,000 to US\$3,000 for engineering work yet Zimbabwe is faced with an acute shortage of foreign currency. This has affected the costs of raw materials that are procured from outside the country (Chazovachii, 2012).

2.6 Summary

Literature reveals that despite several interventions by government and NGOs in most developing countries, the contribution of small scale irrigated agriculture to food security is very minimal. This can be attributed to a number of factors which include the lack of policy in many countries to streamline agriculture, in particular irrigated agriculture. The

development of irrigation infrastructure is very slow, irrigation technology is not adapted to small scale irrigation and productivity and profitability of the schemes is questionable. Crop and vegetable production under irrigation is sometimes taken as part-time occupation resulting in farmers putting less time in it. Farmers often lack commitment and ownership of communal schemes. This may be so because sometimes they do not take an active role in the design, planning and implementation of the schemes. Farmers lack management skills, both financial and agriculture. The lack of production planning and poor market orientation results in over production of some crops by farmers, leading to oversupply in the market. Very few farmers keep records on yields and sale of their products, and thus they fail to achieve household food security.

The farmers targeted by the research are smallholder farmers in Gwanda District of Matabeland South Province involved in crop production using small-scale irrigation. The rainfall is between 450 - 600 mm rainfall per year and this is subject to frequent seasonal droughts (GeoHive, 2012). Gwanda, because of its semi-aridity, is flooded by numerous irrigation schemes so as to overcome the effects of seasonal droughts and ensure food security. Gwanda district has a population of about 654 878 people (GeoHive, 2012). The district falls under the country's agro-ecological region 3, which receives very little and erratic rainfall. It is mainly suitable for livestock production. Crop production mainly includes the production of maize, millet and sorghum, which are drought resistant crops. The district has been frequently hit by food shortages and hunger, which have led to intervention by non-governmental organisations such as World Vision, which provides food and other basic necessities for the people in the area. Gwanda District is shown on the map below

3.2.1 Masholomoshu Irrigation Scheme

Masholomoshu irrigation scheme, established in 1969, is one of the major schemes developed before the independence of Zimbabwe in 1980. The scheme is located in Ward 1, 20km East of Gwanda District. Masholomoshu uses a surface irrigation system with a command area of 38,8ha. Plot sizes range from 0.3 to 0.5ha with a total of 131 beneficiaries. Challenges cited in literature for the poor performance of Masholomoshu include a complicated land tenure system, poor management of the scheme, and political conflicts, lack of credit and poor market opportunities.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that was used in the study. This includes data collection, sampling procedures, how the data was analysed and presented, as well as the limitations of the study.

3.2 Description of the study area

The farmers targeted by the research are smallholder farmers in Gwanda District of Matabeleland South Province involved in crop production using small-scale irrigation. The rainfall is between 450 - 600 mm rainfall per year and this is subject to frequent seasonal droughts (GeoHive, 2012). Gwanda, because of its semi-aridity, is flooded by numerous irrigation schemes so as to overcome the effects of seasonal droughts and ensure food security. Gwanda district has a population of about 654 879 people (GeoHive, 2012). The district falls under the country's agro-ecological region 5, which receives very little and erratic rainfall. It is mainly suitable for livestock production. Crop production mainly includes the production of maize, millet and sorghum, which are drought resistant crops. The district has been frequently hit by food shortages and hunger, which have led to intervention by non-governmental organisations such as World Vision, which provides food and other basic necessities for the people in the area. Gwanda District is shown on the map below.

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Masholomoshe Irrigation scheme, established in 1969, is one of the major schemes developed before the independence of Zimbabwe in 1980. The scheme is located in Ward 1, 20km East of Gwanda District. Masholomoshe uses a surface irrigation system with a command area of 38,8ha. Plot sizes range from 0.3 to 0.5ha with a total of 131 beneficiaries. Challenges cited in literature for the poor performance of Masholomoshe include a complicated land tenure system, poor maintenance of infrastructure, local and political conflicts, lack of credit and poor market opportunities.

The water for the scheme comes from Masholomoshe Dam. Water for irrigation is distributed through a conveyance canal to the field edge. Crops mainly grown include maize and wheat. However, in most cases, farmers fail to do winter cropping due to low water levels in the dam.



Figure 3.1. Gwanda district on Zimbabwean Map (source: Agritex, 2012)

3.2.2 Makwe irrigation scheme

Makwe irrigation scheme is situated in Gwanda District, 30km west of Gwanda town, along the Gwanda-Kezi road. The project, which comprises 229ha, started operating in 1966. The source of water is Tuli-Makwe dam, an arched concrete dam with a capacity of 6 113 000m³. Water for the irrigation is pumped into a conveyance canal by electric powered pumps. The pump house has 4 pumps, which frequently break down. The winding channel is about 5km long and discharges into a 2km long inverted siphon to take the water across the Mtshелеle River. This pipe line (500mm) crossing the Mtshелеle River is the weakest link in the chain as frequent pipe bursts have occurred in the recent past. The conveyance channel is in fairly good condition, although some seepage occurs at various places and all expansion joints need sealing with bitumen putty.



Fig 3.2 Makwe irrigation and dam overview (source: AgriTex, 2012)

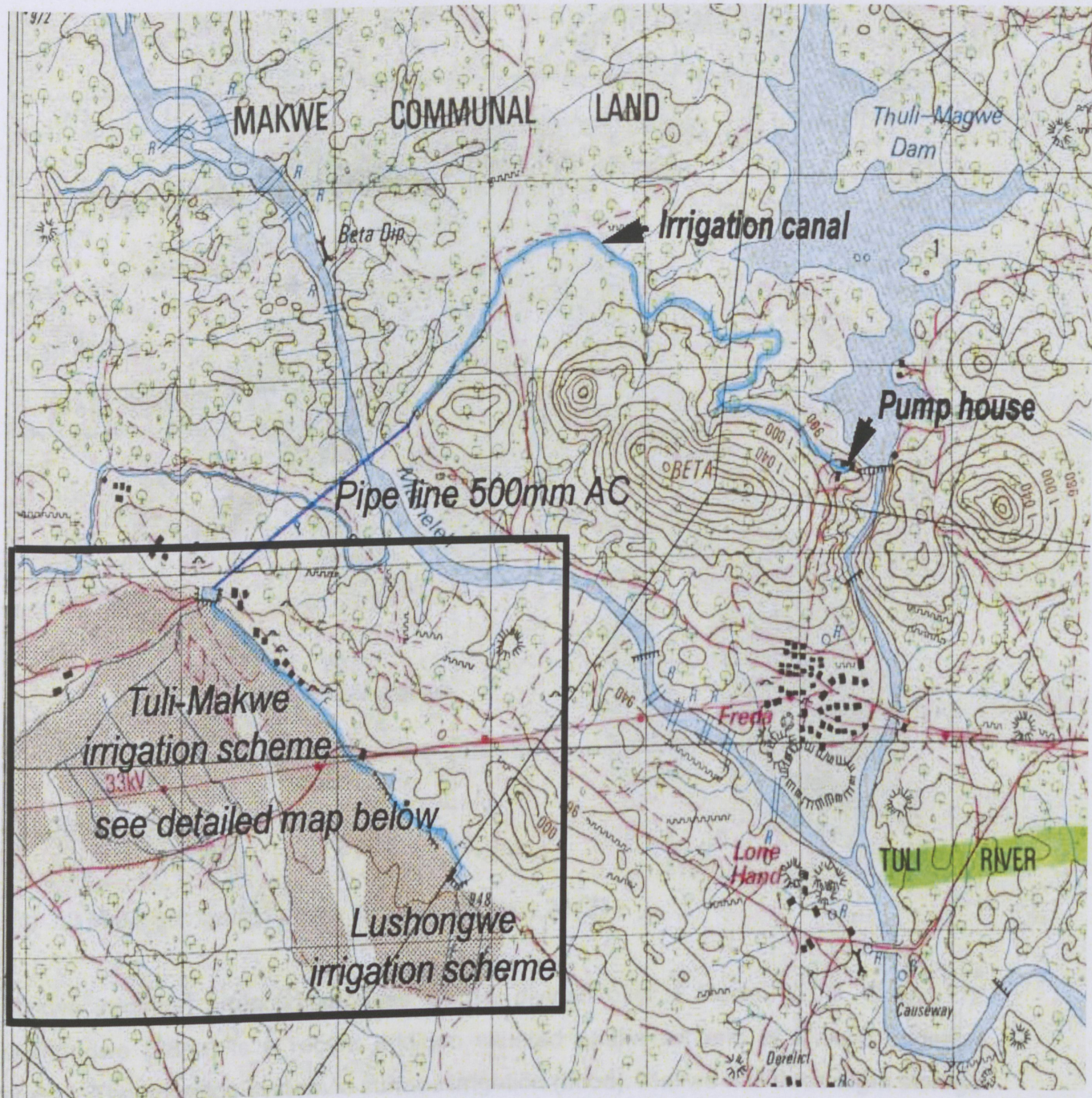


Fig 3.2 Makwe irrigation and dam overview (source: Agritex, 2012)

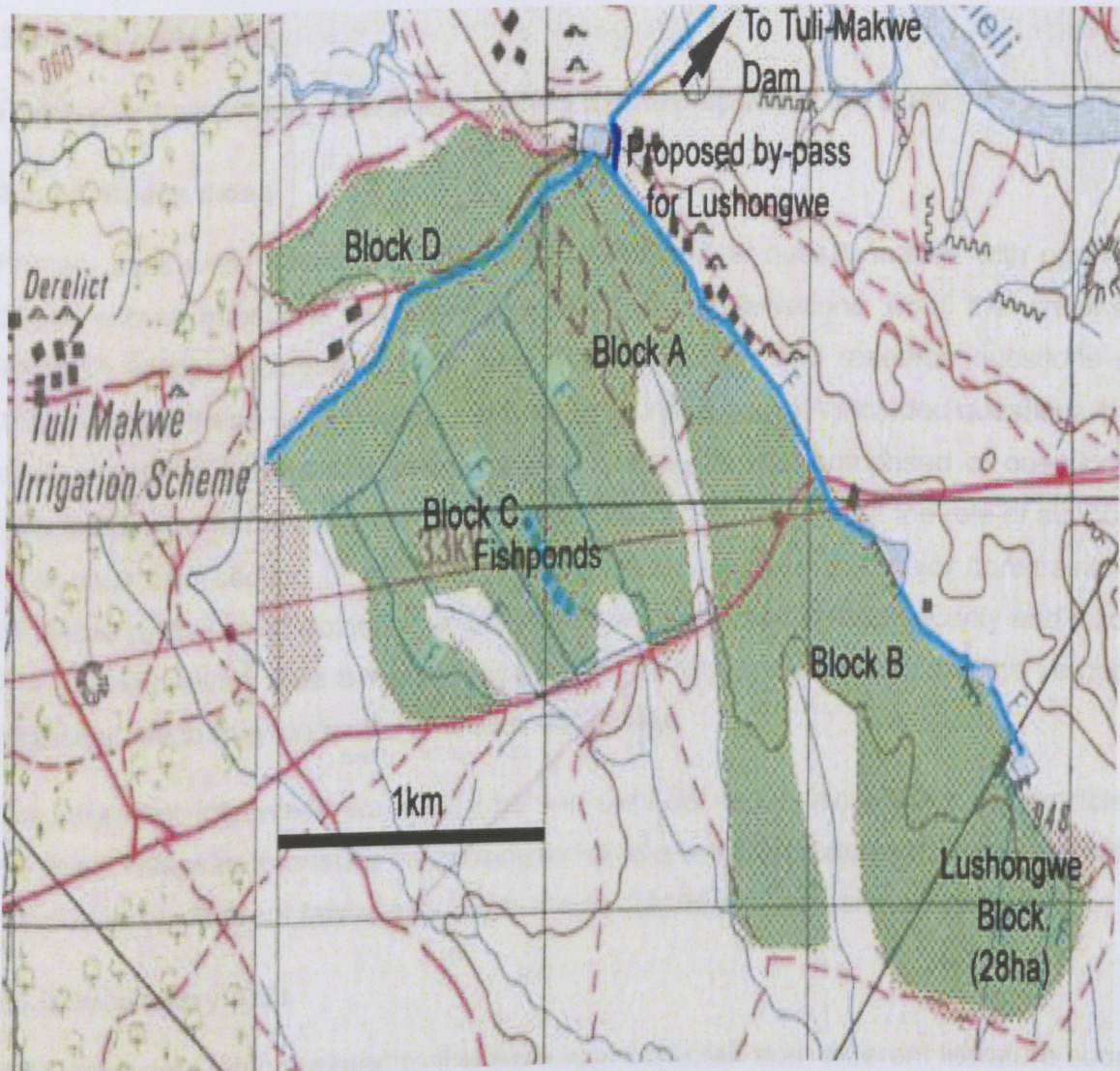


Fig 3.3 Makwe irrigation units (source: Agritex, 2012)

Makwe irrigation project comprises 201ha, divided over 4 blocks (A, B, C and D). Lushongwe (28ha) is a recent addition situated at the tail end of Makwe irrigation project. The irrigation system is surface irrigation (flood). Makwe has three night storage dams. Makwe currently has 500 member farmers, although the official number of plots is 425. The standard plot size is 0.5ha, but some members have sublet parts of their plots, while others are using more than one plot. The actual plot size, therefore, varies from 0.1 to 1.0 ha. Recent crops grown are mainly maize and wheat. Most of the irrigable land is fallow.

3.3 Data collection

Primary and secondary data was collected for the purpose of the study.

3.3.1 Primary data

Primary data were collected using structured interview questionnaires with open- and closed-ended questions supported by personal observations from the small-scale irrigation farmers. Questionnaires based on objectives and research questions were designed and these were divided into four sections. Section A included questions on the socio-economic factors that affect farmers, section B was comprised of questions on yield levels and farm income for each farmer, section C was about the role of supporting institutions and section D was comprised of information on the major constraints that are faced by the small-scale irrigators in achieving household food security and income. The questionnaires were written in English but farmers were asked in the vernacular language which they understand, that is IsiNdebele

Key informant interviews were also carried out with extension officers responsible for the area. This was to ensure that more primary data on agricultural activities carried out in the area by different farmers to improve household food security are gathered.

3.3.2 Secondary data

Secondary data which related to the topic was collected from different literature sources such as previous studies carried out in the area and reports on the performance of small-scale farmers in the area.

3.4 Research design

Both qualitative and quantitative methods were used in this study to mitigate the shortfalls of either of the methods and combine the advantages that each method brings and thus better understand the problems faced by small scale irrigation farmers in rural areas. The advantages of quantitative methods include providing a basis for comparing one result with a result from another source (Goddard and Melville, 2001). Quantitative methods can be subjected to mathematical bodies of data and statistical techniques permit hypotheses to be rigorously tested (Dawson, 2006). The advantages of

qualitative research methods include enabling researchers to study human experience in a great deal of depth (Dane, 1990).

3.5 Populations and sampling

3.5.1 Population

For the purpose of this study, population refers to all the farmers who are involved in irrigation farming in Masholomoshe and Makwe irrigation schemes. There are 135 farmers in Masholomoshe irrigation scheme and 480 farmers in Makwe irrigation scheme. Therefore, the total population for the study was 615 farmers.

3.5.2 Sample

A total sample of 150 small-scale irrigation farmers was used to carry out the study. A proportional sample of 30 (22% of the total population) irrigation farmers was selected from the entire population (135) of Masholomoshe irrigation scheme and 120 (25%) from the entire population (205) of Makwe irrigation scheme.

3.5.3 Sampling technique

In an attempt to survey all members of the population, a sample of 150 farmers from a population of 340 farmers from both schemes was used to represent the population. In order for a sample to reflect the characteristics of the population from which it is drawn, stratified random sampling was used to identify Masholomoshe and Makwe irrigators. A simple random sampling method was then conducted from each strata or group of farmers. A register was used where each individual was assigned a number and then a computer was used to compute random numbers giving each individual an equal chance to be selected for inclusion in the study. In this manner, a sufficiently random sample of the general population becomes representative of the larger whole. The sample was tested at 1%, 5% and 10% confidence intervals.

Table 3.1 Sampling technique table

Scheme	population	Sample
Masholomoshe	135	30
Makwe	205	120
Total sample	150	

3.6 Questionnaire design

An interview questionnaire was designed for the purpose of data collection. The questionnaire was divided into four sections with the first section including questions seeking the demographic information of the population. The second section was comprised of information on productivity and farm incomes and the third section was comprised of the information on the role played by supporting institutions while the last section was comprised of information on the major constraints that prevent farmers from achieving household food security. Interview questionnaires were conducted with irrigation farm households and key informants.

3.7 Reliability and Validity

The interview questionnaires were taken to an authority in the field to be validated. After this a pilot study was conducted on five farmers who were not the target participants in the study. This was done to ensure reliability and validity of the research instruments.

3.8 Data capturing, processing and analysis

Data capturing was done using SPSS and descriptive statistics were used to analyse the data. An inferential test where the multiple linear and logistic regression analysis were used to assess the impact of challenges on household food security was conducted. Gross margin analysis and independent t-test were also conducted to analyse the average farm incomes between the two schemes. Data was presented in the form of cross tabulations.

3.9 Primary data collection

3.9.1 To assess the impact of socio-economic factors that affect small-scale irrigator households in achieving household food security

This information was provided by the farmers who practice small-scale irrigation in the selected schemes. These farmers were randomly selected from a population and a sample of 150 households. A structured questionnaire was used to collect information. This was done in the form of face to face interview questioning. The data that was collected include gender, age, and level of education, marital status and household size. This data was analysed using descriptive statistics and the multiple linear regression model.

3.9.2 To assess the farm incomes from food crops for small-scale irrigator households

This information was provided by heads of households that is those who are responsible and involved in crop production. Extension officers and government officials also provide information. A questionnaire was used to collect this information from the selected sample. Data that was collected included crop type, area cultivated, total cost of inputs, total yields, quantity consumed, and quantity sold, unit price of the products, and total farm income. The data was analysed using descriptive statistics, multiple linear regression model and gross margin. An independent t-test was done on SPSS to test if there was a statistical significant difference between the average gross margins of the two schemes.

3.9.3 To determine the role played supporting institutions in helping farmers achieve household food security

This information was collected mainly from extension officers and irrigation farmers. An interview guide and questionnaire were used to collect information from the extension officers and farmers respectively. Data that was collected included information on input markets, extension services, credit facilities, training and information providers, output markets, farmer organisations. The data was analysed using logistic regression model.

3.9.4 To assess the major constraints faced by farmers and their impact in achieving household food security

This information was collected from the irrigation households, extension officers and government officials. An interview questionnaire was used to collect this data. Information that was required was related to the challenges faced by farmers in production, marketing of their products and general challenges in the scheme. The data run on SPSS was analysed using descriptive statistics.

3.10 Model specification

3.10.1 Multiple Linear Regression

Multiple linear regression attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data. Every value of the independent variable x is associated with a value of the dependent variable y .

Typically, the model for multiple linear regression, given n observations, is

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \dots + b_n + \hat{e}$$

Where;

Y is the dependent variable

b_0 is the intercept or the constant

$b_1, b_2, b_3, \dots, b_n$ are regression coefficients

$X_1, X_2, X_3, \dots, X_n$ are independent variables

$\hat{e}$ is the error term

Expressed in terms of the variables that were used in the model, the multiple linear regression equation is as follows: independent variables represent the constraints that the farmers are likely to face in their irrigation schemes.

$$\text{Household income per capita} = b_0 + b_1(\text{age}) + b_2(\text{hsize}) + b_3(\text{acult}) + b_4(\text{incost}) + b_5(\text{yields}) + b_6(\text{price}) + b_7(\text{qtysold}) + b_8(\text{tffi}) + \hat{e}$$

where;

household income per capita was used as a proxy for household food security and was the dependent variable

$b_1, b_2, b_3, \dots, b_n$ are regression coefficients

age - the age of the respondents at the time of interview in years

hsize - number of people in the household

acult - the size of land used for production per hectare

incost - the total cost of inputs used in production in US dollars

yields - total harvest per crop in kg/year

Price - the price of food crops in US dollars

Qtysold - quantity of the yields sold

Tffi - total farm income

3.10.2 Binary logistic regression model

In logistic regression, the dependent variable is binary or dichotomous, i.e. it only contains data coded as 1 or 0. For the purpose of the study, number of meals a farm household have a day was used as a proxy for household food security and as a dependent variable.

The prediction equation was

$$p(Y = 1) = \frac{e^{\beta x}}{1 + e^{\beta x}} \quad (1)$$

$$p(Y = 0) = 1 - \frac{e^{\beta x}}{1 + e^{\beta x}} = \frac{1}{1 + e^{\beta x}} \quad (2)$$

$$\text{logit}[\theta(x)] = \log \left[\frac{\theta(x)}{1 - \theta(x)} \right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_i X_i + \epsilon \quad (3)$$

Equation 3 is the natural logarithm of the modelled variables. The equation allows the researcher to run a linear estimation of the model where the following definitions apply:

θ = the logit transformation of the odds ratio,

α = intercept of the model,

β = the regression coefficient or slope of individual predictor variable modelled,

X_i = the predictor variable and

ε , is the error term.

Expressed in terms of the variables that were used in the model, the logistic regression equation was as follows

$$\text{Log}(p/1-p) = \beta_0 + \beta_1 \text{gen} + \beta_2 \text{edu} + \beta_3 \text{insoc} + \beta_4 \text{tenure} + \beta_5 \text{ext} + \beta_6 \text{credit} + \beta_7 \text{tranif} + \beta_8 \text{outmkt}$$

Where;

$(P/1-p)$ = probability of the farm household having 3 or more meals a day (yes= 1, no= 0)

β_0 to β_{12} = co-efficient of independent variables

gen - the gender of the respondents (female= 0, male=1)

edu – level of education of farmers (primary= 0, secondary=, high school= 2)

insoc - income sources (farming= 0, non-farm income= 1)

tenure - land ownership system (PTO= 0, tittle deeds= 1, rented= 2)

ext - availability of extension services (no= 0, yes= 1)

cred - access to credit (no= 0, yes= 1)

tranif - access to farmer training and information (no= 0, yes= 1)

outmkt - availability of output markets (no=0, yes= 1)

Table 3.2 Expected signs of coefficients for the variables

Variables	Expected sign
Farm income (dependant variable)	
age	-
Hsize	-
acult	+
incost	-
Yields	+
Price	+
Qtysold	+
Tfi	+
gen	+
Edu	+
insoc	+
Tenure	+
Ext	+
Cred	+
tranif	+
outmkt	+

The variables were tested at 95% confidence interval. Household food security is influenced by physical, natural, human, social, community and financial assets of the agricultural household, therefore all the independent variables are expected to be positive (FAO, 2009). Characteristics of the household, especially those of the household head are major deciding factors on whether to participate in irrigation farming or not. In particular, the household head's age, gender, level of education and household size influences the attitude one may have towards irrigation farming,

therefore the more educated a farmer is, the more likely to have household food security (Bishir, 2004). Household size is also essential for determining the availability of labor to the irrigating household (FAO, 2006). Information regarding markets, credit and the resources at the farmer's disposal play an important role in the efficiency and decision-making in order to improve productivity through small-scale irrigation (Feder, Just and Zilberman, 2010). The quality and topography of land can also influence the productivity of irrigation schemes (Zhou, 2008). It is believed that the farmer is more likely to achieve household food security if his land is good and big enough to produce a good return (Feder *et al.*, 2010).

3.10.2 Justification of the econometric model

The Multiple Linear Regression model (also known as the Ordinary Least Squares Regression (OLS) is the most widely used modelling method for data analysis, and it has been successfully applied in most studies (Montshwe, 2006). Gujarati (2003) pointed out that the method is useful in analysing data with a quantitative (numerical) dependent variable as in this study that is household income per capita. Moreover, multiple linear regression analysis is more statistically robust in practice, and is easier to use and understand than other methods. Binary logistic regression will also be used in this study to analyse qualitative data because it is feasible where there is a categorical dependent variable. Logit model assumes that the probability has to lie between 0 and 1. Therefore it is also suitable for this study as the study also have a categorical dependable variable that is the household eats three times a day or not (Dougherty, 2004).

3.11 Ethical considerations

In an endeavour to abide to the code of ethics in research, the researcher obtained an informed consent from the participants before the research began. Participants were enlightened on the aims and objectives of the research and the benefits that the study has to them and the procedures to be used. Participants were assured of the absence of physical or emotional harm. The researcher also undertook to offer answers to questions about any research procedure and indicated to participants that they had the

right to withdraw from the research at any stage. Participants were also assured that personal information would be kept as confidential as possible and that the study would not be used for commercial purposes but for the advancement of the discipline of agricultural studies and the quality of people's lives.

3.12 Summary

In this chapter, the methods that were used to analyse data were reviewed. Data was collected from 150 small-scale irrigators in Gwanda District. The research focused mainly on the farmers who were involved in irrigation. Stratified random sampling was applied, in order to select a sample from smallholder farmers involved in farming. To collect the data, a questionnaire was administered to the respondents through face-to-face interviews. To analyse data, the multiple linear and binary logistic regression models were chosen and its advantages have been highlighted. The results of the research will be presented in chapter

Table 3.3 Summary of objectives, research questions, hypothesis, data required and analytical tools

Research objectives	Research question	Research hypothesis	Data requirement	Analytical tools
To determine the impact of socio-economic factors of the irrigators on household food security	What is the impact of socio-economic factors on household food security?	There is no significant impact of socio-economic factors on household food security of small-scale irrigators	Gender of farmers Age of farmers Level of education Household size Household income sources Per capita income Land ownership	Descriptive statistics Multiple Linear regression model
To determine and compare the farm incomes of food crops for irrigation households from Masholomose and Makwe small-scale irrigation schemes	What is the difference between the farm incomes from food crops in Masholomose and Makwe irrigation schemes?	There is no significance difference between farm incomes of Masholomose and Makwe Small-scale irrigation schemes	Types of crops grown Size of the farm used for production Levels of yields produced Prices of food crops Input costs Quantity sold Total farm income	Descriptive statistics Gross margin analysis
To assess the role played by supporting institutions in helping farmers to achieve household food security	What is the role played by supporting institutions in helping irrigation farmers achieve household food security?	Supporting institutions play a significant role in helping irrigation farmers achieve household food security	Input markets Extension services Credit facilities Training and information providers Transport to markets Output Markets	Descriptive statistics Logistic regression model
To determine the major constraints faced by farmers in small-scale irrigation and provide recommendations	What are the major constraints faced by farmers in achieving household food security	There is no significant relationship between the constraints faced by the small-scale irrigation farmers and their household food security.	Major problems faced by farmers in production Major constraints faced by farmers in marketing Ranking of problems faced by farmers in the scheme.	Descriptive analysis

Table 4.1 Descriptive Statistics of age and household size

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents survey results of Masholomoshe and Makwe small-scale irrigation schemes. The findings are part of the study aimed at analysing the impact of the constraints faced by small-scale irrigation farmers in achieving household food security. The analysis was done using descriptive analysis, multiple linear and logistic regression models.

4.2 Descriptive statistical analyses

4.2.1 Socio-economic characteristics of small-scale irrigation farmers

4.2.1.1 Age and household size

The results in Table 4.1 shows that the age of the household heads of sampled respondents in Masholomoshe scheme ranged between 28 and 77, with an average age of 60 years and standard deviation of 13.67. The age of respondents in Makwe scheme ranged between 23 and 80 years with mean age of 65.62 and standard deviation of 15.39 years. The age difference between the two groups is not significant and the overall average age was 63 years. This suggests that most small-scale irrigation farmers are old people who have retired from their formal jobs.

Table 4.1 Descriptive Statistics of age and household size

Variable	N	Minimum	Maximum	Mean	Overall mean	Std. Deviation
Age of respondents						
Masholomoshe	30	28	77	60	63	13.67
Makwe	120	23	80	65.62		15.391
Household size						
Masholomoshe	30	3.00	12.00	6.3333	6	2.873
Makwe	120	2.00	12.00	5.7667		2.55783
Valid N (listwise)	150					

(Source: study survey, 2013)

4.2.1.4 Household size

The average household size for Masholomoshe farmers was 6.33 with standard deviation of 2.87 and that of Makwe was 5.77 with a standard deviation of 2.56 as indicated in Table 4.1. The household size has an overall impact on labour availability for any activities at the scheme ranging from irrigation maintenance, repairs to crop production activities.

4.2.1.2 Gender

On average, there were more female than male farmers in the small-scale irrigation schemes. As shown in Table 4.2, the results of the study shows that from the sample selected in Masholomoshe scheme, most (60%) of the farmers were females. The results for Makwe scheme also revealed the dominance of females (67%). Interviews with the farmers indicated that there are more females in the schemes because males work in towns and also prefer to do gold panning to compliment farm incomes. Females are based at the schemes and tend to oversee all the irrigation works at the farm. This implies that all decisions pertaining to any irrigation developments are made by women in the absence of their male counterparts.

Table 4.2 Descriptive Statistics of gender, level of education, income sources and ownership system

Variable	Scheme				Total percentage
	Masholomoshe (n=30)		Makwe (n=120)		30+120=150
	Frequency	Percentage	Frequency	percentage	
Gender					
Female	18	60	80	67	65
Male	12	40	40	33	35
Level of education					
Primary (grade 1-7)	13	43	54	45	45
Secondary (form 1-4)	12	40	49	41	41
High school (form 5-6)	3	10	11	9	9
Tertiary	2	7	6	5	5
Income sources					
Farming	11	37	63	53	48
Employment	3	10	33	27	24
Contribution	9	30	19	16	20
mix	7	23	5	4	8
ownership					
PTO	8	27	17	14	20
Tittle deeds	13	43	30	25	34
Rented	9	30	73	61	46
Total					

(Source: study survey, 2013)

4.2.1.3 Level of education

The descriptive statistics in Table 4.2 indicate a low level of education among the farmers, a majority of whom had primary education. From Masholomoshe scheme 43% of the respondents had primary education, 40% had secondary, and 10% and 7% had attained high school and tertiary education respectively. From Makwe scheme, 45% of respondents had attained primary education, 41% secondary while 9% and 5% had attained high school and tertiary education respectively. Generally most farmers from both schemes have primary education followed by secondary education whilst only a few farmers have attained tertiary education. The prevalence of individuals with only primary education is a result of the fact that most farmers in the schemes are old people who did not have the opportunities to continue with education during their active days. Those with tertiary education prefer to go to the cities in search of white collar jobs than to work in the irrigation schemes.

4.2.1.5 Household income sources between irrigation schemes

The sources of household income were divided into two broad categories of farm and non-farm sources. Farm incomes included income derived from the sale of farm produce and non-farm sources included pensions, remittance, wages and salaries and other sources. Most respondents from the study sample revealed that farming is their main source of income with 37% and 53% from Masholomoshe and Makwe irrigation schemes relying on farming for their household income respectively. Only 10% and 27% of the respondents from Masholomoshe and Makwe, respectively, relied on employment from other sectors, mainly mining and self-employment. On the other hand, 30% and 16% from Masholomoshe and Makwe schemes, respectively, rely on contributions from relatives and other family members, mainly children who have migrated to South Africa for better job opportunities. The farmers were quick to state that farm income alone is not enough to sustain the household for the whole year. Therefore, they supplemented it with incomes from other off-farm activities such as gold panning.

4.2.1.6 Types of crops grown

4.2.1.6 Land ownership system

The inadequate quantity of land available per household was the biggest constraint to production for irrigation farmers to achieve household food security. The issue was also complicated by the land tenure arrangements which indicate that 27% and 14% of the sample farmers from Masholomoshe and Makwe schemes, respectively, currently producing (mostly women) have the PTOs (permission to occupy) registered in their husbands or family names. The situation where women are the actual farmers but title deeds are mostly in the names of men may also be creating disincentives to farming. In the Makwe scheme, most farmers (61%) producing in the scheme are renting the land from owners who failed to grow crops due to high water charges. By contrast only 30% of the farmers had title deeds. In Masholomoshe, 30% of the farmers rented the land whilst 43% have title deeds to the land.

4.2.2 Comparisons of farm incomes between irrigation schemes

Table 4.3 Production information

<i>Scheme</i>	<i>Crop grown</i>	<i>Average area cultivated (ha)</i>	<i>Number of farmers</i>	<i>Average yields (kgs)</i>	<i>Average revenue (US\$)</i>	<i>Average total costs (US\$)</i>
Masholomoshe	Maize	0.3	30	380	285	121
Makwe	Maize	0.2	53	400	300	147
	Beans	0.2	28	250	373	98
	Wheat	0.2	10	300	375	188
	Cabbage	0.1	14	103	103	126
	Tomatoes	0.2	15	18	270	130

(Source: study survey, 2013)

4.3.1 Types of crops grown

Farmers in Masholomoshe scheme only managed to grow maize during the cropping season 2012/2013. Due to water shortages, farmers were quick to say that yields were not enough to sustain them for the whole year and they had to employ other food shortage mechanisms such as contributions from relatives and buying maize meal from shops. In contrast, farmers from Makwe irrigation scheme grew a variety of crops. They practice what they call a block system whereby the scheme is divided into sections of different crops. Farmers are required to pay a certain water charge every time they need to irrigate depending on the size of the land that they want to cultivate. This means that farmers have to choose the crop they want to produce and the size of the area. This has resulted in some farmers withdrawing from irrigation activities because they could not afford the charges. Those who decided to produce opted to produce one crop because the more one produces the higher the water charges. From the study sample, the majority (58%) of farmers had decided to produce maize because it is easy to produce and it is also the staple food in the area. The average area cultivated for maize

was 0.3ha with average yields of 380kg per farmer. The maize farmers incurred average production costs of \$121 and obtained average revenue of \$285.

About 28 farmers from the sample chose to produce beans because they saw it as a cheaper alternative than producing any other crop. Farmers emphasised that beans are cheaper to produce because they do not require a lot of water. The average area cultivated for beans is 0.2ha and obtained an average yield of 250kg and average revenue of \$373. Table 4.4 shows that 10 farmers from the sample who chose to produce wheat incurred high cost of \$188 because wheat is labour and water intensive. The average area cultivated for wheat was 0.2ha with average yields of 300kg and average total revenue of \$375. Other farmers opted for vegetables such as cabbages and tomatoes. The table above shows that the average total costs for cabbages (\$126) was high than the average total revenue (\$103). The average area cultivated for cabbages was 0.1ha which might be the cause of low returns.

The difference in net farm income between farm types was calculated as shown in Table 4.4. The cost of inputs like fertilizers, pesticides, herbicides, seeds, labour and equipment were deducted from the gross farm income of each crop. The result revealed that the average gross margin of \$164 in Masholomoshe scheme was slightly higher than that of Makwe irrigation which was \$146.40. This is because Makwe irrigation farmers experience high irrigation water charges. This could be because the expenditure is very high and the income from the harvest is insufficient to support their household income. The average income per capita was \$59.

4.2.3 Role of supporting institutions

4.2.3.1 Input markets

Figure 4.1 shows that 20% of the sample respondents in Masholomoshe had access to input markets and 30% from Makwe had access to input market. Farmers pointed out that inputs such as seeds and pesticides are very expensive and only a few can afford them. They also emphasised that there was shortage of fertiliser in the markets and when available it is too expensive for the small-scale farmers to buy. Most farmers

Table 4.4 Difference between the gross margins of farmers in Masholomoshe Makwe irrigation schemes

<i>Scheme</i>	<i>Variable</i>	<i>Average Gross revenue (\$)</i>	<i>Average total costs(\$)</i>	<i>Average net farm income(\$)</i>
Masholomoshe	Maize	285	121	164
Makwe	Maize	300	147	153
	Beans	373	98	275
	Wheat	375	188	187
	Cabbage	103	126	-23
	Tomatoes	270	130	140
Total Makwe				146.40
Average income per capita/month				51.00
Average income per capita/day				1.70

(Source: study survey, 2013)

4.2.3 Role of supporting institutions

4.2.3.1 Input markets

Figure 4.1 shows that 20% of the sample respondents in Masholomoshe had access to input markets and 30% from Makwe had access to input market. Farmers pointed out that inputs such as seeds and pesticides are very expensive and only a few can afford them. They also emphasised that there was shortage of fertiliser in the markets and when available it is too expensive for the small-scale farmers to buy. Most farmers

resort to using untreated seeds from their previous harvest, especially those who produce maize, wheat and beans.

4.2.3.2 Extension services

The results on figure 4.2 reveal that the majority of the farmers have access to extension services. 73% and 87% farmers from Masholomoshe and Makwe, respectively, indicated that they had access to extension services. However, some farmers in Masholomoshe were not satisfied with these services. They pointed out that the extension agents are not always available for consultation whilst in Makwe farmers complained that extension agents are too busy with their own farms to provide farming advices to other farmers. They also complained that they still use old farming methods making it difficult to attain high levels of yields and quality crops.

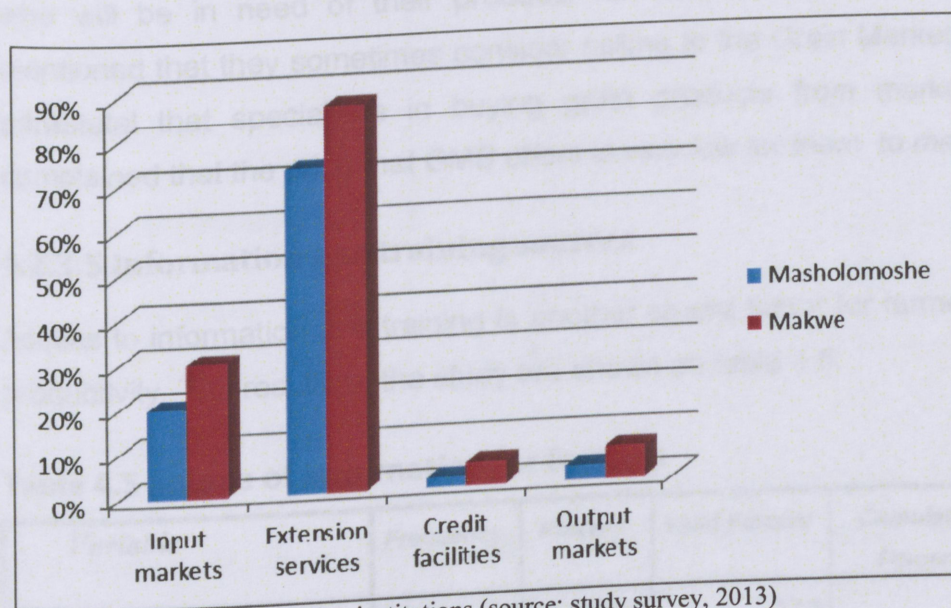


Figure 4.1 Access to supporting institutions (source: study survey, 2013)

4.2.3.3 Credit facilities

Access to credit was a big challenge to farmers as only a few farmers could acquire loans from the bank. The results on figure 4.1 show that 2% of the sample respondents in Masholomoshe had access to a bank loan from Agribank whilst only 5% of the respondents in Makwe scheme also had access to loans. Agribank is the only institution that provides loans to farmers in the area. However, farmers do not want to take loans

because the interest rate is very high. Further probing revealed that farmers also fear to take loans from the bank because yields are not guaranteed due to shortage of water in the schemes and others mentioned that for one to qualify for a bank loan he/she must produce a valid payslip as collateral. Since most farmers do not have formal jobs this means that they do not qualify for the bank loans.

4.2.3.4 Access to output markets

The study also revealed that most farmers did not have access to output markets where they can sell their produce. Only 3% and 5% of the sample respondents from Masholomoshe and Makwe schemes (figure 4.2) had access to output. Farmers from both schemes mentioned that they did not have stable markets therefore they had to search for markets for themselves. People who buy from them are usually individuals who will be in need of their products for subsistence. Maize and wheat farmers mentioned that they sometimes consider selling to the Grain Marketing Board (GMB), a parastatal that specialises in buying grain products from markets. However, they complained that the price that GMB offers is very low for them to make any profits.

4.2.3.5 Information and training sources

Access to information and training is another crucial factor for farmers to increase their productivity. The results of the study are shown on table 4.5.

Table 4.5 Source of information for farmers

<i>Variable</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
extension workers	116	77.3	77.3	77.3
NGOs	7	4.7	4.7	87.3
private organisations	4	2.7	2.7	90.0
Other	15	15.0	10.0	100.0
Total	150	100.0	100.0	

(Source: study survey, 2013)

The study revealed that extension workers were the main source of information for farmers, with 77% of farmers in both schemes relying on extension workers. Only 15%

rely on other sources such as their neighbours and other farmers from neighbouring schemes. On the other hand, a few farmers (4.7% and 2.7%) relied on NGOs and other private organisation, respectively.

4.2.4 Major constraints faced by farmers

4.2.4.1 Major problems in production

Table 4.6 reveal the major problems that scheme farmers face with 42% of the sample respondents from both schemes listing water as their main problem.

Table 4.6 Major production scheme problems

<i>Variable</i>	<i>Frequency</i>	<i>Percent</i>	<i>Valid Percent</i>	<i>Cumulative Percent</i>
Water	63	42.0	42.0	42.0
Management	6	4.0	4.0	46.0
Maintenance	7	4.7	4.7	50.7
Lack of inputs	29	19.3	19.3	70.0
Lack of supporting Institutions	6	4.0	4.0	74.0
Lack of markets	39	26.0	26.0	100.0
Total	150	100.0	100.0	

(Source: study survey, 2013)

Lack of markets and inputs was also a major problem in the schemes with 26% and 19%, respectively facing this problem. Other problems included the poor maintenance (4.7%) where damaged infrastructure takes long to be repaired. Other farmers (4%) also revealed that inefficient management of the scheme was a problem and another 4% of the respondents mentioned lack of supporting institution as another problem that hinders maximum productivity.

4.2.4.2 Major problems in produce marketing

Table 4.7 reveals the major problems faced by farmers in marketing their products per crop. Most farmers (48%) faced a problem of high transport cost while about 33% of the

farmers faced the problem of not having transport to take their products to the market and 14% of the farmers faced a problem of inadequate transport.

Table 4.7 Major marketing problems

variable	Frequency	Percent	Valid Percent	Cumulative Percent
small size transport	22	14.7	14.7	14.7
lack of transport	49	32.7	32.7	47.3
high transport cost	72	48.0	48.0	95.3
other costs	7	4.7	4.7	100.0
Total	150	100.0	100.0	

(Source: study survey, 2013)

4.2.4.3 Challenges ranked according to severity

Farmers were asked to rank the constraints that they face in production that hinder them from achieving household food security according to severity. The results are as shown in table 4.8.

Table 4.8 Major challenges faced by farmers ranked according to priority

Major constraints	Makwe	Masholomoshe
high water cost	97%	34%
shortage of water	53%	83%
lack of credit	81%	46%
lack of inputs	56%	63%
lack of output markets	69%	71%
lack of relevant training and information	19%	22%
damaged irrigation infrastructure	66%	51%

(Source: study survey, 2013)

97% of Makwe farmers ranked high water cost as their number one problem that hinders them from achieving household food security. Lack of credit to buy inputs and labour was ranked second by 81% of the sample farmers. Lack of output market (69%) and damage to equipment and infrastructure (66%) such as the engine pump, canals and fences were ranked third and fourth, respectively. In Masholomoshe scheme, 83% of farmers ranked shortage of water as their main problem, and 71% listed lack of

output market as their second major problem whilst 63% of farmers listed lack of inputs third biggest problem.

4.3 Econometric analysis of results

4.3.1 Linear regression analysis of results

Results of inferential statistical analyses are shown in Table 4.9 which shows the impact of various variables on farm household income per capita generation by smallholder farmers. The household income per capita was obtained by dividing farm income by the size of the household. The table shows that out of the eight variables, five were significant, three at 1% (household size, total yields for maize and total farm income), one at the 5% level (area cultivated) and the last at the 10% level (price of the product)

Table 4.9 Coefficients of variables in linear regression model

Variables	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	39.269	11.716		3.352	.001**
age of respondents	.212	.135	.042	1.569	.119
household size	-9.407	.823	-.340	-11.424	.000*
area cultivated	-72.369	28.633	-.098	-2.528	.013**
input cost	.034	.053	.025	.632	.529
total yields(maize)	.060	.017	.340	3.468	.001*
quantity sold (maize)	-.038	.025	-.167	-1.514	.132
price of the product	-.589	.349	-.048	-1.687	.094***
total farm income	.231	.019	.713	12.271	.000*
R Square = 0.950	Adjusted R Square = 0.898	Std. Error of the Estimate = 21.54428			

Source: study results; Dependent Variable: income per capita; n = 150; * =1% ** = 5%; *** = 10%

The negative coefficients for household size of a farm household and the area cultivated reflect that both variables have negative impacts on household food security of a small-scale irrigation farm household. This means that as the household size increases, it becomes less likely that the farm household will have a high per capita income which

translates to household food security. Also as the area cultivated increases, it becomes less likely that the household will achieve a high per capita income. The last finding is however unexpected and will further be explained in the discussion of results.

Total yields, and total farm income have a positive impact on income generation as was expected as shown in Table 4.9. This means that these variables are important determinants of small-scale irrigation farm household income and food security. If the total yields of farm household increases by 100kg, the household per capita income will increase by \$34, hence household food security. As the total farm income increases by \$100, the household will obtain per capita income of \$71, 30 which adds to household food availability. The price of the product revealed a negative impact on household food security with the p-value of 0.094. The R^2 of the model was 0.903 with an adjusted R^2 of 0.898 as shown in table 4.9. R^2 measures how well the model fits the data and the higher the R^2 the better the model fits the data. Therefore, the results show that the model was a good fit.

4.3.1.2 Correlation between the variables

The results of a 2-tailed Pearson correlation test which measures the relationship or association between variables is given in Table 4.10. This measures the strength and direction of the relationship between the variables.

Table 4.10 Correlation matrix table

Pearson Correlations Matrix									
Variables	income per capita	age of respondent	household size	area cultivated	input cost	total yields	quantity sold	price	total farm income
income per capita	1.000	.046	-.625	.812	.079	.800	.842	-.527	.885
age of respondents	.046	1.000	.002	-.016	-.118	-.007	.022	.051	.026
household size	-.625	.002	1.000	-.020	.106	-.063	-.186	-.009	-.534
area cultivated	.812	-.016	-.020	1.000	.713	.662	.796	-.111	.722
input cost	.079	-.118	.106	.713	1.000	.181	.195	-.245	.172
total yields	.800	-.007	-.063	.662	.181	1.000	.952	.036	.855
quantity sold	.842	.022	-.186	.796	.195	.952	1.000	-.046	.888
price of the product	-.527	.051	-.009	-.111	-.245	.036	-.046	1.000	-.809
total farm income	.885	.026	-.534	.722	.172	.855	.888	-.809	1.000

Source: study results.

The results on the correlation matrix show that there was a significant association between most of the variables that were used in the study with the dependent variable. Household size and the price of the product had a negative relationship with the income per capita whilst size of the area cultivated, total yields, quantity sold and total farm income indicated a positive relationship with the dependent variable.

4.3.2 Binary logistic regression analysis

The results of the binary logistic regression model are shown in Table 4.11 which shows the impact of various variables on number of meals a household have a day which was used as a proxy for household food security. After elimination of many non-significant variables, only 4 variables were significant where rented land and availability of

extension services are significant at 1% while PTO and access to credit are significant at 5%.

Table 4.11 Binary logistic regression results

Variables	B	Exp(B)	Sig
PTO			0.063***
Title Deeds	1.22	3.414	0.022**
Rented	0.027	1.028	0.004**
CRDT(1)	0.110	.895	0.012**
EXT(1)	0.816	.442	0.004**
Constant	0.023	1.225	0.083***

Source: study results; n = 150; Dependent Variable: household have 3 or more meals a day; n = 150; **= 5%;

***= 10%

The model used the number of meals a household have a day as a proxy for household food security. The dependent variable was whether the household eats three or more times a day or not with those who have 3 or more meals a day regarded as food secure. This was regressed against three predictor variables that is, land tenure (TENURE), access to credit (CRDT), and access to extension services (EXT) following the elimination of some highly insignificant variables, that is PTO, having title deeds and rented the land. The results show that tenure system has a positive effect on the number of meals a household have per day with p-values of 0.063, 0.022, and 0.004 for those with PTOS, title deeds and those who had rented the land, respectively, and all had positive coefficients. Access to credit and extension services show a positive relationship with the number of meals a household have a day as was expected. This means that for every extra \$1 a farmer gets in loan, it is 0.110 more likely that the farm

household will achieve food security and for every extra service a farmer gets from extension workers, the odds of achieving household food security increase from 0 to 0.442.

4.3.2.1 Model predictability and Hosmer and Lemeshow Test

The model predictability level is shown in Table 4.12 which classifies the variables that were entered in the model. The model correctly predicted 65% of the cases entered in the model as correct.

Table 4.12 Classification Table

Observed	Predicted		
	household eats 3 or more times a day		Percentage Correct
	household 3 or more times a day	household eats less than 3 times a day	
household eats 3 or more times a day	42	25	62.7
household eats less than 3 times a day	27	56	67.5
Overall Percentage			65.3
Hosmer and Lemeshow Test Chi-square =5.7 P-value = 0.68			

Source: Study Results

The Hosmer and Lemeshow test produced a chi squared value of 5.70 with a p-value of 0.68, indicating that the model's predicted estimates did not differ significantly from the observed data and thus an indication of an acceptable goodness of fit which means that the model was fit for the analysis.

4.4 Discussion of the results

This study revealed descriptive and inferential statistical results related to small-scale farmers at the Masholomoshe and Makwe irrigation schemes. From the former, it could be established that most small-scale irrigation farmers are old people who have retired

from their formal jobs. This finding has a significant impact on the sustainability of irrigation farming. In a study conducted by Fiebig (2010) in Namibia, the age of the household head was found to be a significant factor in affecting household income and food security. Regarding the gender spread of small-scale irrigators, the finding of this study was that females were the most dominant. This is a positive outcome because women are regarded as pillars of ensuring household food security. A study by Nekhavambe et al (2012) uncovered the dominance of males in smallholder irrigation despite women being major providers of labour. The dominance of females in the two schemes that are the focus of this study is therefore a welcome trend.

Results also revealed that most farmers from the two schemes had primary education. This differed from the Heckman two-stage estimation conducted by Grimm (2007) in India that indicated that secondary education was the most significant factor on livelihoods. This corresponds with a qualitative study conducted by Aseyehgn (2012) in which he concludes that most of the small-scale irrigation farmers in developing countries have attained secondary education which enable farmers to have adequate farming knowledge. Farmers with secondary education were also able to calculate and apply required measurements such as plant spacing and fertiliser application. It can be concluded that farmers need to have higher levels of education to improve their household food security.

Farming was found to be the most important source of income for farmers and this confirms its importance as a contributor to household income and food security. However, off-farm income sources enable farmers to purchase inputs and irrigation technology. Therefore off-farm income compliments on-farm income and consequently improves livelihood and per capita income which determines the level of food security a household have with higher per capita income preferred than the lower one.

The results also indicated that household size was significant in determining farmers livelihood because the larger the household size, the more labour available for farming activities. Ayele (2005) concludes that the productivity of labour and technology employed in agriculture is central to household livelihood and food security in developing countries.

Results of the study reveal that most farmers in Makwe irrigation scheme had rented the land that they used followed by those who had title deeds for their land. A substantial number of farmers had Permission to Occupy (PTO). In Masholomoshe scheme most of the farmers had title deed, rented and only a few had PTOs. Shah *et al.* (2007) states that providing security of tenure to small-scale farmers is often seen as a pre-condition for intensifying agricultural production and is increasingly stressed as a prerequisite for better productivity and household income. However, with high percentage of rented land in Makwe, paid rent to the owners of the farms from the little income that they got from farming, farmers ended up with very little to sustain their families. Farmers with title deeds to their land indicated that these documents mean nothing to them because they still lack other resources such as seeds and financial capital to produce at full capacity. Therefore, land tenure status is considered to be an important factor in determining the productivity of small-scale irrigation farmers. In Ethiopia, Aseyehegn (2012) argues that legal system of land and water rights, support services and well-established water users associations through which purposes of irrigation are achieved are not adequately planned and put in place in most small-scale irrigation schemes in Africa. This, Aseyehegn concluded, impacts negatively on productivity and farm household food security.

Farmers in Masholomoshe and Makwe irrigation schemes only managed to grow one crop for the cropping season 2012/2013 due to shortage and high water cost. Most farmers chose to produce maize because it is a staple food in the country and is a significant contributor to food security. This is in contrast with Ojo *et al.* (2011) who attested that small-scale irrigation allows farmers to grow a variety of crops and produce crops throughout the year. According to a qualitative study conducted by Aseyehegn (2012) in Ethiopia, availability of water was the most important component of irrigation schemes to be sustainable and ensure household food security. Shah *et al.*, (2007) further added that shortage and high water cost undermined small-scale irrigation productivity, ultimately risking the feasibility and sustainability of small-scale irrigated agriculture.

The study also revealed that the area cultivated in the two schemes was very small. This in turn had a negative impact on the yields, quantity sold and total farm income. According to a study conducted by Murray (2006), the larger the area cultivated, the bigger the yields a farmer gets and this enables farmers to have enough for household consumption and a surplus for selling, hence improving household income. Therefore, it can be concluded that the area cultivated by farmers was very small and this had a negative impact on production, yields and total farm income and hence the low household food security.

The gross margin analysis revealed that there was no significant difference between the two schemes gross margins. The average per capita income per day (\$1.70) which was obtained by dividing the farm income by the household size was slightly higher than the poverty line critical value of \$1.25 per day (Geohive, 2012). According to the Geohive (2012) all households that rely on more than \$1.25 per capita income per day are regarded as food insecure because they live above the critical poverty line value. However, given the Zimbabwean situation with very high food prices, the average per capita income is not enough to sustain the households. Therefore, it can be concluded that the small-scale irrigation households from the two schemes are food insecure.

Regarding the role played by supporting institutions, the study revealed that farmers had poor access to input and output markets, credit facilities and information and training while extension agents were their main support system. This corresponds with BFAP (2008) who asserts that there is a serious lack of supporting services for small-scale irrigation farmers in most developing countries. Ojo *et al.* (2009) in Nigeria emphasises that access to input markets enables farmers to purchase seeds, fertilisers, pesticides and other inputs which aid production whilst access to credit provide farmers with capital to purchase these inputs. Output markets enable farmers to sell their produce to get income which then enables them to purchase other household necessities that improve their food security status. It can then be concluded that the availability of supporting institutions and services is crucial in the small-scale irrigation farming.

Provision of agricultural extension services, such as practical training and technical advice on improved production techniques help small-scale irrigation farmers increase their knowhow and access to information which in turn improves their production levels. Ayele (2005) revealed that inadequate information, education, and training are significant barriers to attaining food security. Therefore, the role of extension agents in providing improved varieties of crops and practical training to innovative farmers is crucial.

The study identified shortage of water and high cost of irrigation as the main challenges that are hampering irrigation production in Masholomoshe and Makwe irrigation schemes, respectively. The study revealed that Makwe scheme owed Zimbabwe national water Authority (ZINWA), the body regulating water usage in Zimbabwe, thousands of dollars in debt. The scheme is struggling to pay the required amount. In an attempt to raise the money to pay for water they came up with a method of farming called the Block system. The block system divides the scheme into different sections for different crops and only those who were willing to pay designated prices were allowed to grow certain crops. According to Nhundu *et.al.* (2010), insufficient water and high water cost in irrigation production and management have a negative impact on farmer household food security because these challenges impact on the efficiency and operation of irrigation schemes.

The study also revealed that shortage of credit is another major problem that farmers face. Farmers need financial capital to buy inputs such as fertilisers, seeds, pesticides and other farm inputs. This is in line with Machethe et al, (2004) who argue that one of the most critical problems threatening the viability of smallholder irrigation is the absence of credit. Access to credits need collateral mostly in the form of land right which some smallholder farmers do not possess. Credit is very important in that it helps farmers to acquire all the necessary inputs in right quantities and qualities at the right time. Adequate credit could help adopt new technologies. Ayele (2005) added that one way of overcoming financial constraints is improving access to credit. This is because credit access has a direct effect on investment in irrigation. For instance, credit access increases the capacity of irrigators to purchase agricultural inputs and mitigate risks of

crop failures. It serves as a crop insurance which helps farmers to be strongly engaged in such costly farming activities. Therefore, it provides start-up capital to begin more profitable business to generate higher income and ensure food security.

Damaged infrastructure is also among the major constraints that farmers face in their respective schemes. Farmers in Makwe pointed out that their main problem is the constant generator break down. Since the scheme suffers from financial crisis, it takes a long time for them to repair the engine. The generator is used to pump irrigation water from the dam to the scheme. Most farmers in Masholomoshe complained about the damage on water canals that are too old and are worn out. This means that the construction of new canals is necessary. Other problems they face include the worn out fences which allow animals such as goats to enter and graze on their crops. He *et al.* (2006) in a study conducted in Zambia concluded that the absence or unreliable supply of inputs and equipment, as well as insufficient transportation or infrastructure can also be major barriers to improved productivity and profitability in small-scale irrigation schemes.

The econometric results revealed that although household food security of a small-scale irrigation farm household is affected by many factors, only a few variables had a significant relationship to income per capita. In the study, household income per capita was used as a proxy for food security. The variables that proved to be significant on household food security using linear regression model were household size, area cultivated, quantity sold for maize and total farm income. Land tenure, access to credit and extension services were significant to household food security using a binary logistic regression model. However, an analysis conducted by Murray (2006) in which he regressed all the factors affecting small-scale irrigation farming, revealed that income, access to market information, land ownership and access to market information and credit were positively and significantly associated with household income. Thus, improving rural farm households' access to market information is likely to improve small holder farmers' income and household food security.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study revealed the following:

- Most small-scale irrigation farmers were old women with primary education.
- Farming was found to be the most important source of income for farmers and this confirms its importance as a contributor to household income and food security.
- Household size was significant in determining farmers livelihood because the larger the household size, the more labour available for farming activities.
- Most farmers in Makwe irrigation scheme had rented the land that they used followed by those with title deeds for their land whilst a substantial number had Permission to Occupy (PTO). In Masholomoshe scheme most of the farmers had title deed,
- Most farmers in the two schemes mostly grew maize for the cropping season 2012/2013 due to shortage and high water cost. Maize is considered to be the most important staple food in the region
- The area cultivated in the two schemes was relatively small, a factor that has had a negative impact on the yields, quantity sold and total farm income.
- The gross margin analysis revealed that the farmers from the two schemes obtained very little profit (there was no significant difference between the two schemes' gross margins).

- Farmers had poor access to input and output markets, credit facilities, information and training while extension agents were their main support system.
- Shortage of water and high cost of irrigation were the main challenges that hampered irrigation production in Masholomoshe and Makwe irrigation schemes respectively. Shortage of markets, credit and damaged infrastructure, the constant engine break downs and broken fences were other constraints in the schemes.
- Lack of transport and stable markets, and high transport costs were the major challenges faced by farmers in marketing their produce.
- The econometric results revealed that, household size, area cultivated, quantity sold for maize and total farm income regressed on linear model had a significant relationship with household food security. Land tenure, access to credit and extension were significant to household food security using a binary logistic regression model.

5.2 Conclusion

- The first hypothesis of the study was that there was no significant impact of socio-economic factors on household food security of small-scale irrigation farmers. The finding that most farmers were elderly women translates into production and productivity challenges as depicted by descriptive statistical analyses. Despite the low gross margins for example, inferential statistical analyses have shown that if the total yields of farm households were to increase by 1kg, the probability that a given household could have high per capita income was more than 34%, and thus ensuring food security. The hypothesis as stated is therefore rejected.
- The second hypothesis was that there was no significant difference between farm incomes of Masholomoshe and Makwe small-scale irrigation schemes. The results on the gross margin analysis revealed that the net gross margins of the two schemes were very low with minimal difference between their net incomes.

This means that farmers from both schemes obtain almost the same average farm incomes regardless of the schemes. The hypothesis is therefore accepted.

- The third hypothesis stated that supporting institutions play a significant role in helping irrigation farmers to achieve household food security. The study found that farmers had challenges in accessing adequate supporting institutions which provide them with essential services such as markets to sell their produce, credit to buy inputs, farming information and training for them to increase production. This translated to constraints in increasing productivity in the schemes and in achieving household food security. For instance the inferential statistical analysis revealed that if a farmer could get an additional \$1 in credit, the probability of the household having 3 or more meals a day was about 90%. Therefore, the stated hypothesis is accepted.
- The last hypothesis was that there was no significant relationship between the constraints faced by the small-scale irrigation farmers and their household food security. The findings that farmers from both schemes faced many constraints in farming which included high cost and shortage of water, lack of credit to buy inputs, lack of production information and training and damaged infrastructure in the schemes resulting in low yields and gross margins, shows that there is a relationship between the constraints faced by farmers and their household food security. Therefore the stated hypothesis is rejected.

5.3 Recommendations

- This study has noted that most farmers are elderly and less productive, translating into challenges for food security despite the finding that increasing total yields of farm household could significantly increase per capita incomes. Strategies to counter this negative impact could include information sessions with youth at schools and institutions of higher learning to participate in farming ventures. Government could play a meaningful role of providing stipends that

could be allocated to small irrigation schemes at competitive market rates for placement of identified youth holding agricultural qualifications.

- The finding that the farmers from the two schemes obtained very low average net farm incomes can be countered by providing workshops that will teach farmers on how to manage their farm incomes. The government could also assist by giving small-scale irrigation schemes some funds as a start-up capital. This would enable them to buy adequate production inputs and increase their productivity and hence farm income.
- The study also revealed that farmers lacked access to supporting services such as markets, loans, farming information and training. Stakeholders could counter these problems by searching for output markets before production of a certain crop begins. The state could also establish institutions that could be specifically designed to help small-scale irrigation farmers with funds, information and skills transfers. Low interest loans could also be provided to farmers.
- Strategies to counter production challenges could include water price subsidies. The farmers could also be assisted to construct water storage facilities such as dams and water tanks.

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736191759 or by email. langza@electonmail.co.za

Signature: Respondent

Date:

Appendix A: Consent Form

Good day, my name is Ndlovu Langelihle (BN565990) from the University of Venda. I am conducting a research on the analysis of the constraints faced by small scale irrigation farmers in achieving household food security. This is in partial fulfillment of the degree masters of Science in Agricultural Economics (MSCAEC). This research is meant to identify the constraints faced by small scale irrigation farmers in achieving household food security.

I have randomly selected you to participate in this study. i would like you to respond to the questions. If possible, I would like to talk to the principal owner of the plot/farm. i have randomly selected you within this scheme as one of other small –scale irrigation farmers in this area to be interviewed.

Please understand that participation in this study is voluntary and you may decide to discontinue completing the questionnaire at any time. However, i would really appreciate it if you do share your thoughts with me. If you choose not to take part in answering these questions, you will not be affected in any way whatsoever. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this, there will also be no penalties and you will NOT be prejudiced in ANY way. When it comes to answering questions there are no right and wrong answers.

The study will hold no risks for you or to any other member of your community. Although you will not personally benefit from this study, i will do my best to make sure that people in irrigation scheme benefit from this study. All information that you give will be kept confidential and you will not be identified by name or address in any of the reports that will be written.

If you would like some more information about this study please feel free to contact me on 0027-736191759 or by email, langa@classicmail.co.za

Signature: Respondent

Date.....

DECLARATION BY FIELDWORKER

DECLARATION BY FIELDWORKER

I hereby declare that I explained to the respondent that he or she is participating freely in this research. I also explained to the respondent that he or she may stop this interview at any point and that such a decision would not in any way affect them negatively. I explained to the respondent that this is a research project whose purpose is not necessarily to benefit him or her personally. I explained to the respondent that the answers he or she will provide during the interview would remain confidential.

Male

1

Signature of enumerator

Date:

A.3 level of education

Primary	0
Secondary	1
High school	2
Tertiary	3

A.4 numbers of people in household

A.5 income sources

Farming	0
Employment	1
Contributions	2
Other	3

A.6 Please indicate how you are connected with the

PIO	0
Title Deed	1
Rented	2
Other (please state)	3

Appendix B: Interview Questionnaire

This questionnaire will be directed to small-scale irrigation farmers.

NB: TICK THE APPROPRIATE ANSWER WHERE ANSWERS ARE PROVIDED

SECTION A: BIOGRAPHICAL INFORMATION

A1 Genders of respondents

Female	0
Male	1

A2 Ages of respondents

.....

A3 level of education

Primary	0
Secondary	1
High school	2
Tertiary	3

A.4 numbers of people in household

.....

A.5 income sources

Farming	0
Employment	1
Contributions	2
Other	3

A.6. Please indicate ownership of your plot (Tenure Status)	
PTO	0
Title Deed	1
Rented	2
Other (please state)	3

SECTION B: FARM INCOMES FROM FOOD CROPS

B1. Crop and area cultivated, yields, quantity consumed and sold

Crop type	Area cultivated during production season (ha)	Total value of all inputs used for the crop during season (\$)	Total Yields for the crop (kg)	Quantity consumed (kg)	Quantity sold (kg)	unit price (\$/kg)	Total income for the crop (\$)

B2. Why do you select the above type of crops for your irrigation farming?	
0 = Better price	0
1 = Good production	1
2 = High disease tolerance	2
3 = Easiest to cultivate	3
4 = Seed availability	4
5 = Other (specify)	5

B3 Do you cultivate the total area of your irrigable land every season?

0 = No

1 = Yes

B4. If your answer to question 3 is No, what are the reasons? (Circle the answers)

Shortage of family labour	0
Lack of seed	1
Lack of oxen	2
insufficient irrigation water	3
Lack of credit	4
Other (specify)	5

B5 Are the yields enough to sustain the household throughout the year?

0= yes

1= no

B6 If No for how long does agricultural yield sustain the household per year?

B7 When do you experience food shortages?

B8 How many times do the household eat a day?.....

B9 What are your food shortage coping mechanisms?

SECTION C SUPPORTING INSTITUTIONS

C1. Where do you get the production inputs that you use?

0= buy

1= provided by the government

2= provided by the private organisations

3= other (specify)

C2. If you buy which inputs do you buy and how much? List in the table below

Production input amount per ha	Cost of input per ha (\$)
Treated Seeds	

Fertilizer	
Pesticides	
Insecticides	
Other (<i>Specify</i>)	
Total cost of inputs	

C3 How do you cultivate your land? (Tick as appropriate) and indicate the costs

Own	Borrowed	Hired	Cost (\$)
Tractor			
Animal drawn			
Hand			
Other (<i>Specify</i>)			

C4 What help do you need from the government or any organization on your irrigation farming

0=seeds

1= fertiliser

2= markets

3= transport

4= loans

5=other

C5 Do you have adequate infrastructure and irrigation equipment in the scheme?

0= Yes

1= No

C6 Did you ask or apply for a loan from any of the following:	
Family members and friends	01
Neighbours	02
Local dealer / shop	03
Stokvel	04
Money lender (<i>mashonisa</i>)	05
Employer	06
Church	07
Other (<i>Specify</i>)	08
No Response	09

C7 What kind of security (collateral) did you provide?	
None	01
Land	02
House and homestead improvements	03
Equipment	04
Livestock	05
Crops	06
Bank card	07
ID book	08
Television / fridge	09
Other (<i>Specify</i>)	10
No Response	11

C8 What was the loan used for	
Buy food	01
Pay medical expenses	02
Pay school fees	03
Pay for funeral	04
Buy furniture	05
To pay off debt	06
Purchase inputs and services (For business or farm)	07
Working capital (For business or farm)	08
Purchase land/Equipment/Buildings (For business or farm)	09
Other (<i>Specify</i>)	10
No Response	11

C9 Why did you not apply for a loan or for credit from a formal credit institution?	
High interest rate	01
Could not offer security	02
Did not need loan	03
Did not think I would get one	04
Lack information on credit institutions	05
Afraid of debt	06
Other (Specify)	07
No Response	08

C10 Do you receive any sort of extension services available in your locality?

0 = No

1 = Yes

C11 do you receive farming training from any organisation?

0= no

1= yes

2= sometimes

C12 .Do you get market information about prices and demand conditions of agricultural inputs and out puts?

0 = No

1 = Yes,

C13. Where do you get the information?

0 = extension workers

1 = government agencies

2 = NGOs

3 = private organisations

4 = other (specify)

C14. Are you a member of any farmer organisation?

0= NO

1= yes

C15. If yes how do they help you in production?

C16. Are you satisfied with the operation and management of the scheme?

0=Yes

1= No

C17. If no what do you suggest should be done to improve the operation and maintenance of infrastructure and equipment in the scheme

C18 Is the scheme and equipment properly maintained?

0= YES

1= NO

C19. Does damaged equipment get repaired on time?

0= Yes

1= No

C20. If No how long does it take to be repaired and how does it affect your production

C21. Is the amount of water enough to irrigate your land every season?

0= Yes

1= No

C22. If your answer is no, what mechanisms do you suggest to solve the scarcity of water

SECTION D: MAJOR PROBLEMS FACED BY FARMERS IN THE SCHEME

D1. What general problem do you experience in moving your produce to the market? (Please tick)

Small size of transport
Lack of transport
High transport cost
cost Other (Specify)

D2. What are the major problems you face/observe in your irrigation farming?

0= water

1= management

2= maintenance of infrastructure

3= lack of inputs

4= lack of supporting institutions

5= other

D3. What actions do you take to solve the problem?

D4. What problems do you face interms of water allocation

0= insufficient water supply

1= high costs

2= unfairness

3= other

D5. What are the major problems in operation and management of the scheme? What is your opinion about the solution?

0= exclusion from decision making process

1= mismanagement of funds

2= damaged equipment

3= other (specify)

solutions.....

D6. List what you consider to be the major problems you face in production and marketing your farm products and in the scheme in general

D7. Suggest ways in which such problems can be addressed

Thank you!!!!

Appendix C: Extension worker interview guide

This questionnaire will be directed to the extension workers

1. Which irrigation method is used in the scheme?
2. Do you think it is the correct method suitable for the scheme?
3. Who manages the scheme?
4. Do you involve farmers in decision making of the scheme?
5. Do you have enough water supplies for the scheme throughout the year?
6. When do you usually experience water shortage in the scheme?
7. What types of crops are grown in the scheme?
8. Who decides on the crops to be grown?
9. Do you think farmers have enough knowledge and skill to produce those crops?
10. Do you think farmers produce enough for their household consumption and also for selling?
11. What assistance do you provide to the farmers to improve production?
12. Is the infrastructure and equipment in scheme enough for everyone and accessible to all farmers?
13. Do you think all farm households are food secure?
14. What are the main challenges that farmers face in production and in achieving food security?
15. What are the main challenges that the scheme that hinder farmers from improving production?

Appendix D: Work Plan

Date	Item	Activity	Responsibility
April – June 2013	Research proposal	Submission of final research proposal (Supervisor)	Student
		Questionnaire design	Student
	Research assistant	Submission of final research proposal (Higher Degrees Committee)	Supervisor
		Proof reading/Editing of the research proposal	Student
		Submission of final research proposal (SENEX)	Supervisor
July-September 2013	Data collection	Pretesting/ Pilot study	Student
		Refinement	Student
		Field data collection	Student
September-December 2013	Data analysis	Data coding and entry	Student
		Data cleaning	Student
	Final copy of research	Thesis write up	Student and supervisor
		Submission of first draft	
		Submission of second draft	
		Proof reading of thesis	
		Submission to external examiners	
		Corrections from external examiners	
		Binding	
		Final submission of the thesis	

Appendix E: Budget

Activities	Item	Quantity	Unit cost	Total
Travel	Travel to the research site ($\approx 650\text{km}$ / single journey)	4 trips	R3.16/km	R8 216
Accommodation	Accommodation at research site	5 days	R800	R4 000
Administration	Stationery :Bond papers	13 rims	R45	R 585
	Printing(drafts, questionnaires and final copies),	2000 pages	R2.50/copy	R5 000
Data Collection	Research assistants	3 assistants x 8hrs/ day for 10 days	R30/ hr.	R7 200
	Questionnaire pretesting		R1 500	R1 500
	Catering for researcher and assistance	3x 10 days	R120/ day	R3 600
Data analysis	Data cleaning, coding and capturing	3 assistants x 8hrs/day for 10days	R30/hr.	R7 200
	Statistical analysis	1	R3 500	R3 500
	Proof reading of final copy	1	R3 000/copy	R3 000
	Binding of final report	6	R250.00	R1 500
	Contingency	10% of estimated costs		R4 699
TOTAL				R50 000