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Assessment of the performance of smallholder irrigated sugarcane farming in Maphumulo municipality of KwaZulu-Natal Province

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DECLARATION

I hereby certify that this dissertation is my own original work and has not previously been submitted to another university for the purpose of a degree. Where use has been made of the work of others, such work has been duly acknowledged in this text.

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List of Acronyms

CSIR: Council for Scientific and Industrial Research

DoA: Department of Agriculture

P&D: Pest and Disease

MGB: Mill Group Board

CTS: Cane Testing Services

FAO: Food and Agricultural Organization

GDP: Gross Domestic Product

ICRA: International Centre for development oriented Research in Agriculture

IES: Income and Expenditure Survey

IFAD: International Fund for Agricultural Development

LFS: Labour Force Survey

NDP: National department of Agriculture

NGO: Non Governmental Organization

USAID: United States Agency for International Development

SPSS: Statistical Package for Social Science

Abstract

Kwa-Zulu Natal (KZN) is mainly composed of small-scale farmers with low production capacity and knowledge (ISRADS, 2004). The general problem is the performance of smallholder irrigation schemes, issues that cause low productivity; whereas the cost of purchasing machinery is too high. In the rural areas the majority of the people are unemployed due to different reasons such as lack of employment opportunities available to them, lack of skill, and low level of education and mostly they are inexperienced. This study identifies theperformance of irrigation projects amongst smallholder sugarcane farmers in KwaZulu Natal in order to uplift the livelihood of smallholder sugarcane production as well as its sustainability.This was done on the basis of demographics, historical background and agricultural potential. This dissertation will discusses all approaches used to conduct the study. The dissertation also describes the analytical framework used in this study, namely: The research design, sampling, sample size, data, data collection procedures, model description and the specific analyses carried out to address the study objectives.

The results of net values of irrigated and non-irrigated lands, the irrigating households indicated13% of sugar cane production per hector more than non-irrigators. It is clearly indicated that water/ irrigation can contribute on maximizing sugarcane yield and promotes sustainability. Improving the technology from small scale growers' point of view, extension officers from different areas that produce sugarcane should be scheduled to attend Refresher Courses at SASRI to train them on different aspect of irrigation management and sugarcane production. When there is newly established technology, such as invention of a new variety of sugarcane that is resistant to drought and diseases. It would be more essential for agricultural development to encourage government investment on more irrigation schemes facilities.

Keywords: *Smallholder irrigation schemes, sugarcane production, rural livelihood.*

CHAPTER 1
INTRODUCTION

1.1 Background

Sugarcane industries worldwide are located in regions of uncertain and variable climate. Dealing with this climatic variability is important to profitable and sustainable sugarcane production because stability of income from year to year affects the risk of farming and milling operations. Potential exists for seasonal climate forecasting to improve risk management and decision-making leading to enhanced industry competitiveness

It is generally accepted that the adoption by farmers of scientific irrigation scheduling is far below expectations (Clyma, 1996). Leib *et al.* (2002) found that adoption rate depended on the value of the crop and on the type of irrigation system. Clyma (1996) suggests that farmers need more comprehensive technological support that is simpler to use, and that scheduling needs to be integrated into farm management. Adoption of irrigation scheduling techniques in South African sugarcane production has been disappointing, leading to over-irrigation, low water use efficiency and reduced profitably.

According to Feynes (2005), South Africa has invested substantially in smallholder irrigation so as to benefit smallholder farmers in less developed areas. There are more than 200 small-scale irrigation schemes in South Africa, which irrigates about 50,000 hectares, thereby providing income to over 37,000 farmers. However, this production is not as intensive as needed and often involves production of low-valued food crops which do not even meet subsistence food requirements.

Sugarcane industries worldwide are exposed to uncertainties associated with variable climates. This variability in climate produces impact across an integrated value-chain comprising of the following industry sectors: sugarcane production, harvesting and transport, milling, and marketing. According to Deressa, Hassan and Poonyth (2005), climatic conditions have changed for the worst over the past few years and had a negative impact on the production of sugarcane, since production in the small scale sector is solely dependent on rainfall for good yields.

Small sugarcane growers are finding it increasingly difficult to farm profitably due to lack of rainfall, resulting in many abandoning sugarcane production. According to Sokhela Louw and Hastings (1999), farmers will jointly hire a tractor for ploughing, but by the time it reaches the farm, their ground may become very dry for planting. Farmers in developing nations will be least able to adapt to climate change because of a relatively weak agricultural research base, poor availability of inputs such as water and seed of new varieties and inadequate capital for making adjustments at the farm.

1.2 Problem statement

The proportion of the population in the province amounts to 15.3% of the nation's total population but has the highest poverty levels in the whole of South Africa with the majority of the households living below the poverty line as indicated by Statistics SA (2011). This is the situation in many parts of the country, especially among the black population. In response to this, South Africa has invested substantially in smallholder irrigation to benefit smallholder farmers in the less developed areas. There are more than 200 small-scale irrigation schemes in South Africa irrigating about 50 000 hectares and providing income to over 37 000 farmers (Sokhele, 2011). However, this production is not as intensive as needed and often involves production of low-valued food crops and sugarcane which do not even meet subsistence product requirements (Feynes, 2005)

Kwa-Zulu Natal (KZN) is mainly composed of small-scale farmers with low production capacity and knowledge (ISRADS, 2004). The general problem of the performance of smallholder irrigation schemes are issues that can cause low productivity; whereas the cost of purchasing machinery becomes high. However, in the rural areas where majority of the people are unemployed due to different reasons such as lack of employment opportunities, lack of skill and low level of education, the situation is more precarious.

The smallholder sugarcane farmers do not use advanced technology in applying for improved crop cultivars such as constraints for sustainable agriculture and rural development, which are said to impact negatively on rural livelihood conditions such as poverty levels and food security.

The above observations clearly raise a number of questions about the future of the scheme. More importantly, it is of great importance to understand the issues that have culminated in this seeming abandonment of the schemes, in order to assess whether there is any potential for the farmers to operate the schemes on their own, perhaps with minimal initial support in terms of capacity building, organization and facilitation.

The problem of weak support services in the fostering of sugarcane farming poses a constraint for most smallholder irrigation scheme assessment programmes. Machete (2011) made a similar observation. There is therefore a general agreement that human and social capacity development among smallholder irrigators is a pre-condition for turning the current ‘downward ratchet trajectory of schemes into an upward one (Shah, 2002). Training of farmers and their collectives is needed in the domains of farm and scheme management. The provision of support with the development of reliable networks for the marketing of produce beyond the local environment has become a critical issue (Magingxa , 2009).

Provision of these support services to smallholder irrigated sugarcane farming has become the principal mandate of public extension service some 15 years ago, following the withdrawal of provincial departments of agriculture from active involvement in scheme management. Legoupil (2012) emphasized that irrigated farming could only become successful when farmers adopted new farming systems that were more intensive and productive than those they employed when they cultivated dry land plots.

Consequently, in most smallholder irrigation schemes, farmers have not reached the necessary level of competency and confidence to optimally exploit their farms. The need for support services has become a universal issue, even though it varies among schemes. In other words, tertiary education is responsible for the training of extension staff and managers, agricultural research institutions responsible for innovation in smallholder irrigation, and public extension responsible to guide and support farmer development, have all fallen short of fulfilling their mandates.

There is a need to substantiate whether or not the people are truly interested (and believe) in irrigation farming as a reliable source of income and livelihood. If so, then it is important to assess the performance of irrigation in their livelihood strategies. In other words, assessing whether or not irrigation farming forms a significant proportion of their incomes to create strong reliance on it as a source of livelihood, or whether it is merely a supplement to other important income sources has become a pertinent issue.

1.3 Objectives

The main objective is to assess the performance of irrigation schemes in uplifting the livelihood of smallholder sugarcane production in Maphumulo Municipality of KwaZulu Natal Province. Specifically, the objectives of the study included:

- To describe the demographic characteristics of smallholder irrigated sugarcane farmers in the study area.
- To determine the impact smallholder sugarcane production has on employment and poverty alleviation.

- To assess irrigation productivity of sugarcane farming systems.
- To assess service accessibility by sugarcane smallholder farmers.

Table 1.1: Specific Objectives, Questions, Hypothesis and Analytical Tools Framework

Research Objective	Research Question	Research Hypothesis
• To describe the demographic characteristics of smallholder irrigated sugarcane farmers in the study area. • To assess the level of technical efficiency in the use of available resources by the sugarcane small holder farmers.	What is the level of technical efficiency of resources available to smallholder farmers?	Lack of adequate technical efficiency has led to low irrigation development
• To determine the impact smallholder sugarcane production has	What is the impact that is dertemines the production level which alleviate poverty?	Partial or non-functional of production systems has led to low poverty alleviation

on employment and poverty alleviation.		
To assess irrigation productivity of sugarcane farming systems	What is the level of performance of farmers at the schemes?	Poor irrigation productivity has led to low irrigation development
To assess service accessibility by sugarcane smallholder farmers	Which irrigation services are accessed by farmers?	Poor accessibility of irrigation services has led to low irrigation development and poor yields.

1.4 Research Questions

- What is the level of technical efficiency of resources available to smallholder sugarcane farmers?
- What level of impact will determine the level of production to alleviate poverty?
- What is the performance level of farmers at the schemes?
- What irrigation services are accessed by farmers?

1.5 Research Hypothesis

Farmers on irrigation schemes are dependent on each other, because they share the water distribution system. This interdependence requires a willingness on the side of farmers to work collectively in order to achieve their individual objectives. If this became non-functional, that led to:

- Poor performance of irrigation schemes in uplifting the livelihood of smallholder sugarcane production.

- Lack of adequate technical efficiency has led to low irrigation development
- Partial or non-functional of production systems has led to low poverty alleviation
- Poor irrigation productivity has led to low irrigation development
- Poor accessibility of irrigation services has led to low irrigation development and poor yields.

1.6 Limitations of the study

This project was specific only to the areas of Maphumulo Local Municipality, falling under ILembe District Municipality. The amount of data to be gathered and time to be spent was dependent on the availability and the willingness of the respondents to participate. The project will concentrate on the production activities practiced by small-scale sugarcane farmers within the rural areas and exclude commercial farmers as a result of major failures of growers to sufficiently produce due to lack of technical efficiency in production.

Therefore, the current study was limited in highlighting the current production trends, costs of running the scheme and benefits of being in the scheme comparatively to dry lands. The research was also limited to Mansomini sugarcane irrigation scheme at Maphumulo local municipality which is under ILembe District Municipality and comparisons were also done at dryland areas of Maphumulo.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature from studies carried out by other scholars with respect to assessing the performance of irrigation schemes in uplifting the livelihood of smallholder sugarcane production amongst smallholder sugarcane farmers. The concepts reviewed include: the current status of poverty, livelihoods, efficiency, food security, Institutional development for improved access to land, water as well as the challenges and constraints of irrigation development.

2.2 Poverty

Poverty is the failure to meet the basic human needs (World Bank, 2005). There is, therefore, a great variation in the manner in which poverty is defined and measured in developing countries (Hussain *et al*, 2006; Namara *et al*., 2008; Bacha *et al*., 2011; Howe *et al*., 2012; Tshuma, 2012). Historically, poverty can be described as the inadequacies in income, consumption and wealth, while the multiple dimensions of poverty as well as the complex interactions are widely recognized (Hussain and Wijerathna, 2004; Hussain *et al*., 2006; Namara *et al*., 2008; Tshuma, 2012).

Smallholder irrigation plays an important role in the fight against rural poverty in developing countries. Smallholder irrigation development in Africa began in the nineteenth century as a result of its contact with European settlers who have passed through different eras of development. Although participating in an irrigation scheme is necessary, it is not sufficient to lead to improved household welfare.

Water security is said to encourage investment in improved water management and agricultural technologies such as fertilizer and high yielding varieties, leading to increased agricultural production and improved household welfare. However, the impact of irrigation on household welfare has been done using both qualitative and quantitative evaluation techniques. Quantitative impact evaluation methods, particularly quasi-experimental econometric methods, have been more widely applied in irrigation projects, as well as impact evaluations.

Most of the studies have concluded that smallholder irrigation plays a positive role on household welfare. This is the case as many poor people in developing countries depend directly or indirectly on smallholder agriculture for their livelihoods, as 75% of the poor live in rural areas (World Bank, 2008). Smallholder agriculture, therefore, is a relevant and potentially viable vehicle for reducing poverty and ensuring household food security in these rural areas (Altman, 2009). Since poverty is more prevalent among rural dwellers, several authors agree that reaching the Millennium Development Goals (MDGs) of halving poverty and hunger by 2015 requires high priority to smallholder agriculture (Smith, 2004; Matshe, 2009; Tshuma, 2012). However, despite its potential, smallholder agriculture's poverty reduction results in Africa have been disappointing (Lipton , 2003).

With the high variability as well as the insufficient supply of rainfall, agricultural production in Africa is still almost entirely rain-fed (You *et al*, 2010). Lipton (2003) argued that Africa has experienced significantly less reduction in poverty compared to other regions due to, among other factors, its less proportion of cultivated areas under irrigation.

A general consensus is that irrigation remains a feasible and key strategy for improved smallholder agricultural production and/or productivity, household food security and rural poverty reduction in developing countries (Kumar, 2003; Lipton, 2003; Hussain and Hanjra, 2004; Gebregziabher *et al*, 2009; Bacha *et al*, 2011). In fact, Carruthers *et al* (1997), cited in Hussain *et al* (2006), argued that irrigation development is the most effective tool for rural poverty reduction compared to any other public development, particularly in arid and semi-arid climates.

Although irrigation development is costly, and may have negative environmental and health consequences such as increased water logging, salinization and water-borne diseases, it is still recognized as an important factor in increasing crop productivity and improving overall agricultural performance (Hussain and Wijerathna, 2004). Access to irrigation is said to decrease crop losses, thereby increasing the area under cultivation and intensity in crop production (Namara *et al*., 2010).

Moreover, it leads to poverty reduction by expanding opportunities for higher and more stable incomes, and by increasing prospects for multiple cropping and crop diversification (Hussain and Wijerathna, 2004). Irrigation farming is imperative in Southern Africa as rain-fed crop production is inherently risky due to unreliable rainfall and frequent droughts (Cousins, 2012). Southern Africa is generally dry, with over 60% of the country receiving less than 500 mm of rain per annum on the average, and with only 10% receiving more than 750 mm (World Bank 1994, cited in Cousins, 2012). The importance of irrigation farming in Southern Africa is underscored by the fact that the irrigated 8% of land under crop production contributes almost 30% of total agricultural production (Backeberg, 2006; NDA, 2007; Hope et *al*., 2008).

Smallholder irrigation accounts for about 0.1 million hectares (about 8%) of total irrigated land in Southern Africa (Tlou, Mosaka, Perret, Mullins and Williams, 2006; NDA, 2007; Van Averbeke et al., 2011). Although smallholder irrigation accounts for a small area of irrigated area in South Africa, it is important in Southern Africa for several reasons. Its importance arises primarily from its location in the rural areas, where poverty and food insecurity are concentrated (Perret, 2002; Sishuta, 2005; Vink and van Rooyen, 2009).

Southern Africa is said to be food secure at national level, and food insecure at the household level (Hart, 2009a; Backeberg and Sanewe, 2010). Therefore, the major area of concern in South Africa is to ensure availability of food at the household level for the poor and food insecure households (Backeberg and Sanewe, 2010). Van Averbeke *et al* (2011) highlighted the potential that smallholder irrigated farming has to significantly improve the welfare of participating homesteads in these densely populated rural areas.

Furthermore, Van Averbeke *et al*. (2011) noted that smallholder irrigation can create employment in these underdeveloped rural areas, both directly and indirectly through forward and backward linkages. In Southern Africa, the smallholder irrigation sector is also important because a large number of rural people benefit directly and indirectly (Speelman, 2009). The number of smallholder irrigators ranges between 200,000 and 250,000 participants (Backeberg, 2006; Van Averbeke, 2008). Assuming an average household size of 5 members (Machethe, Mollel, Ayisi, Mashatola, Anim and Vanassche, 2004), this translates to over a million rural people directly benefiting, at least partially, from smallholder irrigation.

Therefore, as highlighted by Aliber and Hart (2009), the large number of rural households involved in smallholder irrigation necessitates prioritization and government support. Accordingly, the Southern African government has prioritized and invested in the development of smallholder irrigation schemes as a rural development and poverty reduction strategy (Denison and Manona, 2007a; Van Averbeke et al., 2011).

Smallholder irrigation schemes establishment, rehabilitation and revitalization in Southern Africa were made possible through the investment of large public resources (Denison and Manona, 2007a). Shah, Van Koppen, Merrey, Lange and Samad (2002) valued the public investments in smallholder irrigation at R2 billion (R40,000/ha). In fact, smallholder irrigation schemes continue to be a major budget item on many developmental and district municipality financial plans (Denison and Manona, 2007a).

However, many researchers argue that, despite these public investments, smallholder irrigation schemes have failed to meet the rural development and poverty reduction objectives in Southern Africa (Bembridge, 2000; Perret, 2002; Hope, Gowing and Jewitt, 2008; Speelman, 2009; Yokwe, 2009; Fanadzo, 2012; Van Averbeke, 2012). According to Bembridge (2000), the performance and welfare impact of smallholder irrigation schemes has been poor, and fall far short of the expectations of many stakeholders.

This is despite that smallholder irrigation has been successful in other developing countries, particularly in Asia (Hussain and Hanjra, 2004). Several reasons have been presented in the literature for the failure of smallholder irrigation in Southern Africa. Tlou *et al* (2006) highlighted that infrastructure deficiency as a result of inappropriate planning and design of the irrigation schemes are a cause of this failure. However, most studies have identified institutional issues as the major challenge in smallholder irrigation in Southern Africa (Machete *et al*, 2004; Van Averbeke *et al*, 2011; Fanadzo, 2012).

According to Van Averbeke *et al* (2011), human (capacity) and social (institutional) resource problems are at the centre of the poor performance of smallholder irrigation schemes in Southern Africa. Fanadzo (2012) agreed that weak institutional and organizational arrangements are the major factors leading to the failure of most smallholder irrigation schemes.

Moreover, Kemerink *et al*. (2011) highlighted that the failure of the smallholder schemes is due to the fact that the individual characteristics or heterogeneity of the irrigators have received little attention. While too much attention has been placed on the physical (hydrology or engineering) aspects of irrigation at the schemes level, the social and distributive issues have largely been ignored in Southern Africa (Fanadzo, 2012).

This neglect has left many farmers in irrigation schemes water insecure. As noted by Zeiton (2011), water insecurity is, in many cases, primarily social, with water security of some individuals being associated with insecurity of others. Adopted from Grey and Sadoff (2007) and Muller et al (2009), household water security is defined in this study as access by the household to sufficient and reliable water to meet the agricultural needs throughout the year; the ability of the household to pay for the water and water-related services; and the household's ability to assert their right or entitlement to the water against other parties. An irrigator's access to irrigation, although a necessary condition, is not sufficient for achieving water security and improved household welfare.

Water security is important in enhancing the effectiveness of access to irrigation in poverty reduction and improving household food security.

Findings from Hope *et al* (2008), for instance, indicated that participating in smallholder irrigation results in expected income and food security benefits only to those farmers with secure irrigation access. Therefore, the understanding of how water security should be created and conferred to individual irrigators is an area in which research is urgently required. Hodgson (2004) argued that without sufficient water security in irrigation schemes, the irrigation management transfer (IMT) programmes, where the government cedes the operation of irrigation schemes to the farmers, would be unsuccessful over the long-term as farmers would stop farming as soon as government support is withdrawn.

2.2.1 Irrigation, water security and household welfare linkages

Many studies have argued that ensuring smallholder farmers' access to irrigation is important for poverty reduction thereby achieving household food security in developing countries (Hussain and Hanjra, 2004; Molden *et al*, 2007; Gebregziabher *et al*, 2009; Muller *et al*, 2009). Irrigation is an essential part of the package of technologies, institutions and policies that underpins increased agricultural output (Hussain, 2007a).

Thus, as a production input in agriculture, irrigation water is an important socio-economic good, with a positive role in poverty alleviation (Hussain and Hanjra, 2004). However, Hussain and Hanjra (2004) warned against perceiving access to irrigation alone as the solution to all rural poverty problems. Instead, irrigation farming should be understood as forming part of a broader livelihood strategy (which also includes non-farming projects) among the majority of rural people (Van Averbeke and Mohamed, 2006).

Hussain and Hanjra (2004) highlighted that, even though irrigation water is only a single element in the poverty equation, it plays a disproportionately dominant role and the main pathways through which access to irrigation reduces poverty. Access to irrigation enables farmers to adopt new technologies and intensify cultivation, thereby leading to increased productivity, overall higher production, and greater returns from farming. However, it is not just participation in an irrigation scheme that results in these positive effects, but access to reliable irrigation water.

As was concluded by Hope *et al* (2008), participation in an irrigation scheme although a necessary condition is not sufficient to ensure improved household welfare. It is important that the individual farmers have secure access to adequate and reliable water. It is the access to reliable water under irrigation which actually affects the farmers' incentives to invest in improved inputs and technologies (Hussain and Hanjra, 2004; Tyler, 2007).

In contrast, uncertainties regarding how much water would be available to a particular farmer results in low incentives to invest in improved inputs and technologies (Faurès and Santini, 2008). Faurès and Santini (2008) argued that uncertainty regarding access to a reliable irrigation water supply causes farmers to apply less seed and fertilizer than they might otherwise do. This highlights the importance of ensuring water security, not just irrigation participation, among the farmers. A household's access to irrigation, coupled with physical, socio-economic and institutional factors, results in household water security.

The physical aspect of irrigation includes the canal infrastructure, pumps, etc., that ensure reliable water supply. The socio-economic circumstances of the farmer are the factors (such as gender, income sources, geographic location in the scheme, etc.,) which influence access to irrigation water and the ability to pay for the water and water-related services.

The institutional and organizational structure involves irrigation committees, farmer associations, and rules and regulations that ensure water rights are respected and that conflicts are resolved. Heterogeneity within the scheme in terms of gender, plot sizes, income sources and social capital variables influence households' capacity to participate in the WUAs, management of the scheme, making and enforcement of water resource use rules and regulations, and the resolution of emerging conflicts (Kamara, Van Koppen and Magingxa, 2002).

It is this capacity that determines the water security level of an individual irrigating household. Institutional and organizational Socio-economic factors Physical factors Improved household welfare and food security Improved crop production Household water security Household's access to irrigation. Household water security also encourages investments in improved water management and agricultural technologies (Kumar, 2003) and this leads to improved crop output and household welfare.

Improved household welfare has a positive feedback to crop production and household water security. Improved incomes enhance the ability of a household to invest in improved technologies, pay for water and thus enhance water-use security. Despite its importance, water security has not been achieved in South Africa, leaving many farmers water insecure (Muller et al, 2009).

Water insecurity stems from a combination of the physical environment, built infrastructure, and institutions or human governance (Norman et al., 2010; Zeiton, 2011). The physical environment highlights the hydrological patterns of the area while built infrastructure speaks of artificial water storage facilities such as dams. Zeiton (2011) argued that efforts to achieve water security have failed because the prevailing water policies in many countries have been narrowly focusing on the physical processes.

The narrow and deterministic approach blames water insecurity chiefly on physical phenomena and reacts through infrastructural development (Zeiton, 2011). Fanadzo (2012) highlighted that this was the case in South Africa for a long period, with poor irrigation infrastructure viewed as the single major cause of poor performance and the government has invested huge sums of money towards repairing irrigation infrastructure.

Several researchers have, however, argued that infrastructure development alone as a dominant part of intervention in irrigation has failed in South Africa and beyond (Denison and Manona, 2007a; Innocencio et al ., 2007; Faurès and Santini, 2008; Zeiton, 2011). It has been argued that the development of water infrastructure and institutions should go hand-in-hand to achieve water security (Grey and Saddoff, 2007; Zeiton, 2011). One other major cause of water security is the geographic location of an individual farmer along the water channel. Downstream farmers are usually economically worse off than farmers upstream because of heightened uncertainties regarding water availability downstream compared to upstream (Mbatha and Antrobus, 2008). This is because downstream farmers are usually water insecure, and their production decision uncertainties result in economic inefficiencies.

The economic disadvantage translates to political disadvantage, which has the effect of further worsening water insecurity. Hence, efforts in irrigation schemes should be exerted to improve household level access to reliable and sufficient water to enable farmers to improve productivity within current cropping patterns and to consider diversifying their crop choices (Faurès and Santini, 2008).

According to Faurès and Santini (2008), water security has substantial influence on the motivation, ability and success of smallholders in maximizing production and the value of investments in the water sector. Therefore, authors such as Kumar (2003) and Van Averbeke (2008) have emphasised the need for equitable access to and control over irrigation water for irrigation schemes to operate successfully and contribute to household food security.

Water insecurity increases the vulnerability of the politically and economically weaker poor water users (Bruns et al., 2005). Kumar (2003) highlighted three concerns that need to be addressed to ensure irrigation has the desired impacts on food security: adequate supply of irrigation at national (or scheme) level, water security for the farmers at household level, and adequate economic incentives for farmers to maximize their production from the available land and water with least environmental consequences. While it is clear that there is a need to create and confer water security to individual farmers to ensure irrigation effectiveness in poverty reduction, water security is not the only enhancing factor. The next section presents briefly other factors that improve the effectiveness of access to smallholder irrigation in reducing poverty.

2.2.2 Factors that influence poverty reduction capacity of smallholder irrigation

It has been largely established that farmers with access to irrigation perform better than those without (Tyler, 2007; Namara et al ., 2010). However, evidence from across the developing world indicates that smallholder irrigation has been successful in some areas, while it has performed poorly in other areas. Irrigation has not been successful in ensuring rural poverty reduction in Sub-Saharan Africa (Inocencio et al., 2007). The factors that influence the success of smallholder irrigation schemes in reducing poverty at household level are, inter alia, institutions, land tenure, and support services and infrastructure (such as credit, extension, markets, information services, roads and training). These factors are briefly explained in the following sub-sections.

2.2.3 Poverty dimensions

Namara *et al* (2008) identified poverty dimensions as “isolation, deprivation of political and social rights, a lack of empowerment to make or influence choices, inadequate assets, poor health and mobility, poor access to services and infrastructure, and vulnerability to livelihood failure.” Poverty is divided into two categories: absolute poverty and relative poverty. Absolute poverty denotes the failure to purchase the minimal quantity of basic goods and services required for human survival (Frye, 2005). In other words, absolute poverty refers to subsistence below minimum, socially acceptable living conditions, usually established based on nutritional requirements and other essential goods (Frye, 2005). Relative poverty, in contrast, is defined as when individuals, families and groups in the population lack the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary or at least widely encouraged or approved, in the societies to which they belong (Townsend, 1979 cited in Frye, 2005). The relative poverty concept argues that an individual is poor when he/she is very much worse off than other people in their society (Tshuma, 2012).

Thus, one’s poverty status is measured against other people within the same society. The preferred indicators of poverty and living standards have traditionally been reported using income or consumption expenditure (Achia *et al*, 2010). Poverty is generally measured using income in developed countries, while consumption expenditure is a preferred poverty measure in developing countries (World Bank, 2005; Achia *et al*., 2010). By comparison, expenditure measures are much more reliable and easier to collect than income, especially in most rural settings (Filmer and Pritchett, 2001). The limitation of the income or consumption approach is the extensive data collection required, which is time-consuming and costly (Vyass and Kumaranayake, 2006).

Given the resource constraints to measuring household income or expenditure in developing country settings, other methods of developing poverty indices have been used. Several authors have suggested the asset-based approach as an alternative method of measuring poverty (Filmer and Pritchett, 2001; Vyass and Kumaranayake, 2006; Achia *et al*, 2010; Howe *et al*, 2012). The asset-based approach involves data collection of variables that capture living standards, such as household ownership of durable assets (e.g. car) and infrastructure and housing characteristics such as source of water and sanitation facility (Vyass and Kumaranayake, 2006). However, there is no agreement on the use of the asset-based approach (Vyass and Kumaranayake, 2006; Namara *et al*, 2008).

One weakness of the asset-based poverty measures is that they are more reflective of long-run household wealth or living standards, but fail to take account of short-run or temporary interruptions, or shocks to the household (Filmer and Pritchett, 2001). Another weakness of the asset-based poverty measures is that conceptually, wealth is a stock, not a flow concept. If a household is depleting its asset base and another building its asset base, but these two have the same level of asset at a given moment in time, asset-based approach will put these two households at the same poverty level. However, the poverty status of these households should be different.

2.2.4 Irrigation impact on household welfare

The evidence from international literature on the role played by smallholder irrigation on household welfare presents a mostly positive picture. Whereas few studies such as Jen *et al* (2002) found an insignificant link between irrigation and input use or productivity of farming practices, there are a number of studies in different countries which show that irrigation served as the key driver in increasing household income and alleviating rural poverty (e.g. Hussain *et al*, 2006; Namara *et al*, 2008; Dillon, 2011; Kuwornu and Owusu, 2012). Hussain *et al*. (2006) evaluated the impact of small-scale irrigation schemes on poverty alleviation in Pakistan using descriptive statistics.

They used the FGT indices to measure poverty. The study found that poverty levels were higher in rain-fed than in irrigated areas. For example, poverty head count ratio was found to be 37% in rain-fed areas, compared to 29% in irrigated areas. Interestingly, the study found that poverty head ratio was even much lower (23%) in areas that practiced both irrigated and rain-fed farming. Namara et al.(2008) studied the role played by access to irrigation on rural poverty and inequality in Ethiopia using the logistic regression model. As expected, the poverty incidence, depth and severity values were lower for farmers that had access to irrigation compared to the non-irrigators. The main conclusion of the study was that the incidence, depth and severity of poverty were not affected by mere access to irrigation but by the intensity of irrigation use. The study concluded that there was an economy of scale in the poverty-irrigation relationship.

Gebregziabher *et al* (2009) and Kuwornu and Owusu (2012) evaluated the impact of access to small-scale irrigation on farm household welfare using the propensity score method (PSM). According to Gebregziabher *et al*. (2009), the average income of non-irrigating households was less than that of the irrigating households by about 50% in Ethiopia. The study also found that farm income is more important to irrigating households than to non-irrigating households, and off-farm income was negatively related with access to irrigation.

Kuwornu and Owusu (2012) concluded that irrigation investment in Ghana is justified due to significant irrigation contribution to consumption expenditure per capita in farm households. Dillon (2011) investigated the impact of small-scale irrigation investments on household consumption, assets and informal insurance in Mali using both PSM and the matched difference-in-difference method.

Both estimation methods confirmed the positive role played by small-scale irrigation on household consumption and asset accumulation. Tesfaye *et al* (2008) and Bacha *et al*. (2011) both assessed the impact of small-scale irrigation on household welfare in Ethiopia using the Heckman's two-step estimation procedure. Both studies observed significant welfare differences between irrigators and non-irrigators, and concluded that access to irrigation had played a part in those observed differences.

Tesfaye *et al* (2008) found that about 70% of the irrigation users were food secure, while only 20% of the non-users were food secure in Filtino and Godino irrigation schemes in Ethiopia. The two studies found that irrigation participation was also influenced by unobservable factors, highlighting the need to model for unobservable variables in irrigation impact evaluations.

As highlighted in the previous sections, most of the studies on smallholder irrigation schemes in South Africa have argued that smallholder irrigation schemes have failed to meet the rural development and rural poverty reduction objectives. A review by Fanadzo (2012) concluded that smallholder irrigation schemes in South Africa have failed to bring about the expected social and economic development in rural areas.

However, most of these studies reviewed have not done any in-depth quantitative evaluations of the impact of smallholder irrigation on rural household poverty and food security but have mainly been descriptive. Most of these studies have relied on nothing more than gross margin or correlation analysis (e.g. Yokwe, 2009; Hope *et al*, 2008). Van Averbeke (2012) investigated the factors that contribute to differences in the performances of smallholder irrigation schemes in Vhembe district in South Africa. Using correlation analysis, the study found that gravity-fed schemes were more likely to be (and remain) operational compared to pumped schemes.

Whereas associations between cropping intensity and scheme characteristics were not very strong, the study found that cropping intensity was most strongly correlated with water restrictions at scheme level. This highlights the importance of ensuring household water security. The study reported that water security among irrigators was caused, at least in part, by the front-end blocks extracting more than their share, leaving too little for the tail-end blocks. Front-end tail-end differences in access to water among farmers were commonly reported on canal schemes. Although arguing that smallholder performance has been below expectations, gross margin analysis by Yokwe (2009) and Hope et al . (2008) indicated that irrigators have somewhat greater gross margins per ha compared to non-irrigators.

For the Zanyokwe and Thabina smallholder irrigation schemes, Yokwe (2009) found greater gross margin per ha among irrigators for all the crops that were included. Hope et al. (2008), on the other hand found that smallholder irrigation provides expected incomes and food benefits for those plot holders with secure irrigation access, i.e., those with head plots.

For example, head plots had an estimated average gross annual farm of US$2,047 per year compared to US$543 per year for the tail plots. Both studies, however, are limited as they rely on gross margin analysis. Gross margin analysis is descriptive, and does not account for other relevant socio-economic variables such as educational level, farmer experience, etc., that may influence the revenue differences between irrigators and non-irrigators.

The welfare differences between irrigators and non-irrigators cannot be attributed to access to irrigation without controlling for these other important variables. One attempt to evaluate the household welfare impact of smallholder irrigation in South Africa was a case study of the Taung irrigation scheme by Tekana and Oladele (2011). Using the OLS procedure, the study concluded that irrigation plays a central role in the improvement of rural livelihood and food security.

However, Baker (2000) and Bacha et al . (2011) point that self-selection and endogeneity associated with irrigation participation results in biased estimates from the OLS estimating technique (Greene, 2003). The impact of access of irrigation is either overestimated or underestimated by OLS regression depending on whether the irrigation scheme beneficiaries are more or less able to realize the potential benefits of irrigation due to certain unobservable factors (Baker, 2000).

Therefore, the results of Tekana and Oladele (2011) could be biased, pointing to the need for irrigation impact evaluation studies in South Africa that account for selection bias. The above literature indicates that although there have been a number of comprehensive impact evaluations in other countries, this has not been the case in South Africa. Since smallholder irrigation schemes are not homogenous between countries, as explained earlier, there remains a case for in-depth quantitative impact evaluations specific to South Africa. The next chapter describes the research methodology that was employed in this study to achieve this objective.

2.3 Overview of irrigation in the developing countries

Irrigation refers to the purposive, organized, controlled, and artificial supply of water to a cropped area in order to complement rainfall and to overcome drought, and to reach a given crop production objective (Tlou *et al*, 2006). Irrigation water is applied to ensure that the water available in the soil is sufficient to meet crop water needs and thus reduce water deficit as a limiting factor in plant growth (Van Averbeke *et al*, 2011). Irrigation farming plays an important role in food production and food security in the world today. About 30% of the world's food production comes from about 18% of the total cultivated land under irrigation (FAOSTAT, 2012).

There are wide variations in the proportion of irrigated agricultural land in the developing world, with 37% in Asia, 15% in Latin America, 6% in Africa and 4% in Sub-Saharan Africa (FAOSTAT, 2012). Irrigation, therefore, currently plays a less significant role in African agriculture compared to other regions as Africa's irrigated cultivated land is way lower than the world average.

As highlighted earlier, Lipton *et al* (2003) argued that Africa's poor performance in terms of poverty reduction can be to a large extent attributed to its less reliance on irrigation farming. According to Lipton *et al* (2003), differences across regions, countries and areas within countries in terms of irrigation access is an important factor in determining rates of poverty reduction.

The fact that Asia has experienced significant poverty reduction, while poverty has increased in Africa (Faurès and Santini, 2008; Bacha *et al*, 2011) in recent years is no coincidence, but an indication of the key role irrigation plays in poverty reduction, ceteris paribus (Lipton *et al*, *2003*).

As reported by You *et al* (2010), agricultural production in Africa is almost entirely rain-fed despite that rainfall is highly variable and insufficient in many cases (You *et al*, 2010). Low levels of irrigation in Africa are as a result of high irrigation investment costs, declining world food prices, perceived failures of many past irrigation projects, limited government commitment, rugged topography and poor rural infrastructure, heterogeneous and fragmented farmers, low population densities; and diets tied to crops with low water requirements (Inocencio *et al*, 2007; You *et al*, 2010).

It is largely acknowledged in the literature that the Green Revolution in Asia could not have happened without investments in irrigation water (Lipton *et al*, 2003; Hussain, 2007a; Hussain, 2007b; Turral *et al*, 2010). Irrigation was an important element of the Green Revolution package which not only lifted large numbers of rural Asians out of poverty but also created conditions that were conducive for economic development (Turral *et al*, 2010).

A similar development path as that of Asian countries has been recommended for Africa (Lipton, 1996 cited in Van Averbeke, 2012). This is so, given that the potential of irrigation development for Africa, and Sub-Saharan Africa in particular, is large (Inocencio *et al*, 2007; You *et al*, 2010). According to You et al . (2010), there is a need to prioritize irrigation development in Africa not only because of the existence of water resources, but also because of the high value of irrigated agriculture on the continent and the large number of rural poor that could benefit from productivity enhancement as a result of irrigation investment.

Many countries in Sub-Saharan Africa, South Africa included, have realised the important role of irrigation in food production, and irrigation investments have increased in the region. You *et al* (2010) reported that the average rate of expansion of irrigated area over the past 30 years was 2.3% in both sub Saharan Africa and all of Africa.

Total irrigated land in Africa is estimated to be about 12.2 million hectares and six countries, namely Egypt, Madagascar, Morocco, Nigeria, South Africa and Sudan account for nearly 75% of this total irrigated land (FAOSTAT, 2012). The 1.3 million hectares of irrigated land in South Africa constitute about 11% of the total irrigated land in Africa. Despite some notable irrigation expansion, the developmental impact of smallholder irrigation in Sub-Saharan Africa has been limited and below expectations (Inocencio *et al*, 2007; García-Bolanos *et al*, 2011). According to Van Averbeke *et al* (2011), irrigated agriculture presents an attractive investment in South Africa as the water deficits caused by low and erratic rainfall limits rain-fed crop production in most parts of South Africa.

DWAF (2004) agreed, noting that water scarcity is a major constraint to socio-economic development in South Africa. Therefore, the government of South Africa has invested significantly in irrigation development in South Africa. Smallholder irrigation, particularly, has received high priority in the rural areas to reduce poverty and ensure household food security. The next section discusses the nature of smallholder irrigation in South Africa.

2.5 Water security

Water security is an emerging concept, and there is no universal definition. Instead, there are multiple definitions which are often competing and evolving (GWP, 2000; Grey and Sadoff, 2007; Schultz and Uhlenbrook, 2007; Norman *et al*., 2010). The GWP (2000), for instance, defined water security as meaning that “every person has access to enough safe water at affordable cost to lead a clean, healthy and productive life, while ensuring that the natural environment is protected and enhanced.” Although this definition brings out some components of water security such as the water availability, affordability, and environmental dimensions, its limitation is that it focuses on water availability and affordability for mainly household consumption use.

Grey and Sadoff (2007), on other hand, defined water security as “the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies.” In simple terms, water security involves harnessing the productivity of water while limiting its negative impact (Grey and Sadoff, 2007). Grey and Sadoff (2007)’s definition is more comprehensive, as it indicates the importance of ensuring secure water access for livelihoods and productive uses, not just consumptive use.

The weakness of this definition, however, is that it applies at the national level and fails to address the requirements at local or household level for achieving water security for irrigating households (Muller *et al*, 2009).The water security concept is related to concepts such as food security in that there is need to ensure that the population has access to sufficient water to meet all its productive or consumptive needs.

However, the difference is that unlike food security, it is not only the absence of water that causes insecurity, but its presence as well. The destructive element of water in its natural, unmanaged state e.g. floods, also causes water insecurity (Grey and Sadoff, 2007). Due to the close relation between the food security and water security concepts, Muller *et al* (2009) suggested that they both should be considered in a similar manner.

Muller *et al* (2009) argued that, as it is widely recognized that food security needs to be considered at both household and national levels, water security should also be considered in a similar way, particularly in the rural context. This, however, has not been the case so far. In fact, the common feature of the different definitions cited above is that they relate to water security as it applies mainly at national level.

The emphasis is on the availability of water in a country, and the investments needed to ensure that water reaches the population of that country in appropriate quantities and qualities. An attempt to adapt Grey and Sadoff (2007)’s definition to apply at the irrigation scheme level is presented in Muller *et al* (2009), who highlighted that water security at irrigation scheme level is achieved when the social and productive potential of water has been harnessed adequately to the benefit of all the irrigators, and its destructive potential is sufficiently contained.

This definition albeit being relevant to this study, does not present itself to ease of measurement. In order to operationalize the definition for this study, some elements were modified and/or added. Firstly, all the definitions emphasize the need to ensure reliable water availability to achieve water security, thus this aspect was maintained. Secondly, the ability of the household to access the water is critical. Access here implies the household's ability to afford the water, and also the rights or entitlement to the water.

It is acknowledged that water security of different farmers may not be the same due to their geographic location in the irrigation scheme, gender, and other socio-economic factors. The rights of the individual farmers and their ability to exercise those rights are very pivotal in ensuring their water security. Water security, according to Cremers et al. (2005), implies that an irrigator is able to materialize water use rights now and in the future, and to avoiding, or controlling the risks of, unsustainable water management.

However, this level of water use rights may not be attainable in rural areas as it implies formal rights. Water use rights in the rural areas are mainly informal, and are governed by customary law (Boelens *et al*, 2007). The other aspect of water security is that of the destructive element of water. Since this applies mainly with regards to water in its unmanaged state, this aspect was dropped as this study focuses on water security at a household level from managed irrigation.

The key aspects of water security in this definition are: access to reliable and adequate water supply, the ability of the households to pay for the water, and their right or entitlement to the water which they are able to assert against other parties. Water security was, therefore, understood as a continuum of these above-mentioned components, where a household scoring high on these components is more water secures than the one scoring less.

Water insecurity was, thus, defined as the perceived difficulty farmers face in securing adequate and reliable access to water for agricultural production (Rijsberman, 2006; Komnenic et al., 2009). Cullis and O'Regan (2004) define water insecurity as a lack of capability to obtain water or as lack of entitlement for water. The water security variable is, therefore, aimed to capture whether farmers have or lack these capabilities.

2.6 Institutions

Many researchers have concluded that the poor performance of smallholder irrigation in South Africa is due to institutional issues (Machete *et al*, 2004; Van Averbeke *et al*, 2011; Fanadzo, 2012). Van Averbeke *et al* (2011) argued that poor institutional support is at the heart of the poor performance of smallholder irrigation schemes in South Africa. According to Van Averbeke (2008), the successful co-operation among smallholders in the management of their irrigation schemes depends on functional water institutions and organizations to guide collective action. Water institutions are defined broadly to include organizations and capacity, as well as governance, policies, laws and regulations and incentives in water management (Grey and Sadoff, 2007).

Water institutions address issues ranging from water allocation, quality, rights and pricing, to asset management and service delivery performances (Grey and Sadoff, 2007). Bruns *et al* (2005) noted that improved water institutions can raise water productivity and enhance rural livelihoods. Without the development of appropriate institutions, irrigation water infrastructure will be poorly managed and may not support rural economic growth (Grey and Sadoff, 2007).

The development of smallholder irrigation systems in South Africa has often followed a top down approach with very little input from the farmers the schemes were intended to serve (Tlou *et al*, 2006). The responsibility for the management and even the implementation of the two important functions of sharing of water and maintaining the canals on South African smallholder irrigation schemes was previously the responsibility of the state (Van Averbeke, 2008). This, according to Tlou *et al*. (2006), is why farmers have had little control and interest in the sustainable and profitable running of such schemes.

However, the smallholder irrigation policy was reviewed following regime change in South Africa in 1994. The responsibility to manage the irrigation schemes was being transferred to farmer communities through the adoption of IMT programmes (Perret, 2002). According to Denison and Manona (2007a), IMT programmes necessitate institutional clarity. That is, clear and enforceable rules of engagement regarding the water management are critical to reduce institutional uncertainties. This will allow behavioural change in farming where greater risks are accepted and greater returns can be achieved by the irrigators (Denison and Manona, 2007a). Denison and Manona (2007a) highlighted the need for separating the water-related institutional functions (rules of scheme operation) from the agricultural, organizational and support elements in South Africa.

According to the study, excessive institutionalization of the agricultural production elements (such as input sourcing and marketing), which can hamper individual enterprise and profitability. This suggests the need to balance the level of institutional support to give the farmers without inhibiting their initiatives and entrepreneurship.

2.7 Land tenure security

Land tenure is the relationship, whether legally or customarily defined, among people with respect to land (Hodgson, 2004). Land tenure status is an important factor in determining the productivity of farmers (Machethe *et al*, 2004; Tekana and Oladele, 2011). Economists argue that secure land rights enhance investment incentives (Besley, 1995; Brasselle *et al*, 2002; Fenske, 2011). Farmers with secure land rights are expected to be both more willing and able to undertake investment in inputs and technology for three reasons: the assurance effect, the realisability effect, and the collateralisation effect (Brasselle et al., 2002).

The assurance effect points to the fact that farmers have a greater incentive to undertake investments when they are convinced that they will receive the benefits of their investment, which implies their right or ability to maintain long-term use over their land (Brasselle et al., 2002; Fenske, 2011). The realisability effect, on the other hand, implies that farmers would likely improve their land productivity through investments when that land can easily be sold or rented (Brasselle *et al*, 2002). In other words, secure land rights allow for gains from trade (Fenske, 2011). More so, farmers are more able to invest when secure freehold titles are established as the land acquires collateral value and access to credit becomes easier (Besley, 1995; Brasselle et al., 2002).

This collateralisation effect is very important especially as formal lenders require collateral to lend to farmers. According to Fenske (2011), the most obvious means by which land rights increase access to capital is through the ability to use land as collateral. Tekana and Oladele (2011) suggested that providing security of tenure is a pre-condition for intensifying agricultural production in rural South Africa.

For farmers to be productive, they should have ownership rights so that they can sell or rent their land and also that their children can inherit the land (Tekana and Oladele, 2011). Machethe et al . (2004) argued that the tenure which prevails in smallholder areas limits tenure security and also hampers the exchange of land for productive use. The common practice in smallholder irrigation schemes in South Africa of granting to scheme farmers the permanent status of tenants only does not foster the motivation to invest.

For instance, Mnkeni et al. (2010) found out that the farmers on quitrent and right-to-occupy land tenure arrangements in Zanyokwe irrigation scheme in the Eastern Cape had no sense of ownership and hardly invested in new technologies. Mnkeni et al. (2010) argued that these insecure land tenure arrangements undermined the interest and commitment of irrigators to farming. Perret (2002) and Denison and Manona (2007a) agreed, adding that scheme farmers should have a title-deed to their irrigated plots, as insecure land tenure limits not only the incentive to make investments but provides no room for a land-leasing market as well.

According to Perret (2002), the lack of clear and secure land tenure system is one of the main reasons for low productivity on irrigation schemes as it hampers establishment of a land-leasing market. It has been reported that those farmers who currently have rights access to the irrigated land tend to avoid leasing their plots as they are not sure if they would be able to claim back their land when they want it back (Perret, 2002; Denison and Manona, 2007a).

Consequently, most of the high-value irrigation land on the smallholder irrigation schemes is not being utilized in South Africa because of land tenure problems (Denison and Monona, 2007a). The other challenge is that landholdings in the form of Permission-to-Occupy (PTO) are generally allocated to men (Denison and Manona, 2007a). The implication is that although women are responsible for over 60% of farming activity in the smallholder irrigation sector, decisions are made mainly by men (Denison and Manona, 2007b; Altman et al , 2009).

This disempowers the women and could reduce their incentives to produce. Moreover, in most irrigation schemes, access to water is linked to access to land as the size of the land one owns determines the amount of water one can access (Molden *et al*, 2007). Namara *et al* (2010) argued that this link further disadvantages women as land allocation has been historically skewed against women.

It is, however, important not to overstretch the importance of secure land rights in improving women’s livelihoods. Jackson (2003) called for a multi-faceted approach, that acknowledges the primacy of land rights and also of other factors (such as credit, extension and information services) in tackling the agricultural production constraints affecting women.

2.8 Technology type

The need for appropriate technology for smallholder farmers cannot be overemphasised. According to Horst (1998, cited in Turral *et al*, 2010), irrigation is a socio-technical process which will succeed if technology is matched with human needs, conditions and institutional arrangements. The smallholder farmers need small-scale, low cost and labour-intensive irrigation techniques as they lack capital and/or credit (Lipton *et al*, 2003).

Such irrigation techniques are more likely to be of benefit to the poor than large-scale, capital intensive technologies (Lipton *et al*, 2003). In South Africa, it has been concluded that the smallholder irrigation schemes that were designed to use the large-scale, capital intensive technologies always collapse as soon as external funding is withdrawn (Van Averbeke *et al* , 2011).

Higher operating costs and greater maintenance requirements in intensive pressurised irrigation systems lead to their high likelihood of failure compared to simple gravity-fed systems (Van Averbeke *et al*, 2011). Van Averbeke (2012) found a strong and statistically highly significant correlation between the operational status of smallholder irrigation schemes in Vhembe district and hydraulic head, indicating that gravity-fed schemes were more likely to be (and remain) operational than pumped schemes.

One important technology aspect is that of synergy. If not complemented by other technologies, irrigation alone will not succeed in reducing poverty. The success of the Green Revolution, for example, was established upon the use of technologies such as fertilizers and high yielding varieties to take advantage of moisture availability under irrigation (Hussain, 2007b).

2.9 Farmer participation

Farmer participation is a key success factor in enhancing agricultural productivity (Backeberg and Sanawe, 2010). Experience elsewhere in sub-Saharan Africa has shown that smallholder irrigation schemes can succeed if farmers participate in their design and management (FAO, 2000). Yet, a number of smallholder irrigation schemes were planned and established following a centralised estate design in South Africa (Fanadzo *et al*, 2010).

Control over farming activities and decision-making was strictly enforced by central management with little or no input from farmers (Perret, 2002). According to Perret (2002), 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. Mnkeni *et al* (2010) argued that the poor maintenance of irrigation infrastructure at smallholder irrigation schemes is as a result of the fact that farmers do not view the scheme infrastructure as their property.

To ensure that ownership is entrenched in the minds of the irrigators, Mnkeni *et al* (2010) recommended that all revitalisation and development initiatives at the irrigation schemes should involve the irrigators in a participatory way at all stages of the processes. Denison and Manona (2007b) agreed, emphasising that the overall performance of interventions in irrigation systems is a demand-driven mode. Interventions offered with a high level of farmers' involvement in irrigation projects, has been better than those provided with support in a supply-driven mode with moderate or low levels of farmer participation (Denison and Manona, 2007b).

The study recommended that service providers should be more client-focused and customer-oriented, and include wider stakeholders' participation with the empowerment of water user organisations such as farmers' associations and their involvement. As explained earlier, the South African water policies have put several strategies whose implementation would result in meaningful farmer participation.

2.10 Information services, infrastructure support and market access

Access to relevant information and markets, among other support services, are fundamental to the success of irrigation projects (Faurès and Santini, 2008). Irrigation farming is more likely to be successful when information supply to farmers and market development are prioritised in the overall irrigation intervention design (Denison and Manona, 2007b).

The small-scale farmers especially lack information on the availability of credit, inputs and market information (DAFF, 2011). Viable input and output markets enable smallholders to obtain inputs and sell produce at competitive prices (Faurès and Santini, 2008). The success of irrigation development in the past in South Africa can be related to marketing potential of produce and the level of profitability of farming (Backeberg, 1994 cited in Denison and Manona, 2007a).

According to Denison and Manona (2007a), smallholder schemes will not succeed without profitability even if all other components are in place. Commercialization and the production of higher-value crops are common denominators in schemes that have been successful in South Africa (Denison and Manona, 2007a). Yet, commercialization implies the need to connect the smallholder irrigators with markets for their produce. Market participation of small-scale farmers is a function of transaction costs (costs associated with the search for trading partners, negotiating and drafting an agreement) (Makhura, 2001; Ortmann and King, 2010). Transaction costs are higher when farms are isolated from market information sources by an inadequate information support (Makhura, 2001). Farmers need useful information on market opportunities, production methods and weather forecasts to make decisions.

DAFF (2011) noted that small-scale farmer’s decision making process has been poorly supported due to poor management and dissemination of required information. Backeberg and Sanewe (2010), on the other hand, reported that the low levels of farmer education limit access to information and understanding of commercial farming concepts and development processes in smallholder irrigation schemes.

Other than that there is currently inadequate information reaching small-scale farmers, the other challenge has been that information is mostly disseminated not in the first language of farmers. A lack of communication technology, particularly that providing market information using their first language, implies that small-scale farmers are at a disadvantage in the recently liberalised and now highly competitive South African agricultural market. Mthembu (2008) found strong relationships between rural poverty and isolation from information support infrastructure in the former KwaZulu-Natal homelands.

Mthembu (2008) concluded that the high transaction costs had contributed significantly in creating barriers to market entry by resource poor farmer, resulting in their poverty. DWA (2012) agreed, highlighting that it is unlikely that irrigation access will enable people to truly escape from poverty without access to timely and reliable information and markets. One aspect of market access is that of ensuring good road and communication infrastructure. Makhura and Mokoena (2003) highlighted that under-investment in rural infrastructure, such as road and communication networks is what is inhibiting small-scale agriculture. The poor rural infrastructure curtails access to input and output markets, subsequently increasing small-scale farmers' production and transaction costs (Makhura and Mokoena, 2003).

According to Mthembu (2008), investment in rural infrastructure should be prioritised as this will increase small-scale farmers' competitiveness in the market. This is because access to good road and communication infrastructure reduces transaction costs for both services and technology, leading to better prices for small-scale farmers (Mthembu, 2008). According to Bryant (2005, as cited in Mthembu, 2008), these investments would help integrate small-scale farmers into modern market chains and promote long-term development.

2.11 Extension and farmer training support

Developing the skills base of farmers is the primary objective of extension. Extension officers bridge the gap between available technology and farmers' practices by providing technical advice, information and training (Treguetha *et al*, 2010). However, due to the low number of extension officers, the accessibility of extension by the small-scale farmer is limited in South Africa (Greenberg, 2010).

Hall and Aliber (2010) reported that only about 11% of the rural households contact an extension officer in a year. This implies that only a small fraction of the farmers get advice and/or training on modern farming methods. As a result, limited knowledge of crop production among farmers has been cited as one constraint to improved crop productivity in smallholder irrigation schemes (Machethe *et al*, 2004; Fanadzo *et al*, 2010; Fanadzo, 2012).

According to Fanadzo *et al* (2010), low yield levels caused by poor crop and water management practices by the farmers is arguably the main reason for the failure of many smallholder irrigation schemes in South Africa. Moreover, the education and training of the extension officers has also been under scrutiny. DAFF (2011), for instance, identified poor training of extension officers rather than the size of the workforce as a major challenge in the delivery of technological packages to small-scale farmers.

The farmers too are generally critical of the extension officers' skills and capacity. Vink and van Rooyen (2009) reported that farmers are of the opinion that they have better skill levels than the extension officers. Farmers also claim that extension officers lack basic project management skills (Treguetha *et al*, 2010). Consequently, the farmers in many cases are reluctant to implement the advice and recommendations of extension workers.

According to Backeberg and Sanewe (2010), smallholder farmers do not have adequate technical expertise to operate viable farming projects. Since the majority of the smallholder farmers' main experience in crop production has been through trial and error, they do not possess all the skills required for commercial production such as irrigation management, crop management, financial management, etc. Thus, there is a need to train the smallholder irrigation scheme members and provide knowledge specifically for commercial agriculture for them to practice sustainable farming (Backeberg and Sanewe, 2010).

2.12 Irrigation project impact evaluation techniques

The impact of smallholder irrigation investments on household welfare has been examined using different methods across the developing world. Few studies have used qualitative methods while many have used quantitative econometric techniques. Qualitative impact evaluation focuses on understanding processes, behaviours, and conditions as they are perceived by the individuals or groups being studied (Baker, 2000).

Qualitative impact evaluation methods include rapid rural appraisal, beneficiary assessment, stakeholder analysis, and a wide range of social assessment methods (Bamberger, 2000). These techniques provide insight into the ways in which households and communities perceive an irrigation project and how they are affected by it (Baker, 2000). The benefits of qualitative assessments are that they are flexible, can be specifically tailored to the needs of the evaluation using open-ended approaches, can be carried out quickly using rapid techniques, and can greatly enhance the findings of an impact evaluation (Baker, 2000; García-Bolanos et al., 2011).

However, the subjectivity involved in data collection, the lack of a comparison group, and the lack of statistical robustness are the setbacks of qualitative impact evaluation methods (Baker, 2000). Use of mainly small sample sizes in qualitative methods makes it difficult to generalize to a larger, representative population (Baker, 2000). Ravallion (2008) argued that, although qualitative impact evaluation can be a valuable complement to quantitative methods, it is unlikely to provide a credible impact evaluation on its own.

Hence, qualitative evaluation techniques have rarely been used on their own in evaluating irrigation impacts. Quantitative impact evaluations use quantitative data from statistically representative samples to assess causality using econometric methods (Baker, 2000). They dominate the literature on examining the impact of irrigation on household welfare.

There are two designs in quantitative impact evaluation techniques: experimental (randomized) designs and quasi-experimental (non-randomised) designs (Ravallion, 2008; Baker, 2000; Bamberger, 2000). Experimental or randomized designs are applicable if the intervention is allocated randomly among beneficiaries.

This random assignment process creates comparable treatment and control groups that are statistically equivalent to one another, given appropriate sample sizes (Dillon, 2008; Baker, 2000). Randomization generates a control group that has the same distributions of both observed and unobserved characteristics as the treatment group (Smith and Todd, 2005).

Consequently, experimental or randomized designs are generally considered the most robust of the evaluation methodologies (Ravallion, 2008; Baker, 2000). However, due to the fact that the experimental or randomized designs are often too expensive, unethical or simply impossible, they are rarely used in irrigation project impact evaluations (Smith and Todd, 2005). Participating in an irrigation project is rarely a random event, but a targeted intervention (Bacha *et al*, 2011).

In fact, the assignment of anti-poverty programs typically involves purposive placement, reflecting the choices made by those eligible and the administrative assignment of opportunities to participate (Ravallion, 2008). Therefore, randomized experiments are not always possible or cannot be plausibly implemented when dealing with anti-poverty programs (Baker, 2000).

Quasi-experimental or non-random methods are used to carry out an evaluation when it is not possible to construct treatment and comparison groups through experimental design (Baker, 2000). These techniques generate comparison groups that resemble the treatment group, at least in observed characteristics, through econometric methodologies, (Ravallion, 2008).

In contrast to experimental designs, evaluation methods that use non-experimental data tend to be less costly and less intrusive (Smith and Todd, 2005). Also, for some questions of interest, they are the only alternative (Smith and Todd, 2005). Quasi-experimental or non-random impact evaluation methods include matching methods, double-difference methods, Heckman selection model, instrumental variable methods, and reflexive comparisons (Baker, 2000; Blundell and Costa-Dias, 2000). These methods have been used widely in the irrigation impact evaluation.

The major obstacle in implementing a quasi-experimental evaluation strategy is choosing among the wide variety of estimation methods available (Smith and Todd, 2005). This choice is important given the accumulated evidence that impact estimates are often highly sensitive to the estimator chosen (Smith and Todd, 2005; Dillon, 2011). Among quasi-experimental evaluation techniques, matched-comparison techniques are generally considered a second-best alternative to experimental design (Baker, 2000; Ravallion, 2008). However, project impact evaluators should be open-minded about methodology, adapting to the problem, setting and data constraints (Ravallion, 2008).

The appropriate methodology for non-experimental data depends on three factors: the type of information available to the researcher, the underlying model and the parameter of interest (Blundell and Costa-Dias, 2000). According to Khandker *et al* (2010), it is advisable to use more than one analytical model for triangulation purposes and robustness checks.

2.13 Poverty rate in South Africa

.Several large state schemes were developed during the 1930s when South Africa was affected by severe drought and economic depression. State irrigation schemes were created to increase food production, insure agriculture against drought, establish new owner-operators in the farming sector, provide rural employment opportunities and develop new settlements (Backeberg and Groenewald, 1995).

Public funds were used to pay for the full capital development of state schemes and also for partial payment of their operating expenditure (Backeberg and Groenewald, 1995), whilst irrigation board schemes received one third of the capital cost as a state subsidy (Vaughan, 1997).

During most of the 20th century, South African social policies of racial segregation and separation benefitted whites (Beinart, 2001). Irrigation development was no exception and the lion’s share of irrigation schemes was established for the settlement of White farmers (Bruwer and Van Heerden, 1995; Backeberg and Groenewald, 1995b). Moreover, irrigated holdings of white farmers, which ranged between 8ha and 20ha (Van Averbeke, 2008) were on average about 10 times larger than the 1.5ha plots allocated to Black farmers (Denison and Manona, 2007b). The relatively small size of the irrigation plots allocated to Black farmers explains why in South Africa, the term ‘smallholder irrigation scheme’ is commonly used to refer to irrigation schemes on which the land is held by Black people (Machete et al., 2004). Accordingly, for the purpose of this article, smallholder irrigation scheme is defined as an irrigation scheme that was constructed specifically for occupation and use by Black farmers.

In South Africa, smallholder irrigation schemes are of secondary importance in terms of land area and farmer participation. In 2010, smallholder irrigation schemes covered 47 667ha, compared to the 1, 675, 822ha of registered irrigation land in 2008, of which 1,399,221ha was irrigated annually (Vander Stoep, 2011). The total population of 34, 158 plot-holderson smallholder irrigation schemes in 2010 was also relatively small compared to the 1.3 million Black homesteads that had access to land for cultivation (Vink and Van Rooyen, 2009).

The importance of smallholder schemes arises primarily from their location in the former homelands, which continue to be poverty nodes (Vink and Van Rooyen, 2009). In these areas, irrigated farming has the potential to contribute significantly to food security and income of participating homesteads (Liptonet al., 1996; Bembridge, 2000), and to create employment, both directly and through forward and backward linkages to primary production (Backeberg et al., 1996).

For this reason, the Water Research Commission (WRC) developed a keen interestin smallholder irrigation schemes, when from about 1990onwards it broadened its agricultural water focus from water asa production factor to water as a livelihood resource, against a backdrop of political change in South Africa. Indications are that the WRC made its first enquiry into smallholder irrigation schemes in South Africa in 1985, when it commissioned Jean-Claude Legoupil of CIRAD to participate in an irrigation workshop and advice on irrigation planning and development. Based on visits to 6 smallholder schemes located in different homelands, Legoupil (1985) concluded that: ‘smallholder irrigation’, in spite of large-scale investment, is only marginally effective.

Irrigation is failing to provide high yields and is beset by a whole range of problems such as: technical, management, training, agricultural policy and financing. And yet in South Africa, the increase in food output can partially be achieved by a rise in the number of (smallholder) irrigation schemes, and the rehabilitation of abandoned ones. It is imperative, therefore, to develop a strategy for the improvement of schemes, which encompasses not only the technical and economic aspects, but also the participation and training of the farmers involved in 1992. The WRC commissioned a second study aimed at providing a comprehensive overview of smallholder irrigation in South Africa. This investigation, conducted by De Lange (1994), indicated that there were probably about 150,000 Black irrigators in the country, comprising 3 broad groups, namely:

• Independent irrigation farmers, who privately accessed andapplied water to their farms
• Holders of allotments on irrigated community gardens
• Plot-holders on smallholder irrigation schemes

Du Plessis *et al*. (2002) added a fourth group comprising backyard or home-garden irrigators, who watered crops on parts of their residential sites. There was general agreement that, when combining the groups, Black irrigators farmed on about 100,000ha and that half of this irrigated area was located on smallholder irrigation schemes (Backeberg *et al*., 1996; Bembridge, 1997).

This made smallholder irrigation schemes the most important in terms of irrigated area. IPTRID (2000) reported that in 1999, the combined area covered by the 2 635 irrigated community gardens in KwaZulu-Natal amounted to2 055 ha. Extrapolating this figure to the 9 provinces would suggest that nationally, irrigated community gardens covered between 10,000ha and 20,000ha. By implication, the areas farmed by independent irrigation farmers and home-garden irrigators would be of the order of 30,000ha to 40,000 ha.

IPTRID (2000) reported that, on average, irrigated community gardens in KwaZulu-Natal had a membership of 19 gardeners, and estimated that 51,700 people were participating in these small irrigation projects. This lends support to Backeberg (2006), who indicated that the total population of Black irrigators in South Africa could be as high as 250 000.

One of the factors that probably focused the attention of the WRC on smallholder irrigation schemes, rather than on any of the other forms of irrigation practised by Black people, was that these schemes represented a substantial public investment, valued at R2 billion (R40 000 ha-1) by Shah et al. (2002).

For nearly 20 years, smallholder irrigation schemes have been one of the focal points of agricultural water research initiated, funded and managed by the WRC. Not all research on South African smallholder schemes has been conducted under the auspices of the WRC. Universities (Bembridge,1984; Rossouw, 1989) and other organisations, such as the International Water

Management Institute (Shah et al., 2002),also made important contributions; however, the body of knowledge produced by the WRC stands out for its coverage, depth and attention to practical application. In this article the knowledge that was generated by the WRC research is reviewed. For the purpose of the article, the database of South African smallholder irrigation schemes compiled in 2006 by Denison and Manona (2007b) was updated using primary and secondary information collected by the authors. Primary data were obtained by means of a comprehensive survey of smallholder irrigation schemes in Limpopo. Updates on schemes in other provinces were based on reports that were published after2006.

2.14 The nature of smallholder irrigation in South Africa

The agricultural sector is the highest consumer of water in South Africa, accounting for about 62% of the total water used, while it directly contributes only about 4% of GDP (NDA, 2007; Kanyoka et al., 2008). Although there are efforts to change it, South Africa’s agricultural sector in general, and the irrigation sector in particular, is characterised by a dualistic production structure (Backeberg and Sanewe, 2010). This dualistic production structure consists of two categories of farmers: the large-scale farmers and the small-scale farmers.

Large-scale irrigation refers to the modern, commercial irrigation operations undertaken by an estimated 28,350 farmers whose majority are white men (Backeberg, 2006; Van Averbeke, 2008). The large-scale commercial farmers produce for local and export markets (Backeberg and Sanewe, 2010).

Small-scale irrigation, in contrast, refers to the traditional, subsistence irrigation activities undertaken by an estimated 200,000 - 250,000 farmers whose majority are black women (Backeberg, 2006; Tlou *et al*., 2006). The small-scale irrigators mainly produce for household consumption. Small-scale irrigation farming uses about 4% of all irrigation water, while the large-scale commercial farming uses the remaining 96% of irrigation water (Perret, 2002). Whereas the main criteria often used to classify farmers as small-scale include land size, purpose of production (subsistence or commercial), and income level (whether poor or rich), racial group plays a big role in classifying South African farmers (Fanadzo, 2012).

In the South African context, small-scale farmers are defined as black farmers most of whom reside in the former homelands (Machethe *et al*, 2004; Fanadzo, 2012). Terms used to describe small-scale farmers in South Africa include smallholder farmers, resource-poor farmers, peasant farmers, food deficit farmers, household food security farmers and land reform beneficiaries (Machethe *et al*, 2004). It is generally accepted that the divide between large-scale commercial farms and small-scale farms in South Africa is a legacy of the racially discriminatory policies of the past (Van Averbeke, 2008; Vink and van Rooyen, 2009).

According to Vink and van Rooyen (2009), the policies during the apartheid era were biased towards the white-dominated large-scale farms, while inhibiting agricultural growth and development among the black-dominated small-scale farms. Therefore, as highlighted by Denison and Manona (2007b), the word smallholder in South Africa not only recognises a characteristic of small farm size, but also a partially developed link to the larger economic system.

While large-scale farmers have access to fully formed external markets, small-scale farmers do not (Denison and Manona, 2007b). The fact that the market-oriented part is dominated by white farmers and the subsistence part by black farmers is a cause for concern from a political perspective (Backeberg, 2006). There is, therefore, a political desire to improve the productivity, profitability and sustainability of smallholder agriculture in South Africa through investments in smallholder irrigation schemes (Backeberg, 2006; Denison and Manona, 2007b). Van Averbeke (2008) categorized smallholder irrigation into four groups, namely (i) farmers on irrigation schemes; independent irrigation farmers; (iii) community gardeners; and (iv) home gardeners.

Although smallholder irrigation schemes vary in size (Fanadzo, 2012), Van It should be noted, however, that not every black farmer is a smallholder farmer and that smallholder farmers are not a homogenous group (Machethe *et al*, 2004). Averbeke (2008) defined smallholder irrigation schemes as irrigation projects larger than 5 ha in size that were established in the former homelands or in the resource poor areas by black people or agencies.

These irrigation projects involve many farmers and their major objective is to assist in rural poverty reduction and development (Van Averbeke, 2008). According to Van Averbeke (2012), these irrigation schemes were established specifically for occupation by black farmers and they involve multiple plot holdings depending on a shared distribution system for access to irrigation water.

The key features of the smallholder irrigation schemes are that they usually involve a gravity-based supply system, farmers have limited average plot sizes, and production is prominently subsistence oriented (Perret, 2002; Perret and Geyser, 2007). About 302 smallholder irrigation schemes existed in South Africa in 2010, with a command area of 47,667 ha (Van Averbeke et al., 2011; Fanadzo, 2012; Van Averbeke, 2012).

This represents about 48% of the total smallholder irrigation area in the country and about 4% of the 1.3 million ha under irrigation at the national level (Backeberg, 2006; Van Averbeke, 2008). Van Averbeke *et al* (2011) presented a number of key facts about smallholder irrigation in South Africa. In terms of the beneficiaries, the study reported that there were 34,158 plot holders in smallholder irrigation schemes in 2010. Rivers were reported to be the main source of water for smallholder irrigation schemes in South Africa, while water was mainly pumped to the plots.

According to the study, a total of 96.7% of smallholder irrigated land obtained its water from rivers, while small percentage obtained water from either groundwater (3.0%), municipal water (0.2%) or spring water 0.1%. The study also reported that water was pumped on 48.5% and gravitated on 34.6% of the smallholder irrigated land. The remainder (16.9%) relied on a combination of both gravity and pumping.

The largest number of smallholder irrigation schemes is located in Limpopo Province (about 56%), followed by the Eastern Cape Province (about 23%), and then KwaZulu-Natal Province (about 12%) (Denison and Manona, 2007b; Van Averbeke *et al*, 2011). The above-mentioned percentages indicate that 80% of smallholder irrigation schemes in South Africa are located in these three provinces, while the remainder are scattered across the other provinces.

As reported in Van Averbeke *et al*. (2011), smallholder irrigation sustainability is a major challenge in South Africa. Of the 296 smallholder irrigation schemes with known operational status in 2011, above 30% were not operational. The majority of these non-operational schemes were located in the Limpopo and Eastern Cape provinces, with 69 and 16 non-operational schemes, respectively.

In terms of operational status, the KwaZulu-Natal province fared very well. All of the smallholder irrigation schemes with known operational status were operational in KwaZulu-Natal, and it was the only province with such a remarkable statistic. Use of pumps was cited as the major cause of smallholder irrigation scheme collapse in South Africa (Van Averbeke *et al*, 2011).

The majority of the non-operational smallholder schemes were those that involved pumping of water. According to Van Averbeke *et al* (2011), about 84% of the 90 non-operational schemes engaged in an irrigation system that involved pumping of water while only 16% of the non-operational schemes were gravity-fed. This implies that, as highlighted by Van Averbeke (2012), there is a higher chance of gravity-fed smallholder schemes to remain operational compared to those involving pumping water.

The overheard costs associated with pumps, and high maintenance pump costs make them unsustainable for smallholder irrigation schemes (Van Averbeke, 2012). To understand some of the reasons why some of smallholder irrigation schemes were non-operationally, the next section provides a brief history of smallholder irrigation development in South Africa.

According to Van Averbeke (2008), there is little evidence of the use of irrigation during pre-colonial times, and smallholder irrigation development was as a result of technology transfer from colonial settlers to the locals. This period of smallholder irrigation development is described as the peasant and mission diversion scheme era (Van Averbeke, 2008; Fanadzo *et al*, 2010). This era was associated with missionary activity and the emergence of African peasant farming, particularly in the Eastern Cape (Fanadzo *et al*, 2010). Van Averbeke (2008) reported that these schemes were typically small, with very little land under irrigation. As a result, these schemes were not that important in people's livelihoods, and ceased to function by the end of the 19th century (Van Averbeke, 2008).

This highlights the importance of ensuring that development projects play a significant part in the beneficiaries' livelihoods, otherwise the beneficiaries would lose interest and stop participating as soon as external support and/or funding is withdrawn. The second era of smallholder irrigation development, the smallholder canal era, lasted from about 1930 until about 1960 (Fanadzo *et al*, 2010).

The smallholder canal era was characterized by the development of schemes to provide families in the Native or Bantu areas with a full livelihood (Van Averbeke, 2008; Fanadzo *et al*, 2010). Natives or Bantu areas, also known as homelands or Bantustans, were territories set aside for black inhabitants of South Africa as part of the policy of apartheid (Speelman, 2009).

Most of the irrigation schemes in the smallholder canal era started after the publication of the report from the Tomlinson Commission in 1955 on the socio-economic development of the homelands (Perret, 2002). This report and the implementation of some of its recommendations changed the settlements, land use patterns and irrigation development in black rural areas (Van Averbeke *et al*, 1998, cited in Perret, 2002).

According to Denison and Manona (2007a), at least 37% of the existing irrigation area was developed during this era. The third period of smallholder irrigation development occurred during the time when independent homelands were set up, hence the era is described as the independent homelands era (Van Averbeke, 2008; Fanadzo *et al*, 2010). This era covered the period 1970-1990 (Fanadzo *et al*, 2010).

The independent homelands era saw a number of new irrigation schemes being established with funding from the South African government (Van Averbeke, 2008). According to Van Averbeke (2008), the motivation for the development of these schemes was to give credibility to the concept of independence of the homelands. The policy of independent homelands was aimed at establishing self-government for each of the different African tribes.

Therefore, improving the economic and social conditions in the homelands through smallholder irrigation schemes was deemed important for this policy to succeed (Van

Averbeke, 2008; Fanadzo *et al*, 2010). About 64 of the existing schemes covering about 13,000ha of land were established during this era (Denison and Manona, 2007a). These schemes were large, and their management was placed in the hands of specialised parastatals (Laker, 2005).

Management of these large schemes proved complex and costly to maintain without government support (Laker, 2005). Consequently, the dismantlement of homeland parastatals after democratization in 1994 without transfer of management skills to local communities was followed by immediate partial or total collapse of these large schemes (Bembridge, 2000; Perret, 2002; Laker, 2004).

The collapse of these schemes highlights the importance of appropriate technology that takes into account the skills levels of the beneficiaries. Otherwise, there is a need for governments to implement exit strategies that seek to empower the beneficiaries to operate the projects on their own first before withdrawal of support. The IMT and revitalization era began in the 1990s and is currently underway (Van Averbeke, 2008; Fanadzo, 2012).

IMT refers to the transfer of the responsibility of managing, operating and maintaining irrigation schemes from the state to farmers (Van Averbeke, 2008). Van Averbeke, (2008) reported that at least 62 schemes were developed in the early period of the 1990s with a focus on food security. During this era, some existing irrigation schemes were also identified as important for economic development, and the need for their revitalisation was prioritised.

This revitalisation of the schemes was linked with IMT, which was a global trend (Van Averbeke, 2008). Though IMT is noble and it has been used successfully elsewhere in the world (Shah et al , 2002), the transfers were rushed in South Africa, leading to smallholder irrigation collapses (Perret, 2002).

Consequently, as mentioned earlier, there is a general consensus in the literature that smallholder irrigation projects have failed as development initiatives in South Africa (e.g., Bembridge, 2000; Perret, 2002; Hope *et al*, 2008; Yokwe, 2009; Fanadzo, 2012). Although the assessment of economic performance of irrigation schemes by the 1955 Commission was highly positive (Van Averbeke, 2008), the more recent assessments have mostly reported that the success of smallholder irrigation has been limited in South Africa.

However, even though performance has been below expectations, and many schemes have collapsed, it remains a relevant question to determine the welfare impacts of those schemes that are still operational. This is so, given the poverty and inequality reduction objectives of the water policies in South Africa. The next section presents the water policies in South Africa, and how they relate to smallholder irrigators.

2.15 Water policies and smallholder irrigation in South Africa

Since 1994, the South African government has undertaken many reforms aimed at addressing rural poverty and inequalities inherited from the past regime (Perret and Geyser, 2007). The White paper on Water Policy (DWAF, 1997), the National Water Act (NWA) of 1998 (DWAF, 1998), National Water Resource Strategy-1 (NWRS-1) (DWAF, 2004) and the National Water Resource Strategy-2 (NWRS-2) (DWA, 2012) are among the important policy documents that shape the current water policy in South Africa. This set of policy documents has put South Africa among the leaders in water reform.

The National Water Act (NWA) of 1998 in particular has been lauded by many researchers as a progressive policy with the most promising legal framework to address the country's challenges in the water sector (Perret, 2002; Hodgson, 2006; Tlou et al., 2006; Movik, 2009; Speelman, 2009). The NWA initiated several changes in the management and use of water in South Africa.

While water was allocated on a riparian system during apartheid, the new water law abolished riparianism and water access was separated from land ownership. Water is now understood as a common resource which cannot be privately owned by individuals, but is owned by the public with the state acting as the custodian of the water resources in the public interest (DWAF, 1998).

The government allocates water use rights to individuals who are supposed to apply and be registered. The allocation between uses and users is based on the need to achieve optimum and long-term benefits for the society from their use (DWAF, 1998). Water rights allocations are time limited to allow for flexibility. Licenses are granted on a five year cycle with a maximum length of forty years (DWAF, 1998) .

A licensee may apply to the responsible authority for the renewal of the license. Hodgson (2006) argued that time limited licenses are a source of insecurity if, for instance, license renewals are not certain. Secure water rights help to expand opportunities for farmers by reducing risks associated with appropriation by external agents, and lengthening farmers' planning and investment horizons (Tyler, 2007).

Water access was characterized by racial and gender inequity during the apartheid era (Movik, 2009). Therefore, the NWA sought to ensure that water is shared on an equitable basis, so that the needs of those without water for productive and consumptive activities are met regardless of their gender or race (DWAF, 1998). The NWA also emphasised the need for efficiency, equity and sustainability in the use of the water resources.

The NWA represents a unique approach as it has sought to incorporate issues of racial and gender equity in water reform, something that has not been done by many countries (Faysse and Gumbo, 2004; Hodgson, 2006). Many modern water policies allocate water resources to activities with the highest productivity per cubic meter, benefitting predominantly the economically and politically well-to-do (Boelens et al., 2007).

However, researchers have reported that the reallocation of water resources to promote equitable distribution in South Africa has progressed slowly (Anderson et al., 2008; Movik, 2009; Muller et al., 2009; Van Koppen et al., 2009). Movik (2009) reported that water redistribution has been hindered by an emergency of views that purport that the continuation of the status quo is pivotal for economic stability and sustainability.

Water redistribution to the historically disadvantaged individuals (HDIs) has been perceived as associated with low production and/or productivity, thus posing a high degree of risk of destabilizing the economy (Movik, 2009). Moreover, achieving gender equity in water access has been hampered by culture, especially in the rural areas (Kemerink et al., 2011).

Therefore, although the equity vision established by the South African water act is clear, actually achieving that vision on the ground has been elusive (MacKay et al., 2003). Whereas irrigating farmers were organized into irrigation boards (IBs) before, the NWA called for the transformation of all the IBs into Water User Associations (WUAs) (DWAF, 1998).

The WUAs are expected to incorporate all users in the defined area of jurisdiction, whether they have a formal water entitlement or not (Faysse, 2004). It is through these WUAs that water user groups like smallholder farmers should secure water rights. It was also envisaged that the transformation from IBs to WUAs would enable better participation of HDIs in the management of water resources (Faysse, 2004).

Although incorporating smallholder irrigators into WUAs holds promise, there has been little progress with the establishment of WUAs so far (Perret, 2002; Tlou et al ., 2006; Speelman, 2009). The government is currently working on the transformation of all irrigation boards into WUAs by 2014 and the required transformation plan, according to DWA (2012), is already in place. It remains to be seen if this would happen as envisaged, and whether these new WUAs will successfully work as vehicles for building capacity of smallholder farmers. One important aspect of the WUAs is their role in irrigation schemes.

Each irrigation scheme is to be managed by a WUA, which will take charge of both water management, and cost recovery for water services (Perret and Geyser, 2007). The WUA is expected to achieve financial sustainability by selling water and water services to farmers, who it is assumed are willing and/or able to pay (Perret, 2002; Backeberg, 2006).

The NWA pointed to the need to introduce water pricing and full cost recovery. Although introducing water pricing and full cost recovery would be viable in the long-run, the NWA acknowledged the need to waive these water charges for a determined time so that the disadvantaged groups could also access water for productive purposes such as agriculture (DWAF, 1998). Speelman (2009) reported that there was yet to be water charges in many smallholder irrigation schemes.

Speelman (2009) and Yokwe, (2009) argued that introducing water charges would lead many of the small-scale farmers to become bankrupt as they currently do not make enough money to cover other costs despite not paying for water. Perret and Geyser (2007) also argued that achieving full cost recovery is unrealistic in developing countries like South Africa because of the subsistence-oriented nature of smallholder irrigation schemes. The NWA also sought to ensure widespread stakeholder participation which includes the poor, women and those in rural areas in the water sector (DWAF, 1998). However, this stakeholder participation as envisaged in the NWA has not been accomplished (Kemerink et al ., 2011). Although there has been establishment of water management structures meant to promote stakeholder participatory governance, this has not materialized in rural areas (Malzbender, 2005).

The participation of the poor, the majority being women, has often been limited in rural areas because of language and illiteracy (Marlzbender, 2005; Kemerink et al ., 2011). The water policy also acknowledged the importance of farming in rural areas, stressing that water should not be transferred from agriculture to other sectors based on water productivity as this would destroy the backbone of the rural economies (DWAF, 1998). This is why the introduction of water markets needs to be regulated. Farolfi and Perret

(2002) gave evidence that if allowed to trade water rights, the small-scale farmers would easily transfer all their rights to the mining sector because of the high water productivity of mining compared to agriculture.

Generally, despite its noble intentions, the setback of the NWA has been in the implementation of its provisions. Many of the challenges faced in the water sector, according to DWA (2012), are related to poor implementation of good policies and strategies. Tlou et al . (2006) agreed, adding that the NWA remains unclear about the implementation of key issues such as water rights, local institutions, and water markets. Tlou et al . (2006) noted that the NWA has been difficult and slow to implement especially in smallholder irrigation farming.

It should be highlighted, however, that the fact that the NWA states the need for such reforms to take place offers hope that ultimately, the smallholder farmers and the poor will play a meaningful role in the South African water sector. The importance of smallholder irrigation in reducing poverty in the rural areas is compelling, and the next section describes the poverty-irrigation inter-linkages.

2.16 The current status of smallholder irrigation schemes in South Africa

In South Africa the term smallholder or small-scale irrigation is mainly used when referring to irrigated agriculture practised by black people. South Africa has about 1.3 million ha under irrigation, of which 0.1 million ha is in the hands of smallholders (Backeberg, 2006). South African smallholder irrigation schemes are multi-farmer irrigation projects larger than 5 ha in size that were either established in the former homelands or in resource-poor areas by black people or agencies assisting their development. Gibb, (2004) counted 287 smallholder irrigation schemes in South Africa in 2004.

Estimates of the combined command area covered by South African smallholder irrigation schemes range between 46 000 ha and 49 500 ha (Bembridge, 2000). This represents about 47 % of the total smallholder irrigation area and 3.6 % of the 1.3 million ha under irrigation in South Africa (Backeberg, 2006). The importance of smallholder irrigation schemes in South Africa arises primarily from the number of participants involved (Bembridge, 2000). In 2003, it was estimated that the land on smallholder irrigation schemes was held by about 31 000 plot holders, representing about 15 % of the total smallholder population (Gibb, 2004).

By comparison, the 1.2 million ha of irrigated land in South Africa, which is referred to as large-scale commercial, is held by about 28 350 land holders (Backeberg, 2006).

Most smallholder irrigation schemes are found in the former homelands of South Africa, where the incidence of poverty peaks (Aliber, 2003).

In these particular socio-economic environments smallholder irrigation schemes present an attractive opportunity for the development of local livelihoods. They can be used to increase and diversify the livelihood activity of plant production, resulting in improved livelihood outcomes, either directly in the form of food or income for plot holders, or indirectly by providing full or partial livelihoods to people who provide goods and services in support of irrigated agriculture on these schemes.

For many decades smallholder irrigation schemes have generated public interest, mainly because their establishment and revitalisation were made possible through the investment of public resources. Factors that contributed to their modest performance were poor infrastructure, limited knowledge of crop production among smallholders, limited farmer participation in the management of water, ineffective extension and mechanisation services and lack of reliable markets and effective credit services (Bembridge, 2000).

Another factor that constrained the economic impact of smallholder irrigation was the predominance of subsistence-oriented farming. Backeberg et al. (1996) reported that 37 % of farmers on smallholder irrigation schemes were commercially oriented, whilst the remaining 63 % were mainly engaged in subsistence production. The results of the survey by Gibb (2004) painted a similar picture.

It needs pointing out that economic success through market-oriented production has not always been the objective of these projects (Van Averbeke et al., 1998), nor should the measuring of success ignore the importance of food security through own production. As Perret (2002) points out, food security remains the major objective for many plot holders and subsistence-oriented crop production patterns have never been changed. For this reason it is important to also assess the success of smallholder irrigation from the perspective of plot holders and their livelihoods

2.17 Smallholder irrigation can impact positively on livelihood and poverty eradication

Bembridge (2000) reported that the proportion of plot holder homesteads living below the poverty line on four smallholder irrigation schemes ranged between 50 % and 75 %, questioning the impact of small-scale irrigation on livelihood and poverty. In contemporary dryland settlements the overall mean contribution of agriculture (in cash and kind) to rural homestead income typically ranges between 6 % and 12 %.

2.18 Overview of smallholder irrigation schemes in South Africa

The available evidence indicates that in 2010 there were 302 smallholder irrigation schemes with a combined command area of 47 667 ha in South Africa. The plot-holder population on these schemes totalled 34 158. Rivers were the principal source of water. A total of 46 114 ha (96.7%) obtained its water from rivers, either pumped directly, diverted by means of weirs, or through dam storage.

Groundwater was used on 1 405.5 ha(3.0%), municipal water on 110 ha (0.2%) and spring water on 37.6 ha (0.1%). Water was pumped on 23 111.8 ha (48.5%), gravitated on 16 497.2 ha (34.6%) and on 8 058.5 ha (16.9%)gravity and pumping occurred in combination. On all existing schemes, the irrigation system was constructed after 1950. Smallholder irrigation scheme development in South Africa has a much longer history (Van, Averbeke, 2008), but in 2010, schemes that were constructed before 1950 no longer existed in their original form. One example was Taung in North-West Province, which dates back to 1939 (Bembridge, 1997), but the original canal irrigation system has been replaced with an overhead system.

In 1952, when the Commission for the Socio-Economic Development of the Bantu Areas within the Union of South Africa (1955) completed its data collection, it identified 122smallholder irrigation schemes, which covered a total of 11,406ha. This irrigated area was held by 7 538 plot-holders, each holding a plot with an average size of 1.513 ha. All of these were river-diversion schemes and it would appear that in most cases their water conveyance and distribution systems had no linings at that time (De Lange et al., 2000).

After 1950, the state upgraded existing smallholder canal schemes by constructing permanent weirs or dams and by lining canals and furrows with concrete. Several new smallholder canal irrigation schemes were also built and all of these had concrete linings (Van Averbeke, 2008). At the time, the Commission for the Socio-Economic

Development of the Bantu Areas within the Union of South Africa (1955) predicted that these lined canal schemes would have a 20 year to 40 year lifespan.

However, some of them have now been in operation for more than 50years, although most are presently in need of repairs (Van Averbeke, 2008). The construction of canal schemes came to an end around 1975. In the Vhembe District, for example, the last canal schemes that were built were Morgan and Klein Tshipise in 1974. Of the total command area covered by smallholder irrigation schemes in 2010, 12 802 ha (26.9%) was located on gravity-fed canal schemes.

Invariably, surface irrigation was practised on such schemes, almost always by means of the short-furrow method (De Lange, 1994; Crosby *et al*., 2000; Van Averbeke, 2008). Surface irrigation occurred on an additional3 278ha (6.9%) located on pumped schemes, where short furrow or border-strip irrigation was practised.

Considerable smallholder irrigation development occurred between 1975 and 1985, particularly in the Eastern Cape (Van Averbeke *et al*, 1998). Overhead irrigation systems replaced canal irrigation in the design of these schemes, in line with the global trend of modernisation (Faurès *et al*, 2007). Some of the large smallholder schemes that were developed during this period in South Africa included Ncora, Keiskammahoek, Tyefu, Shiloh and Zanyokwe in the Eastern Cape.

All of these projects were capital-intensive (Bembridge, 1987; Van Averbeke *et al*, 1998; Laker, 2000). For example, the cost of construction of the 473ha pilot phase of the Tyefu scheme in1976 amounted to R12 000ha^{-1} (Bembridge, 1987), equivalent to R282 189 ha^{-1} when adjusted to 2010 South African Randvalues. In most cases, construction of these large schemes involved the building of dams and use was made of modern water-distribution and -application systems (Van Averbeke *et al*, 1998; Denison and Manona, 2007a).

The mechanized farming system that prevailed on these schemes carried high operational and maintenance costs and required sophisticated management systems (Laker, 2004). All costs were expected to be carried by the projects but financial viability was never achieved. As a result, these projects remained dependent on state subsidies for continued operation (Van Averbeke *et al*, 1998; Laker 2004).

In 2010, various forms of overhead irrigation were found on the largest part of the existing command area of smallholder irrigation schemes. A total of 27 758 ha (58.2%) was involved, all on schemes that were built after 1975 or on schemes where the canal systems were replaced with overhead systems. The extent of micro-irrigation systems on smallholder schemes was limited to 3 830 ha, which represented 8% of the total command area. Not all 302 smallholder irrigation schemes were operational in 2010 and not all operational schemes were fully operational but the data available on provinces other than

Limpopo Province did not allow for estimates of the extent to which operational schemes were functioning. In 2010, 206 schemes were operational and 90 were not. The status of one gravity-fed canal scheme in KwaZulu-Natal and 5 overhead irrigation schemes in the Eastern Cape could not be established. Significant was that the likelihood of schemes to be operational was 81% for gravity-fed canal schemes, 70% for pumped surface irrigation schemes, 65%for overhead irrigation schemes and 56% for micro-irrigation schemes.

Among the primary constraints identified by extension staff on 164 of the 302 smallholder schemes, poor management topped the list (50% of the cases); followed by infrastructural problems (15%); water inadequacies (13%); conflict (12%); and theft (7%). This suggested that human (capacity) and social (institutional) resource problems were at the heart of the below-expected performance of smallholder irrigation schemes in South Africa identified by nearly all assessments that were made (Bembridge, 1997; Bembridge, 2000; Kamara *et al*, 2001; Shah *et al*, 2002; Machete *et al*, 2004)

The majority (65%) of schemes had a command area that did not exceed100 ha and all, but 18 schemes had a command area that did not exceed 500ha. Only 6 schemes were larger than 1,000ha. These included Majeje (1,169ha) and Middle Letaba (1,730ha) in Limpopo Province, both not operational; Ncora (2,490ha) and Qamata (2,635ha) in the Eastern Cape and Makhatini

2.19 Institutions and organisations

Farmers on irrigation schemes are dependent on each other, because they share the water distribution system. This interdependence requires a willingness on the side of farmers to work collectively in order to achieve their individual objectives. The domains in which farmers on irrigation schemes have to collaborate include the routine maintenance of the water distribution system (Letsoalo and Van Averbeke, 2006a), payment for energy where pumping is involved (Machete *et al*, 2004) and payment for water where this has been instituted (Backeberg, 2005).

On many schemes, particularly canal schemes, collaborative arrangements governing the distribution of water to the various hydraulic units and individual plots are essential to ensure that all farmers get their fair share (Letsoaloand Van Averbeke, 2005b; Van Averbeke, 2008). In addition, farming on smallholder schemes can benefit from a collective approach to market access, both input and output (Letsoalo and Van Averbeke 2005b; Van Averbeke, 2008).

Rules to govern collaboration (institutions) and structures to enforce these rules (organisations) are necessary for effective and sustainable functioning of collective action. Indications are that on their own, irrigator communities and their volunteer leadership structures, usually in the form of elected scheme committees, find it difficult to enforce rules. Farmers pursuing individual goals (rational individual behaviour), instead of collective goals (rational collective behaviour) challenge institutions and erode organisations of irrigator communities (Letsoalo and VanAverbeke, 2006a; Orne-Gliemann, 2008).

Institutional and organisational decline has its most profound impact on routine maintenance of the water distribution system, which includes cleaning and minor repairs (Letsoaloand Van Averbeke, 2006a). Inadequate routine maintenance reduces water delivery and shortens the life-span of the water distribution system, posing a threat to the sustainability of irrigated farming. Shah *et al* (2002) identified inadequate routine maintenance as one of the important factors that contributed to the ‘downward ratchet’ that characterised smallholder irrigation schemes in South Africa. De Lange *et al* (2000), paid considerable attention to the building of social capital among irrigator-communities in their guidelines for trainers and development facilitators, but evidence suggests that capacity on its own might not be enough (Van Averbeke, 2008).

Ways to support the institutions and organisations of smallholder irrigation scheme communities need to be investigated more thoroughly. Assessments of smallholder irrigation schemes invariably identified the institution of land tenure to be important factor for 3 main reasons. Firstly, tenure restrictions prevented the development of a land-exchange market among farmers (VanAverbeke *et al*, 1998; Bembridge, 2000).

2.20 The future of South African smallholder irrigation schemes

Backeberg *et al*. (1996) developed a comprehensive policy proposal aimed at assisting the development of the smallholder irrigation sector. This proposal recognised that smallholder irrigation and associated livelihoods are affected directly by three policy domains, namely: irrigation policy, agricultural policy and rural development policy.

In the domain of irrigation policy, the proposal called for the following:

(i) the review and reform of water resources development and irrigation policies and strategies;
(ii) the creation and empowerment of water user associations (WUAs), with the state facilitating the formation of these organisations and providing technical and management training;
(iii) the assessment of present irrigation technologies to identify their suitability and sustainability for smallholders;
(iv) the consideration of active farmer participation in the re-planning of existing and future smallholder irrigation projects;
(v) the transformation of public extension services to cope with issues related to water use and irrigation; and
(vi) the assignment of the responsibility for the maintenance of water storage and primary reticulation systems to the state, and the responsibility for maintaining and operating in-field distribution systems to WUAs or the private sector.

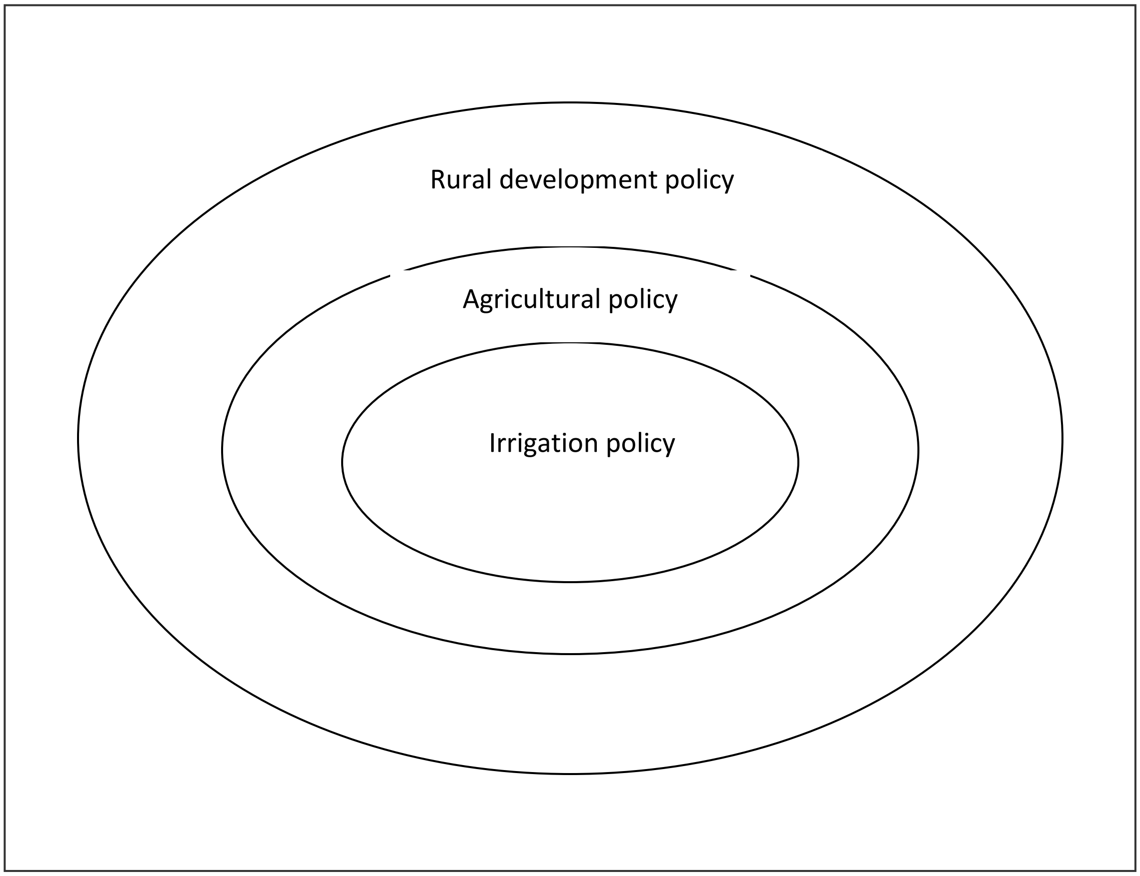

FIGURE 2.1 *Policy domains that directly affect the smallholder irrigation sector and associated livelihoods*

2.21 Improving smallholder irrigation

When seeking to improve smallholder irrigation schemes, it is important that diversity among schemes is acknowledged. Each scheme represents a particular set of circumstances. Differences among schemes may occur in many domains, including spatial (remote or close to urban markets), ecological, technological, available land and water, agricultural traditions, historical evolvement, institutional arrangements and social organization, to name but a few opportunities for improvement of smallholder irrigation schemes need to be considered within the context of diversity among schemes.

2.22 Institutional development for improved access to land and water

There is a general agreement that society at large stands to benefit when small holder irrigation schemes are transformed from predominantly subsistence-oriented projects to schemes where production is primarily market-oriented. On the other hand, as was demonstrated earlier, the plots on these schemes are owned by people with different farming objectives, and at any one time there are large numbers of land holders who are not interested in getting involved in full-scale market-oriented farming.

Existing land legislation prevents the state from evicting farmers who are not farming commercially from the schemes. The most promising avenue to expand market-oriented production on smallholder schemes is to regard the diversity in farming and livelihood among plot holders as an opportunity.

2.23 Operation and management

While governments have participated in the expansion of irrigation schemes, (Water Sector Board, 2007), the schemes‟ performance has been sub-optimal. Where there has been sufficient investment and management input from governments, irrigation schemes have contributed to rapid increases in food production, the major public policy goal.

However, the supply-led approaches and large-scale irrigation infrastructure that were to fuel growth have resulted in bureaucratic institutions that lack the structure and incentives for efficient management and have resulted in inflexible water-delivery systems not capable of responding to farmers‟ needs.

The study by Gyasi *et al* (2006) in Ghana analysed the determinants of the success of community-based institutions for irrigation management. The study indicated that 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. Many schemes severely deteriorated or broke down completely in the past due to insufficient maintenance.

Gyasi *et al* (2006) also noted that market integration generates exit options as maintenance schedules that coincide with market days would receive very poor responses. 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 and accountability reduces trust and confidence in leadership, and undermine management efficiency as leaders perceived to be corrupt lose their moral authority to enforce rules and regulations.

2.24 Irrigation productivity

The World Bank's current rural strategy, "*Reaching the Rural Poor*", recognizes . Water as an essential input into agricultural production, as well as the basis for livelihoods of rural communities and the quality of natural resources (FAOSTAT, 2002). It recognises that efficient agricultural irrigation production for local and export markets will become increasingly important for economic growth and poverty reduction. Globally, irrigated agriculture represents only 17 percent of the total land cropped, but provides 40 percent of the world's food. Meeting the food and fibre needs of the global population in the next 25-30 years requires that irrigated agricultural area be expanded by 15-20 percent (Tiwari & Dinar, 2002).

2.25 Irrigation viability and cost Recovery

A South African Development Community (SADC) report (1992) indicated that most new smallholder irrigation schemes in the South Africa region will not cover the cost of development and operation and are therefore uneconomic. Similarly, FAO (2002) notes that cost recovery from poor farmers for operation and maintenance of irrigation systems is controversial as subsidising these services and providing irrigation water far below cost is financially unsustainable. FAO (2002) argued that stepped tariffs in which the basic need is provided free to poor people may work in the case of drinking-water but is difficult to implement for irrigation water.

Mupawose (1984) 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 (1984) advocated for the reduction of subsidies on smallholder irrigation and indicated that irrigation development has become expensive. Moreover, he suggested that some form of cost recovery should be employed in these schemes.

However, as Gyasi *et al* (2006) notes, irrigation scheme management agencies have largely failed to raise sufficient revenues from the collection of water charges to meet operational expenses. Consequently, there has been a growing promotion of community-based irrigation management in many developing countries to improve efficiency and reduce cost.

2.26 Success stories of irrigation development

FAO (1997a) in a brief general overview of the smallholder irrigation sub-sector in South Africa concluded that smallholder irrigation has brought success stories to farmers. The following observations were made: Smallholder farmers are now able to grow high value crops both for the local and export markets, thus effectively participating in the mainstream economy.

In areas of very low rainfall, as in Natural Regions IV and V, farmers enjoy the human dignity of producing their own food instead of depending on food handouts from the Department of Social Welfare. Irrigation development has made it possible for other rural infrastructure to be developed in areas which could otherwise have remained without roads, telephones, schools and clinics. Smallholder irrigators have developed a commercial mentality.

Crop yields and farmer incomes have gone up manifold. Similar inferences were also highlighted in a study of an irrigation scheme in the village of Chakunda in the Gambia; Webb (1991) gave the following as some of the benefits of irrigation: Increased income that was translated into increased expenditure, investment, construction and trade. Backward and forward linkages: traders were reportedly coming to purchase irrigation produce (rice) and in turn sell cloth, jewellery and other consumer items.

At the village level, this was in the form of construction of a large mosque built through farmers' donations and an improvement of the village clinic. At household level, increased wealth could be seen in 55 houses built in the village, fourteen with corrugated metal roofing.

2.27 Challenges and constraints

Rukuni *et al* (2006) state that a number of problems have befallen irrigation schemes that are managed by central government departments, such as poor marketing arrangements, limited access to water, inability to meet operational costs due to poor fee structures and the lack of a sense of ownership, financial viability and poor governance. Some of these problems have necessitated government transferring responsibility to farmers.

Gyasi *et al* (2006) state that in many countries, institutional weaknesses and performance inefficiencies of public irrigation agencies have led to high costs of development and operation of irrigation schemes. Poor maintenance and lack of effective control over irrigation practices have resulted in the collapse of many irrigation systems. The study by Gyasi *et al* (2006) concluded that collective action for the maintenance of community irrigation schemes is more likely to be problematic when the user group size is large and ethnically heterogeneous, and where the scheme is shared by several communities. Use of labour intensive techniques in the rehabilitation of irrigation schemes promotes a sense of ownership and moral responsibility that help ensure sustainability. A high quality of rehabilitation works and regular training activities also contribute to successful irrigation management by communities.

The FAO (1997b) report identified a number of constraints, which hampered smallholder irrigation development in Zimbabwe. Some of them are: The high cost of capital investment in irrigation works when one considers that communal farmers are resource poor. Poor condition of rural infrastructure to facilitate input procurement and produce marketing is weakly developed in some areas, for example roads, telecommunications and electricity.

FAO (1997b) further identified the following constraints to be affecting the capacity of farmers to investigating and managing irrigation projects in South Africa:

- Poor resource base of farmers
- Fragmented and small size of land holdings
- Unsecured or lack of land titles
- High interest rates
- Poor transportation and marketing facilities

In support of the above inferences, Webb (1991) further pointed out that some of the irrigation schemes collapsed in Gambia because of the following reasons:

- Frequent pump breakdowns due to poor operation and maintenance.
- Poor design of canal structures.
- Pest infestation of crops.

- Periodic fuel shortages.

2.28 Small-scale sugarcane production

According to Feynes and Meyers (2005), the small scale growers form an integral part of the sugar industry and contribute an estimated 16% to the sugarcane crop in South Africa. The viability of the small scale growers (SSGs) is important from both a rural development and economic perspective. According to Legal and Requis (1999), mills like Gledhow sugar mill receive a high proportion of their sugarcane, approximately 25%, from SSGs.

A collapse in the SSG sector is therefore expected to have a marked effect on the flow of sugarcane to the mills. SSGs provide essential mechanical operations such as land preparation, crop maintenance and sugarcane haulage tasks. According to Sokhela *et al* (1999), the productivity of these contractors is generally low, with costly delays in transportation of sugarcane and unreliability of service.

The productivity of contractors is expected to benefit not only the contractors themselves through lower costs and higher profitability, but also SSGs through higher quality services and competitive prices and milling companies with a steady flow of high quality cane to the mill. Sokhela *et al* (1999) identified many problems associated with contractor management (lack of business skills), finance (lack of capital finance) and operations (inappropriate implements). Many short-comings were identified by the role played by contractors that led to depreciation of small scale sugarcane production.

South African research institute based at Mt Edge Combe conducted a survey in ten sugar mills in Kwazulu Natal sugarcane producing areas, whereby a random selection of SSGs were interviewed using questionnaires on service delivery of contractors. The results showed that the growers were not satisfied with the performance of contractors.

The majority of the growers pointed a accused to the contractors of being the main cause of the deterioration in sugarcane production. Reasons given included:

- The relative time taken to transport cut sugarcane, either to loading zones, for indirect haulage contractors or mills for direct haulage contractors.
- The overall capability of contractors to ensure that sugarcane is cut, carted and delivered to the mill within three days.
- The ability of the contractor to meet his daily rated delivery, which is the agreed upon amount of sugarcane that the contractor is required to deliver to the mill to ensure a steady flow to the mill.

Studies have established a positive link an owner's level of experience and the success of his/her business. Dyke *et al* (1992) argued that the longer the contractor has operated in the industry the more experience he would have gained in terms of management decision and management practices. Robinson and Sexton (1994) argued that the higher levels of education led to higher success rates in new business ventures.

Furthermore, they showed that education has had a positive impact on business growth rates and educated businessmen are more successful in terms of financial and size scale measurement. Woodburn (1994) reported that commercial farmers in KwaZulu-Natal regard their farm records as the most important source of information for production, marketing and financial decisions. However, they also found that keeping their own records and preparing their budgets were the two most time consuming information gathering on the farm. Record management concerns the management of information and that business operating in both the private and public sectors need this information to make decisions.

Hussain *et al* (1994) found that more extension contact through training and visiting extension programs increased the farmer's technical knowledge and induced earlier adoption of technology. Recognition of the training needs, specifically linked numeracy, bookkeeping and marketing, have in the past been highlighted by small scale growers. According to Eweg (2002), most contractors are themselves growers and have therefore benefitted from relevant grower training programs. It is expected that the increased training of contractors will improve their service quality.

2.29 Gaps in literature

Literature is scanty on factors that influence farmers‟ participation in irrigation development. It is important to note that prior knowledge of farmers‟ objectives and predisposition with respect to the usefulness of development interventions program can also help to gear development intervention programs to the needs of different group of farmers.

This is so because farmers, who are the ultimate users of the irrigation scheme, take decisions to participate and adopt any development intervention in line with their utility maximisation objective. Alternative intervention programs are valued based on their contribution to the household welfare and derived utility. This study therefore seeks to investigate the performance of farmer participation in irrigation development and fill the void or the information gap with regards to the irrigation participation determinants and their impact on irrigation development.

2.30 Chapter summary

While studies have shown that the performance of irrigation has brought success stories especially to the smallholders in many Southern African countries, a number of challenges and constraints have also been identified alongside irrigation development and management. Some of these centre on project level of funding, design and implementation of irrigation systems, poor irrigation productivity, operation and maintenance of irrigation systems and on labour availability.

Also among these problems is the low crop productivity in smallholder irrigation farmers. Of paramount importance and significantly contributing to the collapse of some irrigation schemes is the high cost of irrigation infrastructure compounded with high technology not compatible to the smallholder needs. This is the case especially with the new farmers from the Southern African context.

CHAPTER 3

METHODOLOGY

3.1 Introduction of methodology

The overall objective of the study was to analyze the performance of irrigation projects amongst smallholder sugarcane farmers. This chapter describes the two study areas chosen for the research. This was done on the basis of demographics, historical background and agricultural potential. This chapter discusses all approaches used to conduct the study. The chapter also describes the analytical framework used in this study, namely: The research design, sampling, sample size, data, data collection procedures, model description and the specific analyses carried out to address the study objectives.

3.2 Description of study area (Maphumulo Local Municipality) and Justification

Maphumulo Local Municipality is an administrative area in the iLembe District of KwaZulu-Natal. Maphumulo is an isiZulu name meaning "place of rest". The municipality is predominantly rural, mostly comprising tribal land, which is administered by the Ingonyama Trust on behalf of local communities. Sugar cane cultivation is the predominant economic activity and land use in the municipality. Subsistence agricultural activities in the form of small cropping areas attached to traditional family units dominate land usage. The R74 Main Road provides access from KwaDukuza to the hinterland and then leads on to Kranskop and Greytown. The linkage to the N2 is vital as it provides for migrant labour transport, and access to commercial and employment markets in the Durban Metro and to the Tongaat/Maidstone, the Dolphin Coast, KwaDukuza, Gledhow, Darnall and Isithebe areas. Figures 3.1 below shows the geographical position of the study area which is Maphumulo Local Municipality and Mansomini irrigation scheme.

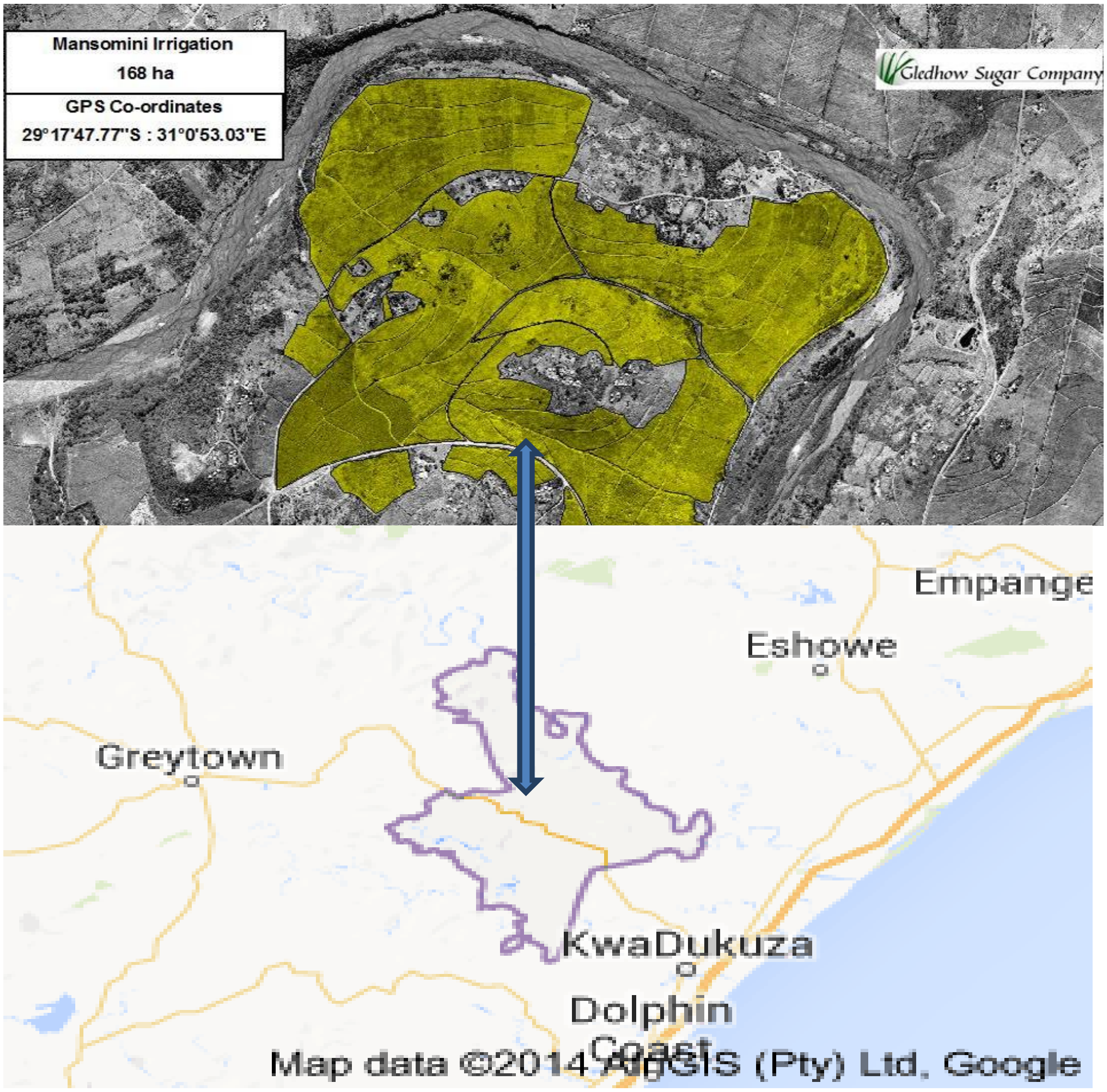

Figure 3.1: Shows the Geographical Position of Mansomini irrigation scheme and Maphumulo Local Municipality.

Source :(Gledhow sugar mill; 2012)

3.3 Description of the Mansomini irrigation scheme

Mansomini irrigation scheme was formed in 1984 in Maphumulo local Municipality which is in Ilembe District Municipality in Kwazulu Natal province of South Africa with 72ha planted. A further 114ha's were planted in 1985, thus totalling 186 ha's under cane, (Khuzwayo, 2012).

This irrigation scheme is a part of the lower Mvoti irrigation board which control the use of irrigation water. The scheme maintained a constant production over the years averaging above 100 tons per hector per annum (Ntshangase, 2012). The scheme comprises of 75 growers of which 35% are males and 65% are females and is closely situated to the main road with infield roads and zones being in satisfactory condition. All development is undertaken by the local contractors using local manpower.

It is meaningful when one considers that using industry benchmarks that a total of 19, 320 mandays would be generated from the first year of re-establishment and thereafter 8400 on an annual basis if submissions were successful (Gledhow millers, 2012). Via the Gledhow Development Committee, a thorough consultation has been in place for the past three years and small scale grower's debate around prioritizing community projects is well established.

Opportunities now exist to form a business entity that can leverage benefit for the entire small scale grower sector. Gledhow place significant importance on training and in partnership with South African Sugar Association (SASA). About 447 beneficiaries in training, 20 attends Junior Sugarcane Certificate course, one attends senior sugarcane Certificate course, 107 attends Shukela practical training courses and 319 attends outsourced training.

The study was conducted in the Kwazulu Natal Province, within ILembe district Municipality in one of its local municipality called Maphumulo Local Municipality in the rural tribal Authority of Qwabe under Inkosi B.M.Qwabe , the place called Mansomini irrigation scheme (GPS co-ordinates: 29'17' 77''S and 31 53'03'') .

This is the one of the poor rural communities in South Africa where poverty is aggravated by growing unemployment and limited economic opportunities. The situation is worse in the former homeland areas of this province where very few improvement efforts have been successful (Chirwa, *et al*., 2008).

The selected town was Mphumulo which is under the Maphumulo municipality at ILembe district and its two villages that is Mansomini and dryland areas. And these villages benefited from the sugarcane plantations that are marketed to Gledhow Sugar Mill. These villages are situated approximately 20km away from town and Mphumulo town is situated approximately on120km from Durban and these two villages are situated approximately 30km from Gledhow sugar mill.The area lies in semi-arid environment which receives less than 600mm of rainfall.

3.4 Theoretical framework

From a theoretical perspective, the decision to participate in a community development project can be viewed as being driven by how much utility a household gains from its choice (Ngugi *et al*, 2003). The research borrows such a concept and assumes that the decision to participate in 40 irrigation development is viewed as being driven by the extent and magnitude by which a farmer derives and maximises utility from participating in irrigation development.

3.5 Research design

This section describes the research design used in collecting and analysing data and intends to show how the study was conducted using research tools. The research design refers to the researcher's overall plan for obtaining answers to the research questions and testing the research hypotheses (Polit & Hungler, 1999). It goes on to describe the data collection methods and the tools that were used for collecting data. The data collected on the variables used in the study is also presented in this section.

The analytical and empirical frameworks are also explained. The section also outlines the data processing tools and model and a justification why the model has been chosen. Both qualitative and quantitative data were gathered on existing livelihoods, demographics, sources of income and market size and potential adoption of technology in farming households.

3.6 Survey data

Primary data was used for the study. Variables examined in the study are presented in Table 3.1 below. Data focused on issues related to sugarcane production and socio-economic factors.

Table 3.1: Variables examined in the study.

Variables	Unit	Type of variable
Gender	Female or male	Categorical
Marital status	Married, single, widowed or divorced	Categorical
Age of h/hold head	Actual years	Continuous
Size h/hold	Actual number	Continuous
Educational level	Attendance of the formal school	Categorical
Employment status	Employed or not employed	Categorical
Land for Agric purposes	Purpose of land usage	Categorical
Land Acquisition	Purpose of land usage	Categorical
Land size	Actual size in hectares	Continuous
Land Usage	Land is used or not	Categorical
H/hold income	Actual amount	Continuous
Total harvest	Actual numbers	Continuous

***Source**: (Generated from data collected, 2014)*

(I) Gender- This variable was intended to show whether the household is male or female-headed. Agriculture in rural areas is usually practiced more by women than men because men tend to move from rural areas to urban areas in search for paid employment. In other words, women are responsible for farming in rural areas to a much greater extent and especially in subsistence agriculture, as well as in food processing (FAO, 1995). Studies in Zambia show that female-headed households are more likely to adopt to resource conservation/improvement technology than male-headed households, holding other factors like household size and age constant (Thangata *et al*, 2002).

However, female headed households, according to Thangata *et al* (2002), are often more resource constrained particularly with regards to labour and cash than their male-headed household counterparts.

Moreover, studies in South-West Nigeria revealed that women also face constraints in using alley-farming technology (Fabiyi *et al,* 1991), due to gender-bias in land allocation and inheritance systems or in rights to plant or own trees. In many low developed countries (LDCs), women are not allowed to own land or plant trees. Furthermore, Versteeg & Koudokpon (1993) points out that there also exists an implicit gender bias in the selection of who participates in on-farm trials of agro-forestry technologies, with men being mostly preferred.

Women sometimes could not benefit from technological change because new technology was not introduced to them due to the notion that women were not really responsible for farming (Quisumbing, 1994). Persistently, certain technologies were introduced to male farmers even though women were in reality primarily responsible for the particular crop or task affected. Whether technical changes benefit women depends on their control over resources. Women in farm households who have control over income from land will benefit from any type of technical changes in agriculture. This resulted to them reaping the returns from increased productivity of both household labour and land (Quisumbing, 1994).

In their study on adoption of improved maize technology in Ghana, Doss & Morris (2001) basically asked the question – Why do men and women adopt agricultural technologies at different rates? Evidence from Ghana suggests that gender-linked differences in the adoption of modern maize varieties and chemical fertilizers are not attributable to inherent characteristics of the technologies themselves, instead resulted from gender-linked differences in access to key inputs. On the whole, these results from Ghana suggested that technology adoption decisions depend primarily on access to resources, rather than on gender *per se.*

However, this assertion should be interpreted with caution, because it does not necessarily mean that modern varieties and fertilizer are gender-neutral technologies. If adoption of modern varieties and/or fertilizer depends on the access to land, other resources, and if in particular context men tend to have better access to these resources than women, then in such a context the technologies will not benefit men and women equally. The fundamental issue is that it is important to examine both the nature of technology itself and the physical and institutional context in which the technology is implemented in order to predict whether it will be adopted successfully by women as well as men.

Kolli and Bantilan (1997) studied the gender-related impacts of a crop and resource management technology package in Maharashtra, India. The study indicated that to ensure effective and committed involvement of men and women in agriculture, views and perceptions of both men and women of the farming communities needed to be incorporated during technology generation and development. A research and development (R&D) agenda that incorporates analysis of gender-disaggregated farmer perspectives is likely to lead to a more appropriate and acceptable technology that will gain wider adoption.

The complex nature of gender and poverty notwithstanding, female-headed households may exhibit pronounced preferences to invest in household wellbeing. Certainly, studies from a diverse range of countries indicate that women and men‟s relative control over resources has significant and often gender differentiated impacts on household consumption and expenditures (Haddad *et al*, 1997).

It was based on this background that gender is a critical variable in the social analysis of technology promotion and in the constraints and success of technology adoption. As such, it is important to investigate how gender is related to participation in irrigation development.

(Ii) Age of the household- Age is an important variable that determines the commitment of the household in agricultural practices. The older the farmers the more chances there are to have more resources at their disposal (Mushunje, Delete and Fraser, 2003). This variable is expressed as the factual number of years.

Literature puts forward contrasting arguments on how age affects participation in projects. On the other hand, older farmers are likely to be more risk averse and more resistant to change (Turner *et al*, 1983), thereby making them reluctant to participate. Adesina & Zinnah (1993) posits that age is typically found to be negatively correlated with adoption. This relationship is explained by the assumption that as farmers grow older, there is an increase in risk aversion and a decreased interest in long-term investment in the farm.

On the other hand, younger farmers are typically less risk-averse and are more willing to try new technologies. Turner *et al (*1983) further highlights that many studies have found age to be negatively related to farm technology adoption. This study will also try to investigate whether there is a relationship existing between age and farmer participation in irrigation development.

(iii) Size of the household- This is the number of people living together in one household (house). Increase in household size lead to the more availability of the labour which enhances farm production in rural areas. Large household size may cause the farming system to be more labour intensive to take advantage of cheaper labour.

Larger households adopt new technologies more often than smaller households, holding other factors constant (Bonabana, 1998; De Souza Filho *et al*, 1999). Households containing members able to participate in on-farm activities enable farmers to adopt labour-intensive technologies (Feder *et al*, 1985). If technologies are capital-intensive, household members may work off-farm to generate income to purchase farm inputs. Similar inferences by (Gladwin *et al*, 2002) suggest that household size has a positive relationship to technology adoption since larger households mean more labour. It is expected that larger households would show more willingness to participate in project activities. This research study also assumes that participation in irrigation development is negatively impacted upon by lack or shortages of labour.

(iv) Educational level- This means the highest education level a household head has. Education is an important attribute to agricultural production, as it contributes to the knowledge of many aspects in agriculture. Education is also important in decision making. Formal education increases the farmer‟s ability to understand and respond to information concerning new technologies (Feder & Slade, 1984). Human capital increases the ability to think analytically, make practical adoption decisions, and use a technology appropriately (Rahm & Huffman, 1984). Studies show that farmers with more formal education tend to adopt new agricultural technologies (Chaves & Riley, 2001; Strauss *et al,* 1991; Feder *et al*, 1985). Education of the household head often influences adoption of technology positively (Hoag *et al,* 1999). Pitt & Sumodiningrat (1991) attributes this to the fact that heads with more years of schooling would be expected to better visualize the benefits of technology.

Matsumura (1997) and Beard (2005), indicated that several studies, both in the developed and developing worlds, have confirmed that the better educated a household head, the more likely they are to participate in projects. Also supporting the importance of education in investments projects are Atta-Krah & Francis (1987) whose study in Nigeria indicated that alley farming is a knowledge and management intensive technology, requiring ability to manage the hedgerows properly to achieve optimal results. Furthermore, lack of proper management knowledge can lead to poor tree performance and abandonment of alley plots. The research study seeks to establish whether the inferences follow the same suit with regards to participation in irrigation development. However, given the nature of benefits and the time it takes to realize them, it is expected that more educated household heads would have a higher opportunity cost of labour; hence this variable would be negatively related to participation.

(v) Employment status- This variable measures whether household head are employed or not employed. Employment has an effect on agricultural practices, because households do not devote sufficient time for agriculture due to their unavailability.

(vi) Land usage- Land usage is an important variable because it has an impact on agricultural production. Some of the households let the land to lay fallow for quite a long time or let the land to become grazing camps for livestock.**Land acquisition-** This is how the land is required. In most rural areas of the Kwazulu Natal, households acquire land for agricultural purposes through traditional laws, inheritance, and freehold, communal tenure or by purchasing on the land market.

(vii) Land size-Is the total size of the land owned by the household measured in hectares. Land size has the impact on agricultural production. The larger the land size, the higher the production level.

(viii) Household income–This looks at the total amount of money a household receive per month, whether it is from social grants, remittances or non-farm income. FAO (1999) reported that employment in off-farm and non-farm activities are essential for diversification of the sources of farm households' livelihoods.

Conventional wisdom and past studies suggest that household with higher incomes would be more likely to participate than those with lower incomes, since the former would even hire labour if they were constrained in that direction (Thangata *et al*, 2002). The study is also investigating the impact of income on irrigation development and it is expected that results follow the same direction to that of adoption of technology.

3.7Sampling method

Non-probability sampling procedure would be employed to sample 100 farmers under Maphumulo Local Municipality. Non-probability sampling was said by Bless and Smith (2000) to refer to that case where the probability of including each element of the population in a sample is unknown. For this research, the availability and snowball sampling methods will be used.

The advantage for using non-probability sampling procedures, such as availability sampling method, only those people who were conveniently available would be interviewed so as to obtain a large number of complete questionnaires quickly and economically. However, though these advantages acknowledged, this sampling method had a problem of the sampling errors due to the fact that they are bias.

Snowball sampling method was also used in addition to availability sampling whereby the available farmer identifies and refers to other farmers in the population to be interviewed. A follow up of contacts mentioned by previous respondents was carried out. Snowball sampling is very good for cases where members of a special population may be difficult to identify.

3.8 Data collection

Structured, interviewer-administered questionnaires was used to acquire information on the livelihoods, market size and potential adoption of technology. The questionnaires will be interview-administered so as to alleviate the problem of misinterpretations or misunderstandings of words or questions. Structured interviews regulate the order in which questions are asked, so the questions are always answered within the same context.

The questionnaire also ensures that all questions are answered and that respondents do not omit difficult questions. By having the questionnaires administered by an enumerator, it also means that information can be obtained from respondents who can neither read nor write. All these advantages, however, overshadow the disadvantages of this method. Such disadvantages include costs in terms of time and money, as interviewers have to interview the respondents separately and require transport to reach the respondents.

The questionnaire will consist of both open ended and closed ended questions. Open ended questions are important as they allow respondents to express their views freely, but they were minimized for easy data analysis as well as to pay focus on issues relating to research. Most of the questions will be closed ended to make the coding of responses easier so as to get as much information as possible from the respondents without taking too much of their time.

The questionnaire focuses mainly on the demographic data (family size, age and gender), educational qualifications, average amounts earned, income, types of farming and constraints towards adoption and the efficient use of technology. Therefore the questionnaire is designed in such a way that reasonably accurate data is obtained to validate the hypothesis of the study.

3.9Sample size

A comprehensive survey of 100 farmers would be selected in Mansomini and dryland respectively. The sample size of 100 would be representative of the population at large. The sample size also limits financial and time constraints that might occur. The head of household or the owner for each farm would be interviewed using person to person interviews. This type of interview was advantageous because it can ensure that the respondent understands questions and can clarify and interpret the respondent's response.

3.10Sampling procedure and data collection

A structured questionnaire was used to obtain further information about the role of irrigation scheme in sugarcane production in rural livelihoods of Maphumulo. Two villages were selected for the study. The sampling frame was the rural households that were producing sugarcane.

The sample size was drawn from this frame. The questionnaires were administered by the interviewers to avoid the difficulties of misinterpretations or misunderstandings of words or questions by respondents. The questionnaire was used to gather all the information about irrigation scheme and sugarcane production in those selected areas. Hence, the advantage of this data collection method is that an interviewer will be in a position to probe for more information from respondents.

The respondents were sampled using availability sampling whereby the households were sampled based on their availability by the time the interviews were carried out only for those households that owned sugarcane plots for marketing purposes with no special characteristics. except that the interviewee had to be the head

3.11 Data analysis and presentation

The study was collected both qualitative and quantitative data. All the information from the questionnaires was coded in Microsoft excel. All statistical analysis was done using the Statistical Package for Social Scientists (SPSS) version 21 and STATA 11. Due to the fact that the data collected for the research were mostly qualitative, the study made use of graphs, tables and descriptive statistics to analyze the data. Descriptive statistics was used in the analyses of personal and household information (Demographic information), while graphs and tables were also used to analyze other relevant information as the case may be. Averages/mean, percentages and frequencies were also used in data analysis.

3.12 Analytical framework

The study carried out simple inferential analysis to compare the performance of irrigated and non-irrigated sugarcane farming. In this case, an analysis of variance (ANOVA) was carried out. ANOVA is a parametric statistical technique used to partition the sum of squares in a data set where we can group our observation by one or more criteria. Since it is not clear what the underlying distribution of the population is, it was decided to check the results of the ANOVA against a non-parametric alternative, notify the kruskal-wallis test.

The basic reasoning behind the study is that household welfare is a function of a number of variables, including a set of demographic variables, socio-economic characteristics of the household head, the employment status of the household head, as well as what the household head earns from main and supplementary occupations. For the assessment of the comparisons of irrigated and dryland sugarcane farming to improve the contribution of farming to sustainable rural development, a model was be fitted by means of the Gross Margin (GM) technique.

Among the economic indicators used in the management of production activities of agricultural holdings, the gross margin has a central place, due to the fact that it provides opportunity and relevant information that substantiate decisions in the specific farm conditions, relating to: planning the structure of production, reducing variable costs based on the analysis of different combinations of resources allocated, establishing deviations causes between partial planned results and the achieved ones(Chetroiu and

Iurchevici, 2012). Gross product (GP) of an activity includes: primary and secondary production value priced delivery, plus subsidies to business. The data used to calculate the total production value and specific variable costs, meet a production period of 12 months (either calendar year or agricultural production year).

The main characteristics of the gross margin are:

- Differ from one product to another, from one period to another, from one farm to another, due to the technological conditions, level of production and prices, which affect the gross product value and variable costs;
- Gross margin is a measuring tool for analyzing the efficiency for planning technologies through the variable costs. However, in relation to the products obtained, achieving a positive gross margin seems to be bigger;
- The products' negative gross margin indicates that the activity causes losses and must be improved at farm level. Some activities may have negative gross margins, while some others will have a positive sign. In essence, the overall total gross margin must be positive.

Based on the above indicators, the gross margin is the difference between the gross product value and specific variable costs (Chetroiu and Iurchevici, 2012). However, for this study to achieve the objective of determining the profitability of the projects under study, a comparison of gross margins will be made with those of an ideal broiler enterprise. The ideal broiler enterprise gross margins will be obtained from the department of Agriculture (combud data). Equation 1 shows a simple mathematical expression of gross margin for an enterprise and can be presented as:

$$\text{Gross Margin (GM)} = (GI - TVC) \qquad (1)$$

Where:

Gross Margin (GM) = Gross Margin measured in terms of the Rand

GI = Gross income measured in terms of the Rand

TVC = Total variable costs measured in terms of the Rand

Gross Profit Margin (GPM)

Computation of Gross Margins alone has the disadvantage of not showing the profit obtained by each enterprise. Therefore, Gross Profit Margin (GPM) will be used. A Gross Profit Margin is gross margin expressed as a percentage or in total financial terms or the ratio of gross profit to costs. A higher margin percentage is a desirable profit indicator.Equation 2 is an expression of a Gross Profit Margin for an enterprise:

$$G \quad \text{Gross Profit Margin} \quad \frac{\quad}{\text{Net sales (Revenue)}} \quad X\ 100\ \% \qquad (2)$$

3.13Chapter summary

The research was conducted at Maphumulo in (Mansomini irrigation scheme). The study targeted members Mansomini irrigation scheme sugarcane plots. A total number of 100 respondents were interviewed using close ended questions. The data were captured on excel and transferred to SPSS version 17 for analysis. A descriptive analysis was used to map out the demographic characteristics of the households and other aspects such as livelihood strategies and livelihood assets. Stochastic frontier analysis (SFA) was fitted to determine the performance of irrigation projects amongst the smallholder sugarcane farmers.

CHAPTER 4

PRESENTATION OF RESEARCH FINDINGS

4.1 Introduction

This chapter is a presentation of research results in the context of the contribution of sugarcane production to rural livelihood in Mansomini and Dry land in the Kwazulu Natal of South Africa. The aim of this chapter is to highlight the various factors contributing to livelihoods of the farmers from sugarcane farming in these rural households. Household demographic characteristics, farm characteristics, land use, water use, production and input acquisition and marketing of sugarcane will be addressed in this chapter.

4.2 Demographic Characteristics of Study Households

In this section the demographic characteristics of the study were presented. These include gender, age, marital status and educational levels. These aspects were important because the main household activities were coordinated by the household head and the head's decisions were most likely to be influenced by such demographic aspects (Makhura, 2001). Demographic characteristics were important determinants of livelihood activities and outcomes especially in sugarcane farming in Kwazulu Natal, as elsewhere in South Africa.

4.2.1 Gender distribution of the sample

It was expected that male-headed households will participate more in sugarcane production than female-headed households in the study area. This expectation was based on the findings of Dlova *et al* (2004) that males are physically stronger, and therefore are more capable in coping with heavy manual demands of farming practices compared to women. Also, there is a gender-linked distribution of economic roles in the rural economy of Kwazulu Natal whereby men are involved in farming while women undertake petty/retail trading (FAO, 2003). The results of the analysis of the gender distribution of the household heads were in Figure 4.2 below.

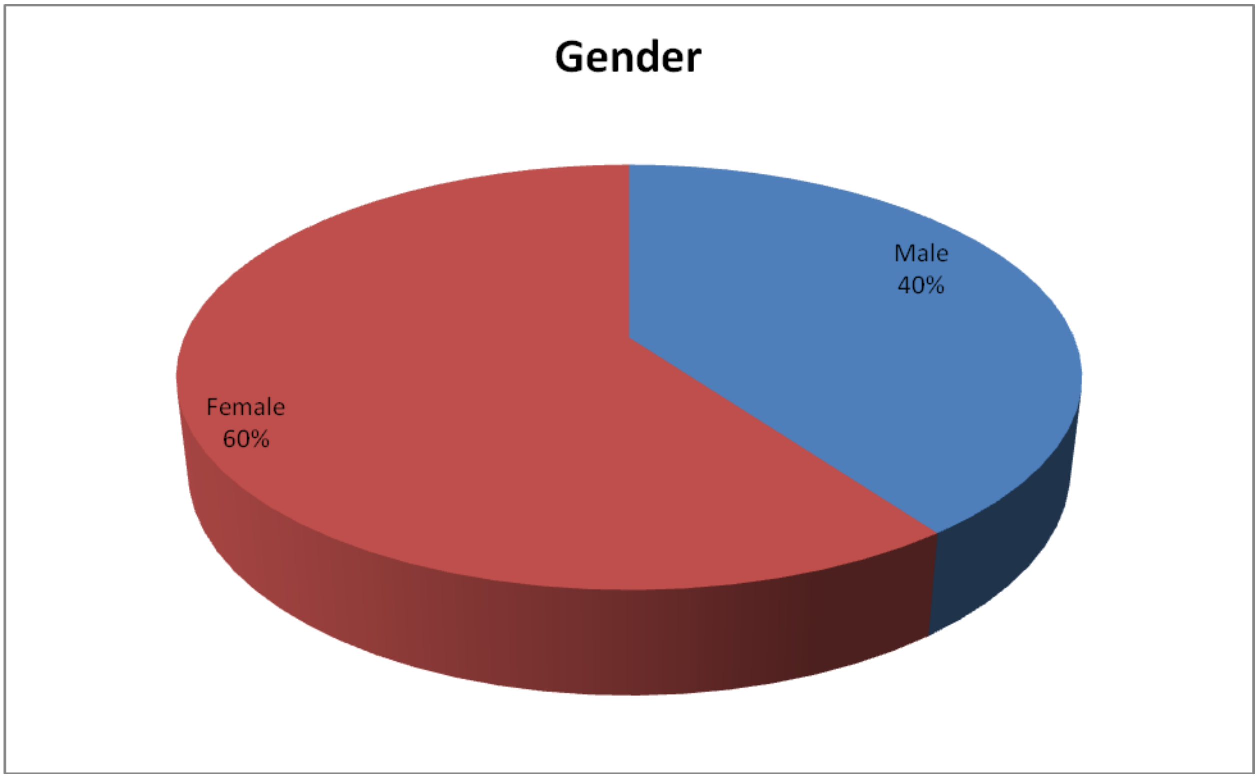

Figure 4.1:Distribution of households by Gender of the household head
Source*: (Survey data, 2014)*

Figure 4.2 above shows that out of 100 people that were interviewed, 40 were males and 60 females. This implied that the males and females were 40% and 60%, respectively. Females in Maphumulo are more involved in sugarcane production than men.

4.2.2 Marital status of the sample

Marital status was considered in this study because it was important in accessing the time devoted to household activities and agricultural production in communal areas. A study by Zenda (2002) revealed that married people are able to share household activities such as agricultural production. This is further explained Figure 4.2 below

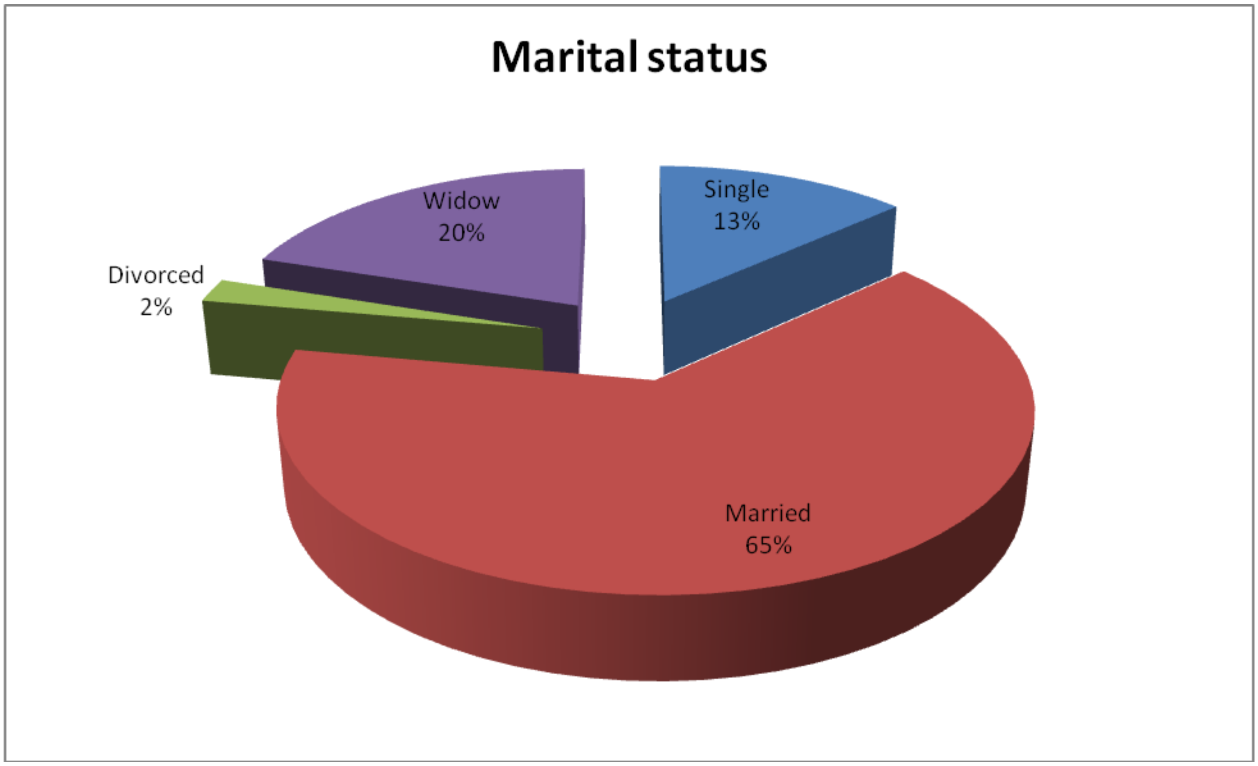

Figure 4.2: Distribution of households by marital status

***Source**: (Survey data, 2014)*

Figure 4.2 shows that most of the households that were interviewed consist of married people followed by the widow households then single and divorced households. Married household heads make up 65% of the study population, while 20% are widow, 13% are single and only (2%) of the household heads were divorced.

Most of the household heads producing sugarcane were married, an indication that marital status might have effect on sugarcane production. On the other hand, households with single, divorced and widowed heads have to do all the household activities as they do not have all the support needed unless from children who are old enough to do some household activities.

4.2.3 Education level of household

The number of years spent in formal education was one of the important determinants of increased agricultural production. Education catalyses the process of information flow and leads the farmers exploring as wide as possible, the different pathways of getting information about agriculture and technology especially in the use of modern technologies such as the use of new sugarcane varieties. Bester *et al*. (1999) also noted that illiteracy is one of the factors that limit economic, social, physical, technological and educational development in less developed countries. Hence, educational considerations generally influence farmers' adoption of new technologies. Results are shown in Figure 4.3 below.

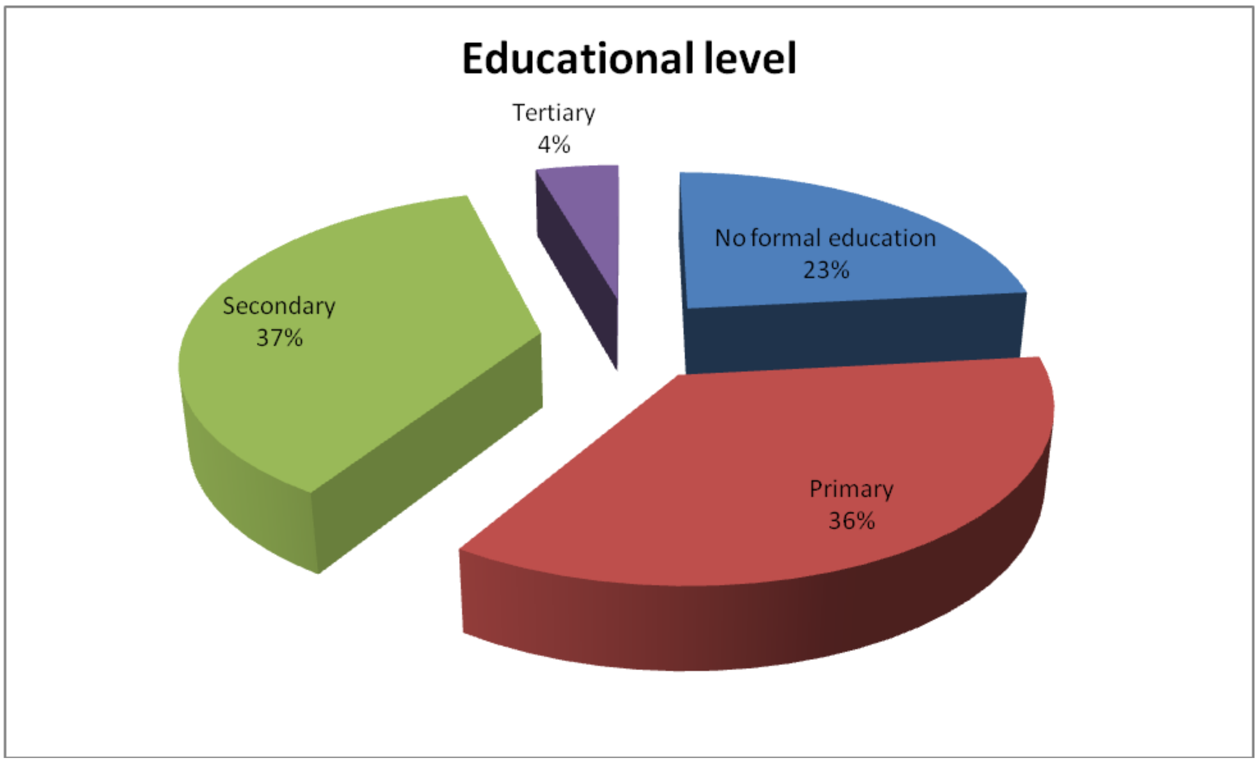

Figure 4.3: Distribution of households by educational level of household head

***Source**: (Survey data, 2014)*

Figure 4.3 show that most of the household's heads attended secondary education. Constituting 37% of all households, while primary education came next with 36% of all households. Household members who do not have formal education were about 25% of the study population and those who attained tertiary education were 4% of the sample. Majority (23%) of the people in rural areas of Maphumulo did not have to be educated in order to do farming. Although education has a huge impact on farming, rural households still take it for granted.

4.2.4 Distribution of households by household size

The majority of households in the rural areas of Maphumulo are small-scale or subsistence producers with limited participation in agricultural activities. Small-scale farming heavily depends on the family for labour. The more members a family has the more production it can undertake. Figure 4.4 below shows the distribution of household by household size.

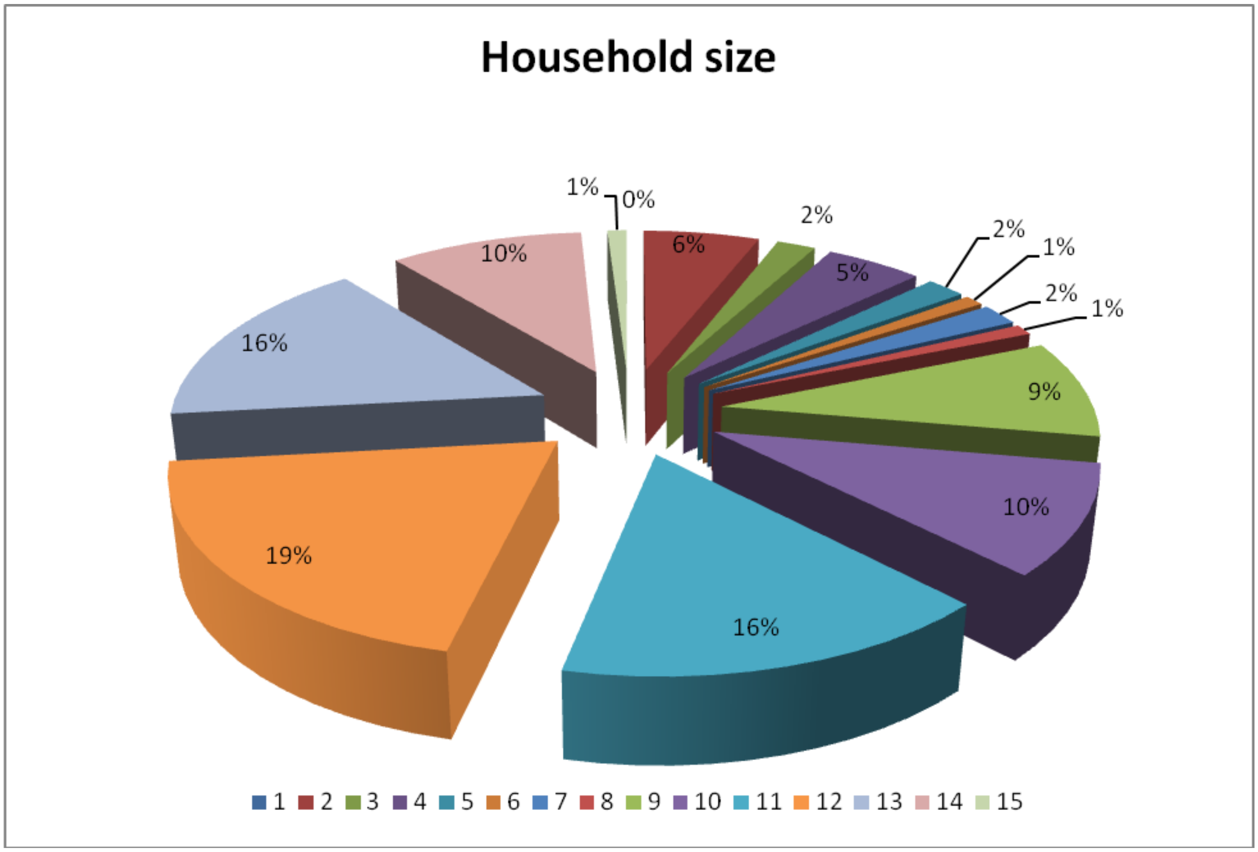

Figure 4.4: Distribution of households by Household size
***Source**: (Survey data, 2014)*

The study revealed that household sizes were in the range of 1 and 18 for Maphumulo people per household. It can be inferred that most of the households had enough labour to produce because the average household size was about 7 people per household. A larger family size also means that a variety of labour capacity is available in the form of young, middle aged and elderly members (Hayes *et al,* 1997). Increasing family size tends to provide households with the required labour for agricultural production especially in sugarcane production (Paddy, 2003). Figure 4.4 shows that the majority of the households consist of 4 and 5 members, while the rest of the households had less than 8 household members. Mean of the household sizes was 7.52 and the standard deviation was 2.576.

4.2.5 Age of the households

Age is one of the most important aspects pertaining to the individual's personality make up, since the needs and the ways in which an individual thinks are closely related to the number of years a person lived. According to Romuld and Sandham (1996), young people are more adaptable and willing than older people to try out new innovations since old people believe in their old cultural way of doing things. The result of the analysis of the distribution of households by age of household head shown inFigure 4.5 below

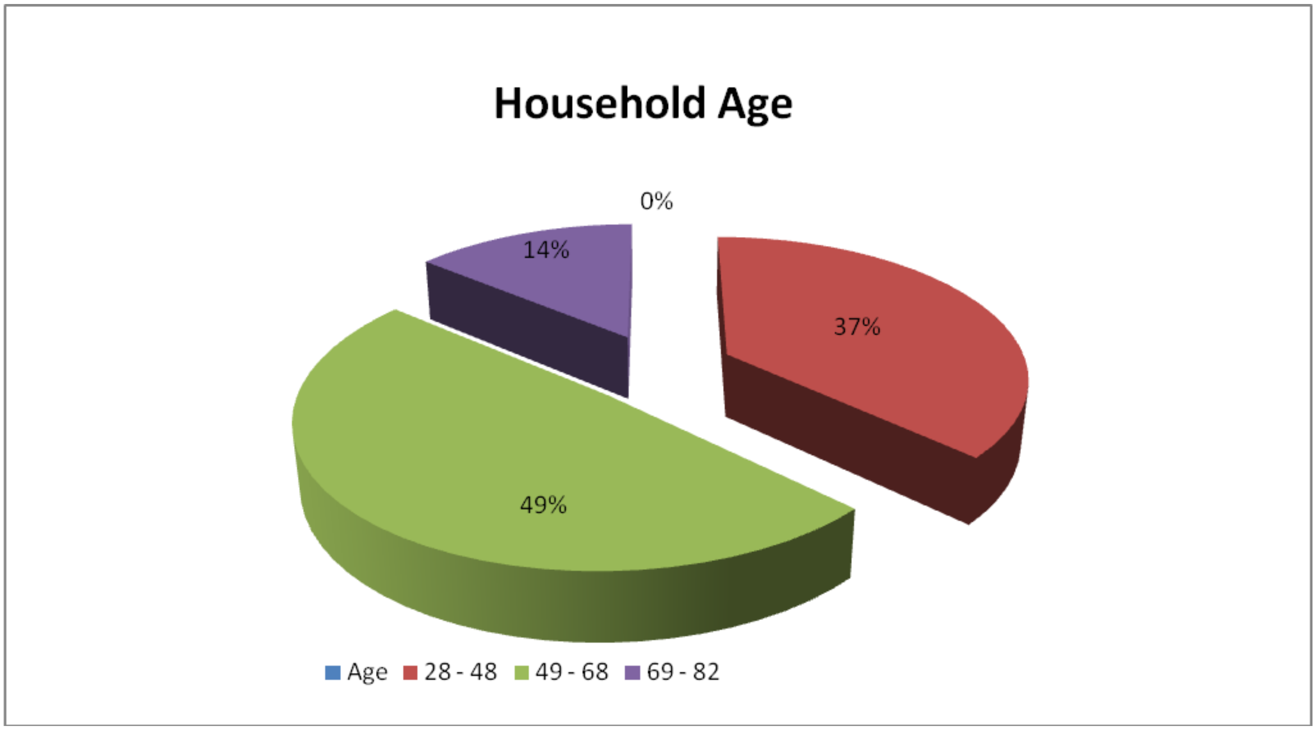

Figure 4.5: Distribution of households by Household age

***Source**: (Survey data, 2014)*

Households who mostly concentrate on farming were the households that were between the ages of 49 to 68 and these households represent 37 percent out of the total number of household, followed by households who ranged from 28 to 48 years. Minimum age was 28 and the maximum age was 82 with the mean being 56.80.Bembridge (1984) stated that age influences behavioural patterns.

4.3 Farming systems

This section is about how households use their land for agricultural purposes, in addition to the mode of land acquisition and land size controlled by the family. Land is the most important resource for agricultural production and is necessary for people in rural areas. This section also deals with water usage like price of water per ton of sugarcane produced and the coping strategies that were used to keep sugarcane in a proper state through the use of water and other management practices.

The Gledhow sugar company is unique in the sugarcane industry in that it the first BEE sugar mill in South Africa and that 72% of the cane supply falls under the umbrella of land reform. They are 1,879 small-scale sugar cane farmers in the mill area of which 494 are currently active growers. The current production of 65, 000 tons per cane has fallen from a high of 258, 000 tons and has the potential to reach 350, 000 as the case may be. The reason that the production has declined is as a result of the political instability in the 1980's, a period of low sugar prices combined with high input costs and five year of below average rainfall (Gledhow millers, 2012).

The reason for selecting Mansomini project was due to the fact that there are incidences of hunger at the community level to:

- Re-establish sugarcane
- 30year history of cane production ensuring land tenure.
- Tribal authority support, endorsement and recognition.

- High yield potential (soils)
- High level of unemployment

4.4 Comparison of irrigation and dry land sugarcane production

Tables 4.1, 4.3 and 4.3 showing the comparisons between irrigated and non-irrigated xcirrigation sugarcane quantity harvested in Mansomini irrigation scheme. Tables has been formulated based on irrigated and on non-irrigated sugarcane fields.

Table 4.1 below shows variables in terms of quantity harvested with water as a source that separate the one that irrigated and those that are non-irrigated within the scheme.

Table 4.1: Comparison of irrigated and non-irrigated sugarcane fields.

Variable	**Obs**	**Mean**	**Std. Err.**	**Std. Dev.**	(**95**% **conf**	Interval)
Quanti~d	100	254.7	16.79734	167.9734	221.3704	288.0296
Source~r	100	1.5	.087388	.8703883	1.327296	1.672704
Diff	100	253.2	16.76196	167. 6196	219.9404	286.4594

Source: *STATA statistics/Data analysis, 2014*

Mean (diff) = mean (quantity harvested – source of water); t = 15.1056

Mean (diff) = 0 degrees of freedom = 99

Table 4.1 shows that quantity harvested are high where there is irrigation when comparing with those fields where there is no irrigation. The difference is clear when looking at the results, which are t = 15.1056 mean quantitative harvest where there is irrigation and .99 where there is no irrigation.

Tables 4.2 below indicate the comparisons between irrigated and non-irrigated sugarcane fields. Since it is not clear what the underlying distribution of the population is, it was decided to check the results of the ANOVA against a non-parametric alternative, notify the kruskal-wallis test.

Table 4.2: Comparison of irrigated and non-irrigated sugarcane fields using ANOVA

Variable	**Obs**	**Mean**	**Std. Err.**	**Std. Dev.**	**95% conf**	**Interval)**
Quanti~d	100	254.7	16.79734	167.9734	221.3704	288.0296

Source: STATA statistics/Data analysis

Mean (diff) = mean (quantity harvested – source of water)   t = 15.1631

Mean (diff) = 0   degrees of freedom = 99

Table 4.2 indicates the comparisons between irrigated and non-irrigated field, the results on an ANOVA shows that the irrigated fields has more yield than non-irrigated fields. The difference is clear again when looking at the results, which are t = 15.1631 mean quantitative harvest where there is irrigation and .99 where there is no irrigation.

Table 4.3 below shows the comparisons between Mansomini irrigation scheme and dryland using Gross Margin. Gross Margin (GM) technique is fitted for the assessment of the comparisons of irrigated and dryland sugarcane farming in other to improve its contribution to farming for sustainable rural development,

Table 4.3: Comparison of irrigated and non-irrigated sugarcane fields using Gross Margin

Activities	**Mansomini (irrigation scheme)**	**dry land**
Sugarcane production/ha	100tons/ha	40tons/ha
RV price (October 2012)	R3 139.67/ton	R3 139.67/ton
RV%	13.5	13.5
Sugarcane	**R423.86/ton**	**R423.86/ton**
Less deductions		
Planting loan repayment	R65/ton cane	R65/ton cane
Herbicides /Chemicals	R20/ton cane	R20/ton cane
Hand weeding	R20/ton cane	R20/ton cane
Fertilizers	R50/ton cane	R50/ton cane
Electricity charges & main	R65/ton cane	R0.00
Harvest & infield	R78/ton cane	R78/ton cane
Transhipment	R4/ton cane	R4/ton cane
Hilo charges	R60/ton cane	R60/ton cane
Grower council	R0.12/ton cane	R0.12/ton cane
P&D Levy	R0.66/ton cane	R0.66/ton cane
MGB Levy	R0.55/ton cane	R0.55/ton cane
CTS Levy	R2.84/ton cane	R2.84/ton cane
Association Levy	R2/ton cane	R2/ton cane
Total deduction	**R368.17/ton cane**	**R303.17/ton cane**
Net pay/ton to grower	**R55.69/ton cane**	**R120.69/ton cane**
Net pay/ha to grower	**R5 569.00**	**R4 827.60**

Map Source: (Gledhow mill, 2013)

Comparing the net values of Mansomini irrigation and dryland of R5569.00 - R4827.60 = R742 which is 13% more on irrigators than non-irrigators. From Table 4.3, household heads on the irrigation scheme earns more than those on dry land, even after paying for electricity and irrigation maintenance because of the quantities harvested. Considering the three Tables above, it is clearly indicated that water/irrigation can contribute on maximizing sugarcane yield which at the end promotes sustainability

4.5 Distribution of sugarcane fields on Irrigated and dry land

Land that research was conducted was arable since it was planted with sugarcane and was used for other activities that were done by the households. Land in rural areas is used for housing, growing crops and keeping livestock. Figure 4.6 below shows that there are more farmers that irrigating their sugarcane than those planting on dry lands at Mansomini irrigation scheme.

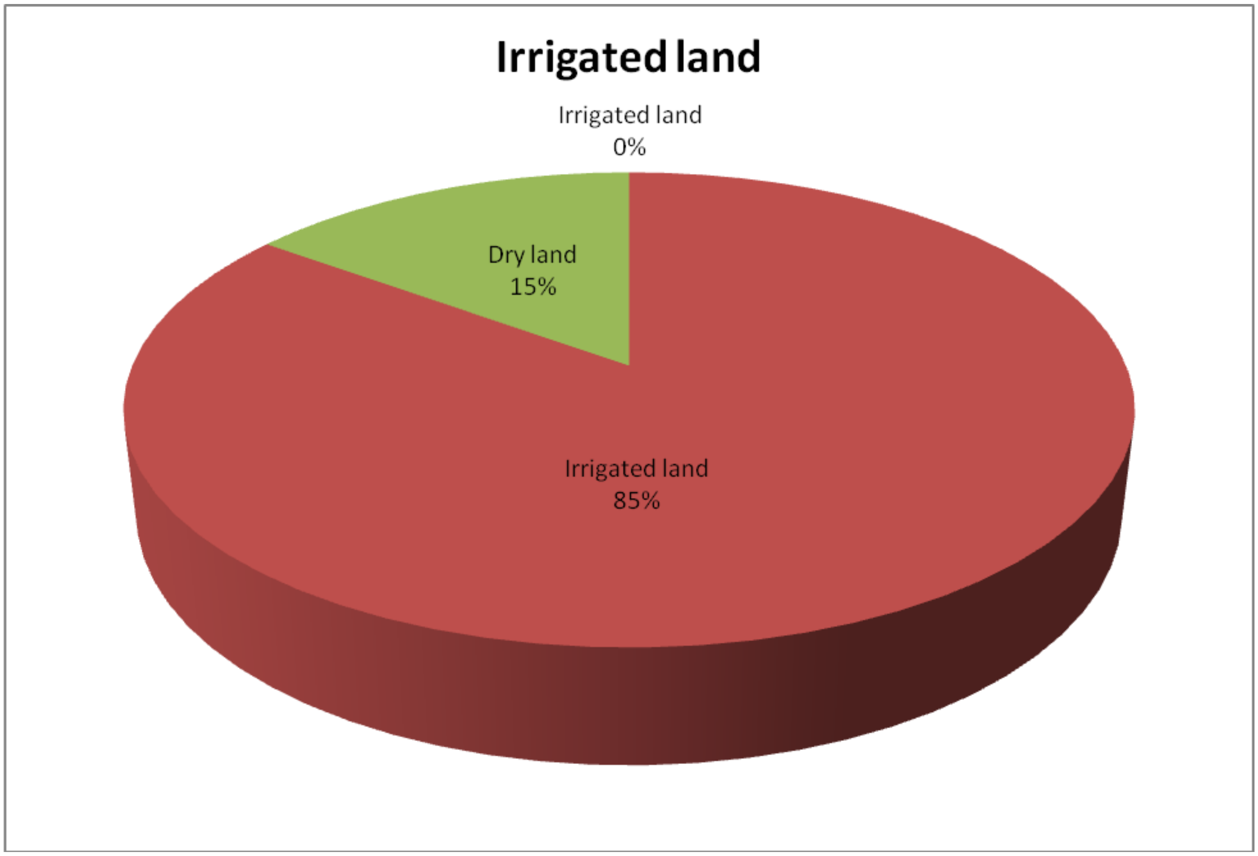

Figure 4.6: Number of sugarcane fields that are Irrigated and dry land at Mansomini

Source: (Survey data, 2014)

The land that is used as irrigation scheme is about 85% and the land that is not used as irrigation scheme (dry land) is 15%. This result of this research implies that irrigation is the main activity in the livelihood of these communities.

Sugarcane is seen as a catalyst of development. It was accepted at community level that with the current infrastructure and support from both local authorities and mill that sugarcane production is the catalyst of rural development.

4.6 Land acquisition

Land acquisition is how the households acquire the land or is the way of getting the land. The following scenarios were looked at lease, freehold, quitrent and communal or buying.

(i) Tenure system

The majority of the rural households got their land from freehold, according to this research, no household has other systems of having land.. These results were consistent with current realities since the end of apartheid when more land is now available to the average black household in South Africa.

(ii) Distribution of the Land size

Land size is the total land owned by the household measured in hectares. The size of the land in agriculture influences household food security; the larger the land size the higher the production (Najafi, 2003). This implies that these households were producing small quantities of food crop products as they only produce using backyard gardens instead of producing using both home gardens and fields. The households face serious financial constraints and not always able to acquire the necessary inputs to expand production, hence limited land sizes

The majority of the households that were interviewed own small portions of land that is in their backyards and used for crop production, and some fields that are used as sugarcane production. 20% of rural households own less than 1.4 hectares, 25% of the households own 1.5 hectares, and 7.5% own less than 1.9 hectares. Results suggest that about 17.5% own 2.0 hectares while 12.5% own 2.5 hectares. Household that own larger plots approaching about 5ha which constitute about 17.5% of the sample. Results were presented in Figure 4.7 below.

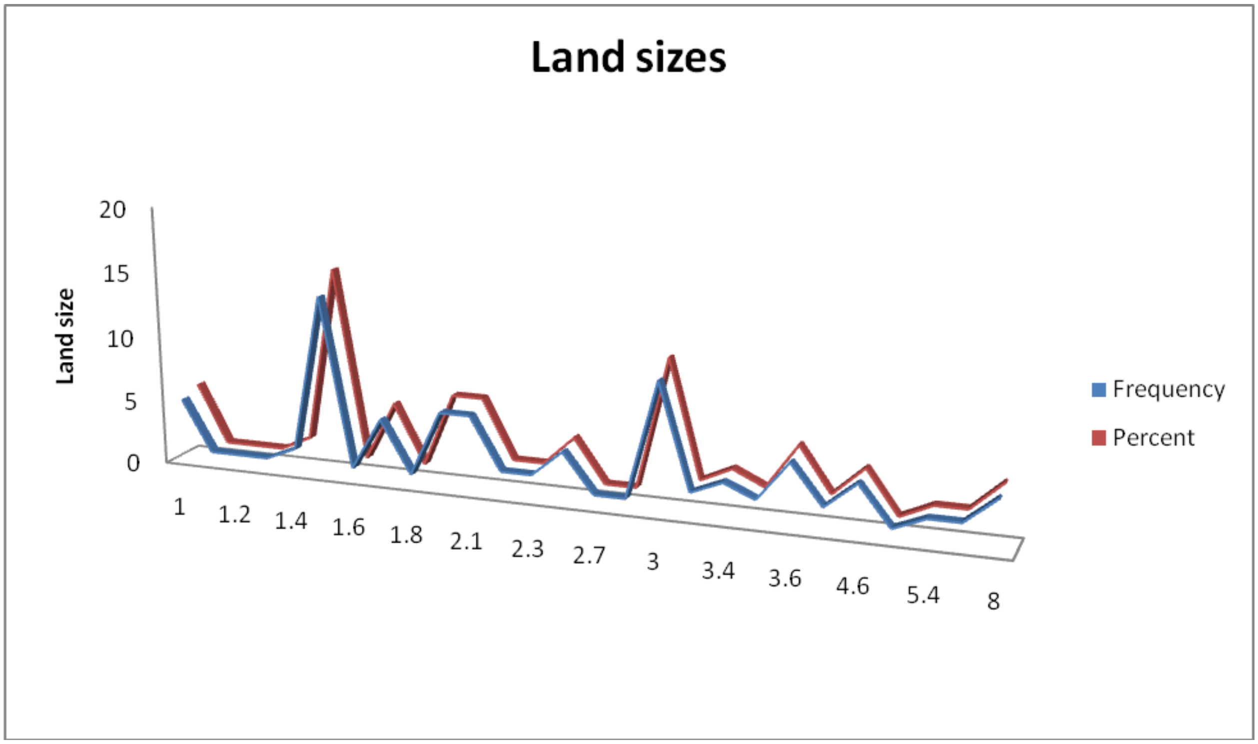

Figure 4.7: **Distribution of households of land by land size**

Source: (Survey data, 2014)

Figure 4.7 illustrate the distribution of the household land sizes, the Figure shows that the land sizes ranges from the minimum of one to eight hectors.

4.7 Distribution of irrigation water based on water sources.

Source of water is where there is a point of water supply, be it a dam, river, tap or a borehole. Sugarcane depends on water to survive the drought and the changes in climate conditions. Results were presented in figure 4.8 below.

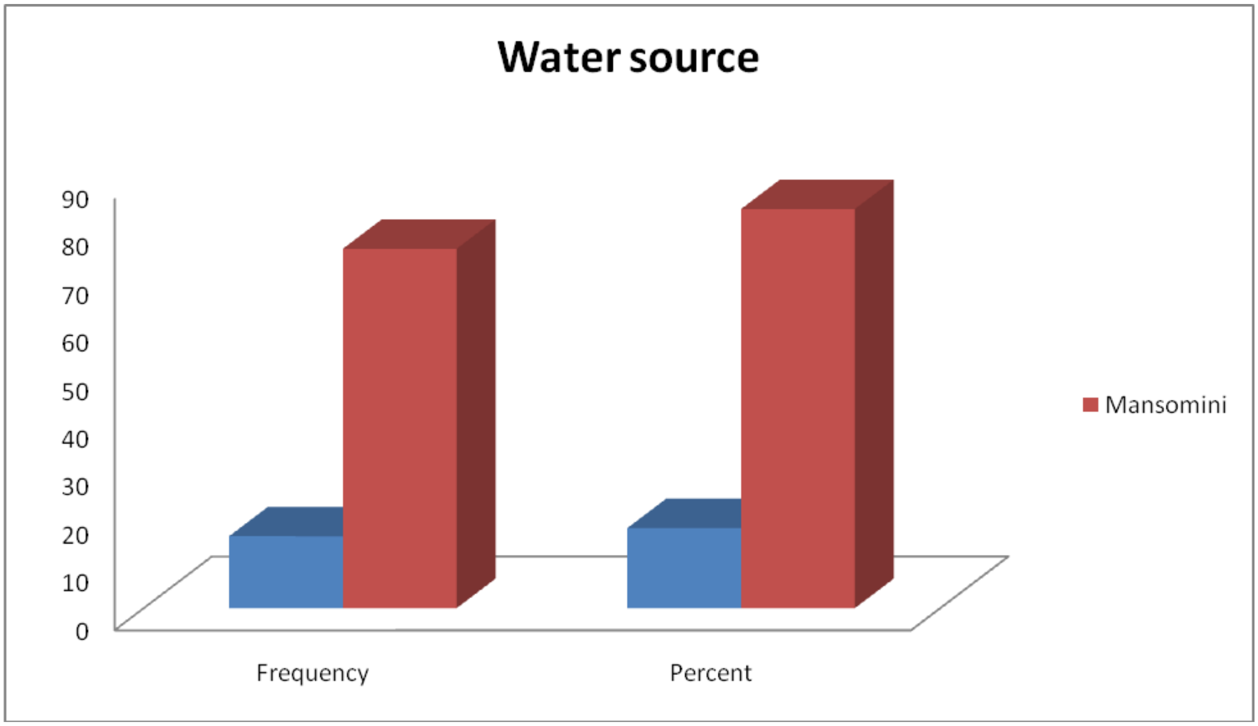

Figure 4.8: Distribution of irrigation water based on water sources.

Source: (Survey data, 2014)

The Figure above shows that Mansomini households rely on water from the river as the source of water for their sugarcane production, and dryland households had no water for their sugarcane production.

4.8 Distribution of household by occupational category

This section looks at the occupation holds by the household head, its help to estimate the household's earnings and the standard of living. It also helps to measure the poverty rate of these communities. Results were presented infigure 4.9 below

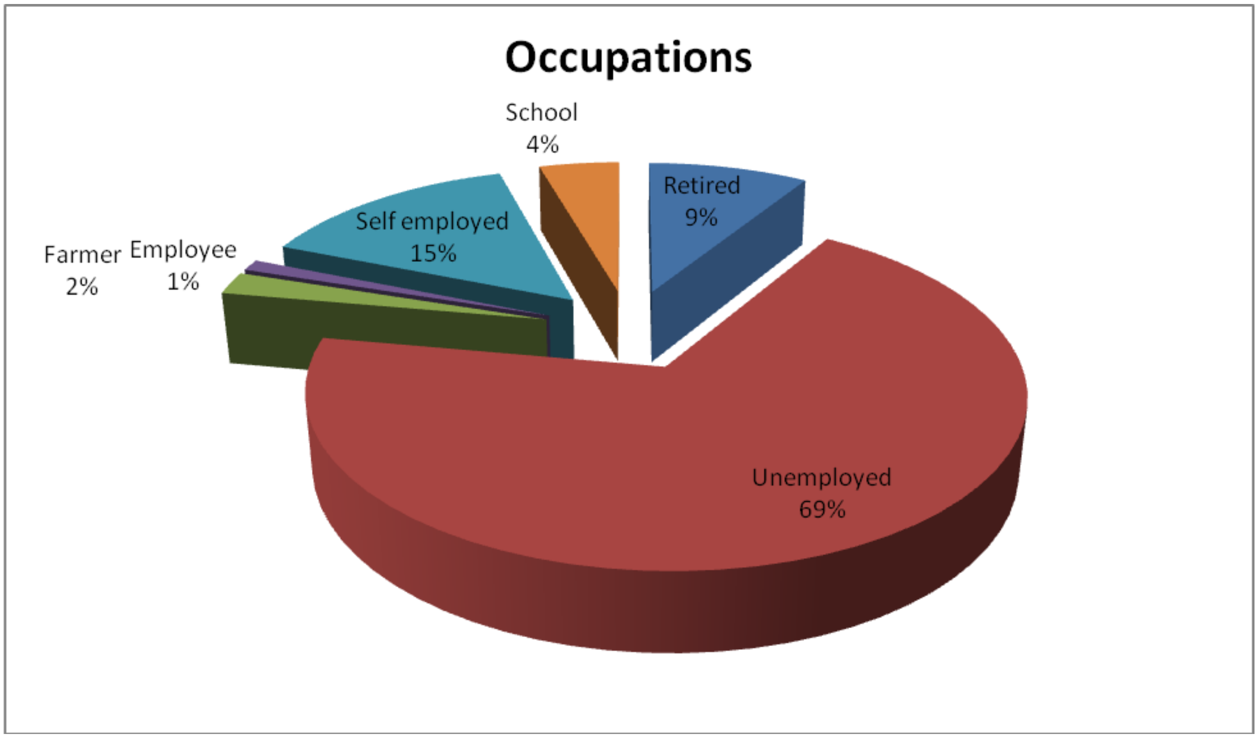

Figure 4.9: Distribution of household by occupational category
Source: (Survey data, 2014)

Looking at the findings, these communities are poorer, the unemployment rate was 69%, people that are employing themselves were 15%, those household heads that are retired were 15%, 2% of them were farmers , 4% are working at different schools and only one percent of people employed, this means most household are solely dependent on sugarcane production for living.

Job creation and value chain opportunities arising from the scheme

All development is undertaken by the local contractors using local manpower. It is meaningful when one considers that using industry benchmarks that a total of 19320 mandays would be generated from the first year of re-establishment and thereafter 8400 on an annual basis if submissions were successful, (Gledhow millers, 2012).

Via the Gledhow Development Committee, a thorough consultation has been in place for the past three years and small scale grower's debate around prioritizing community projects is well established. Opportunities now exist to form a business entity that can leverage benefit for the entire small scale grower sector.

4.9 Harvesting

This section looks at who is performing the harvesting activities, like who is taking control of all harvesting, is it the household since most of them are not employed or they hire the contractors to do that work.

4.10 Abilities of harvesting contractors to harvest sugarcane production

This section is looking at the failed of contractors to do a satisfactory work of harvesting sugarcane. Results were presented in Figure 4.10

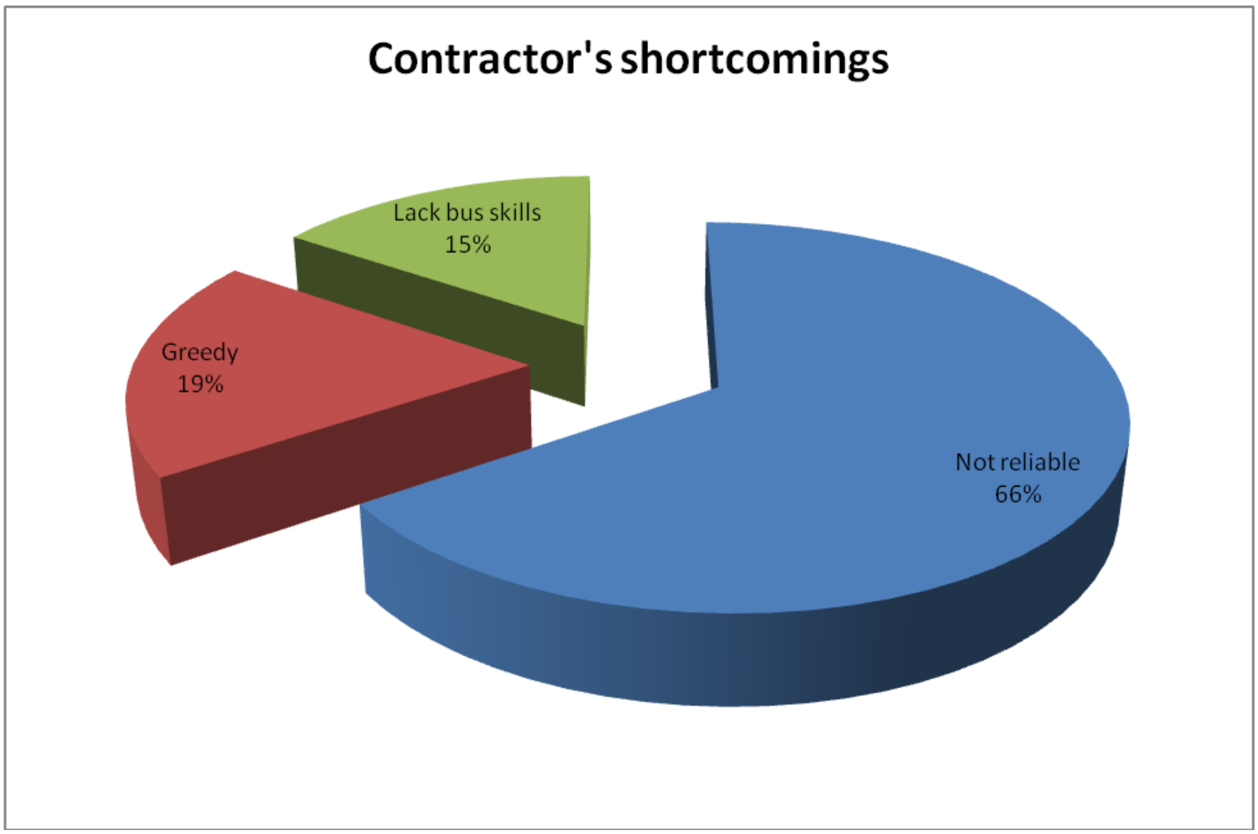

Figure 4.10: Abilities of harvesting contractors to harvest sugarcane production
Source*: Survey data (2014)*

Research findings show that about 66% sees constructors as an unreliable people that cannot be trusted, where else 19% thinks that contractors are greedy and 15% thinks that contractors lack the business skills.

4.11 Condition of the roads to and from the fields

Conditions of the roads are very important as it reduces the spillover of the sugarcane when it is transported to the loading zone and/or to the mill. Results are presented in Figure 4.11

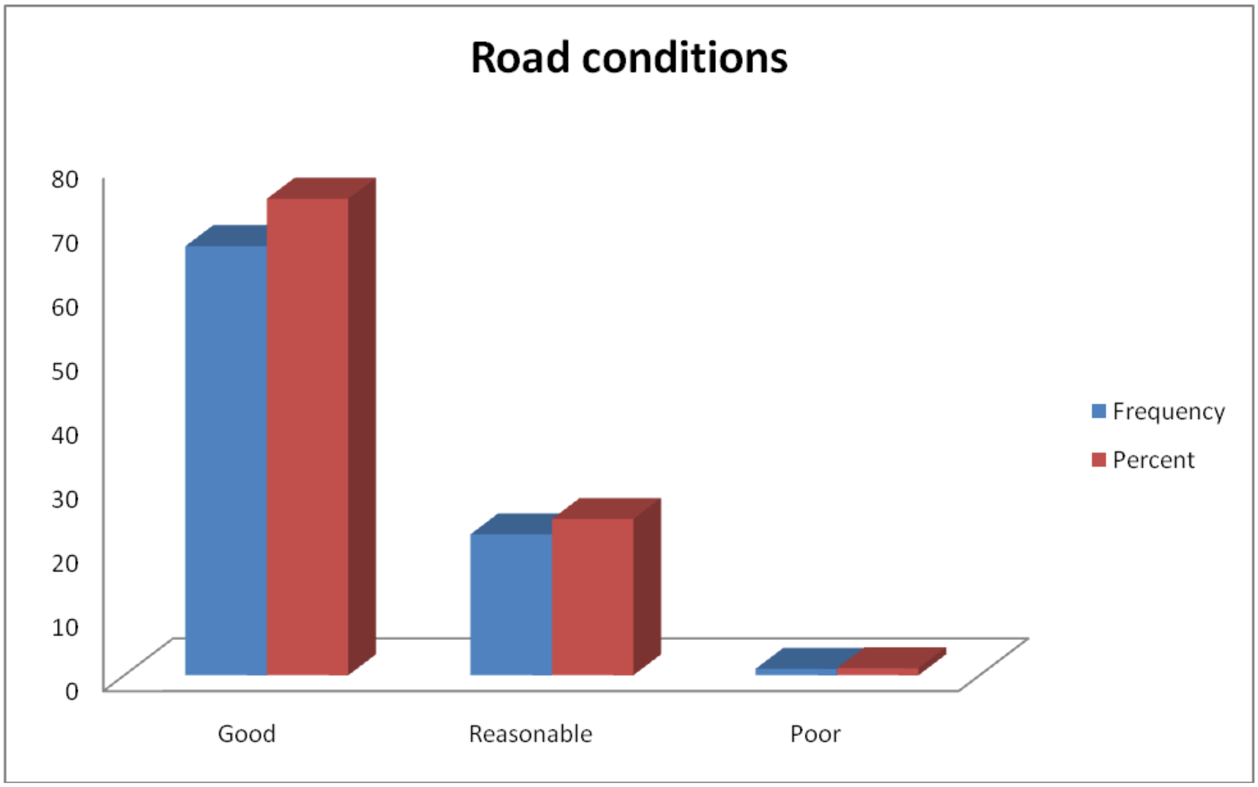

Figure 4, 11: Condition of the roads to and from the fields
Source: Survey data (2014)

Findings of this research shows that about 80%of household head in Mansomini and dryland areas feel that there is nothing wrong with the roads, 18% of them think roads are reasonable while 2% thinks that roads are in poor condition.

4.12Distribution of Water for irrigation purposes.

Water supply is very important as it shows the flow, constant and reliability of water for sugarcane satisfaction. Results were presented in Figure 4.12

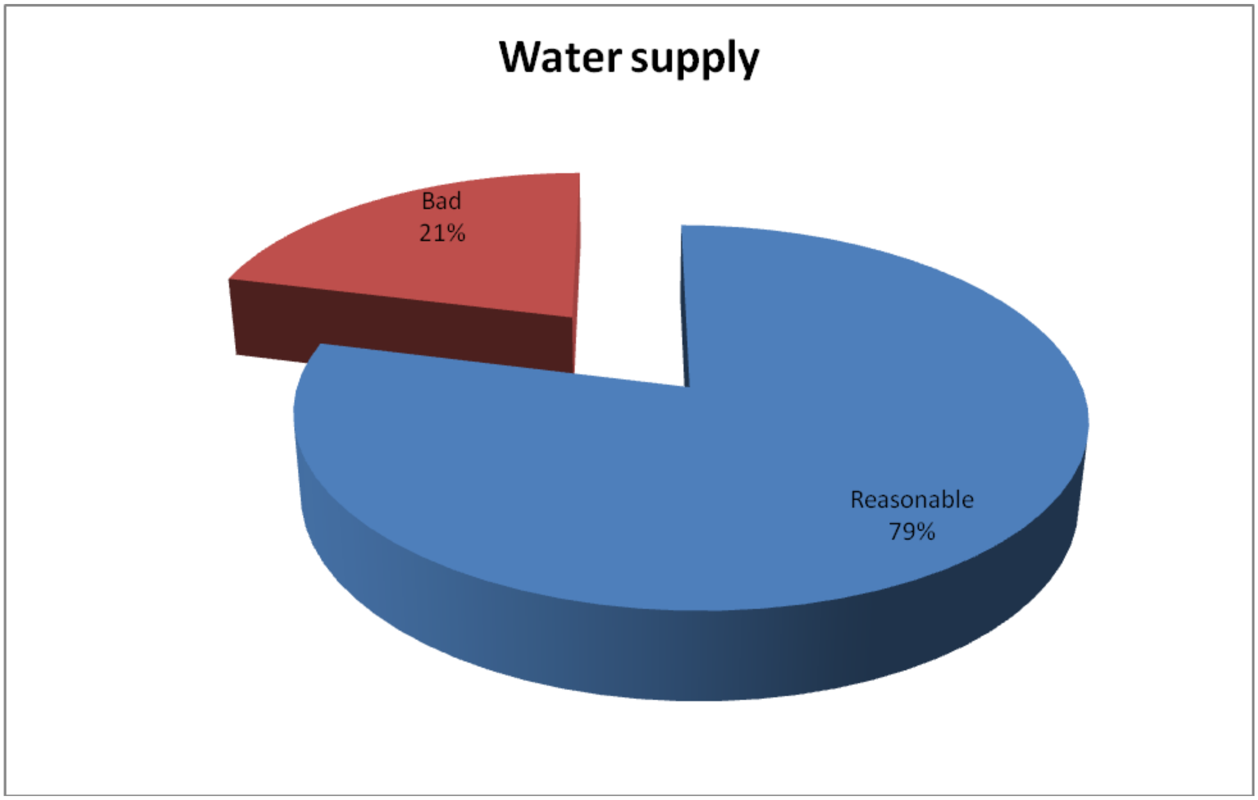

Figure 4.12: Distribution of Water for irrigation purposes.

***Source**: (Survey data, 2014)*

79% of the household heads said water supply is reasonable distributed to all fields, which is the good signs because many household heads were positive and only 21% of them thinks that water supply is poorly distributed.

4.13 Distribution of Electricity in Mansomini irrigation scheme.

This is the source of energy used to pump water from the river to the holding dams and from those holding dams distributed to the sugarcane field. Results were presented in Figure 4.13

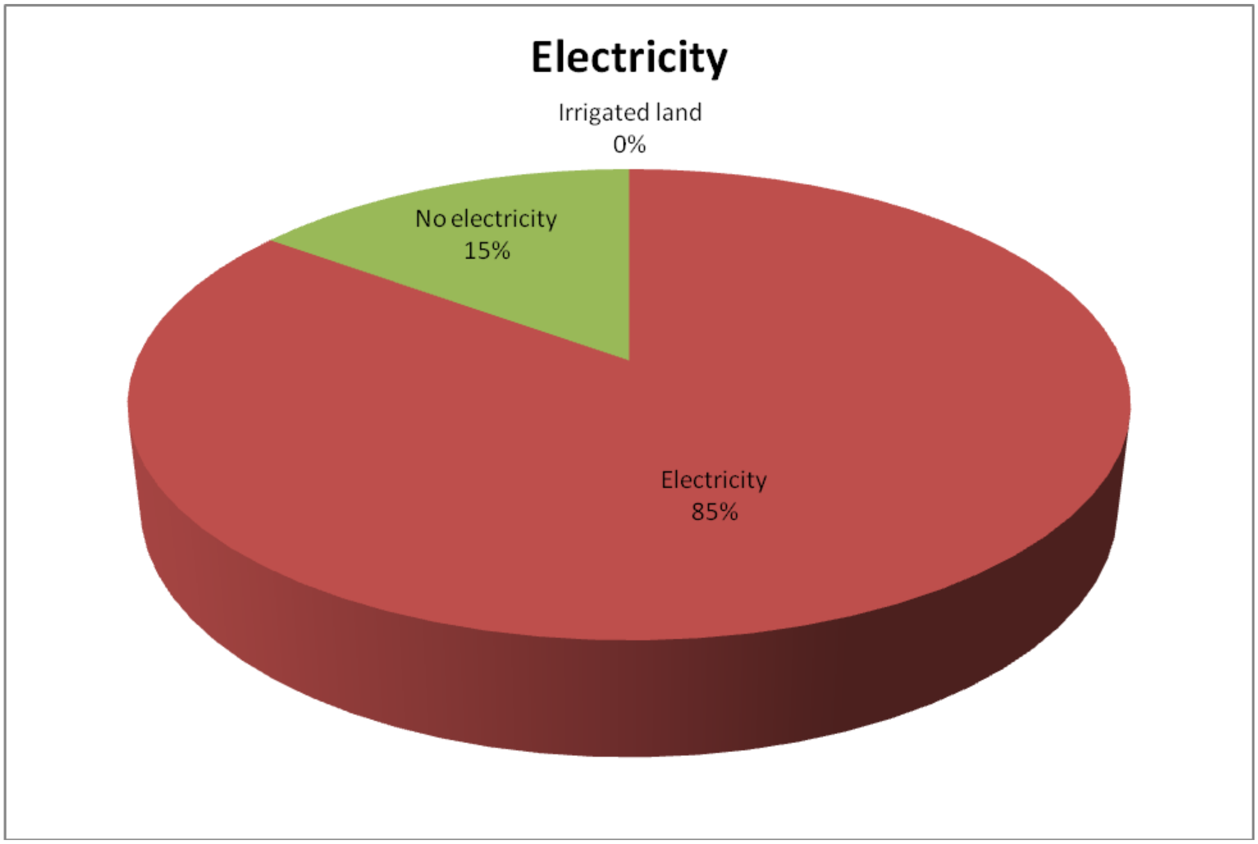

Figure 4.13: Distribution of electricity in Mansomini irrigation scheme.
Source*: Survey data (2014)*

Results show that 85% household heads said electricity is distributed on a reasonable manner, which goes together with the previous findings about water supply. But 15% of the households thinks that the electricity distribution is bad, which also agreed with the previous variable of water supply. This finding shows that not all people are satisfied about the way irrigation scheme is being managed.

4.14: Trainings on management of irrigation scheme and sugarcane production.

Training helps to equip household heads about the way they have to manage their irrigation scheme, water laws and regulations, water conservations and usage, sugarcane production operations such as weeding, fertilizing, herbicides, pest and disease control, as well as harvesting. Hence, the importance of planting new sugarcane varieties and reading of the payment statement cannot be over emphasized. Results presented in Figure 4.14

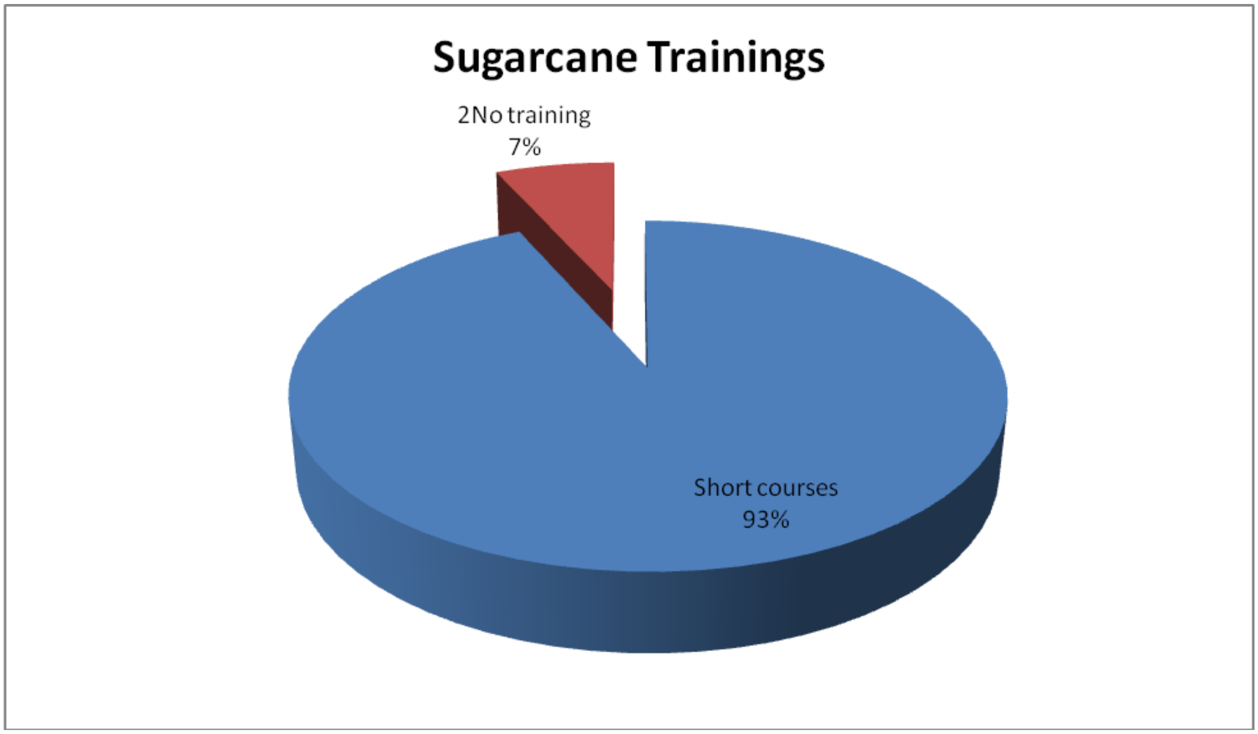

Figure 4.14: Trainings on management of irrigation scheme and sugarcane production.
***Source**: (Survey data, 2014)*

The results of this research shows that 93% had receive short course training and all these household heads said they have used the advices from these courses, though 7% of them said they never receive any training about irrigation nor sugarcane production.

4.15 Training and skills development

Gledhow place significant importance on training and in partnership with South African Sugar Association (SASA). About 447 beneficiaries in training, 20 attends Junior Sugarcane Certificate course, one attends senior sugarcane Certificate course, 107 attends Shukela practical training courses and 319 attends outsourced training.

A number of candidates who passed the Junior Certificates have of their own accord asked to work under local contractors with no remuneration to gather agronomic experience. It is this group of youth that would benefit from a two-year stipend whilst being groomed to become a potential farmers qualifying on merit for additional industry capacity building. These young men and women would then be suitable for Land Reform acquisitions.

4.16Current status of the scheme

- 80% of the production has been harvested.
- Out of 15 000 tons that was estimated, 18 000 tons harvested with very good quality sugarcane of averaging 13.5% sucrose.
- Maintaince costs are higher than expected because of bursting of the old underground pipes.
- Fields are fertilized but not completed.

4.17Chapter summary

Chapter four is the analysis of the research findings. In this chapter it was established that most the people who were involved in farming were females. The majority of the household members had primary education. Most of the interviewed respondents were married. Farming was the primary occupation. Stochastic frontier analysis (SFA) was fitted to determine the performance of irrigation projects amongst smallholder sugarcane farmers. Sugarcane was used as Dependent variable while independent variable such as household size, land size and others were used. The model results were also presented in this chapter.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the dissertation. This chapter will start by summarizing the introductory part that highlights the performance of irrigation scheme in sugarcane production, importance of rural areas and smallholders and the nature of the livelihoods. Chapter two focuses on literature review with respect of poverty in rural areas, rural livelihoods and production of sugarcane at large. Then chapter three summarizes the methods that are used to collect the data and the procedures that are followed when selecting the sample.

5.2 Summary

This section covers the chapters that were dealt with in this study starting from chapter one which is the introductory part. Chapter two which is literature review, chapter three which is methodology and then covers chapter four which are the results.

5.2.1 Background

The paper documents the history of smallholder irrigation scheme development in South Africa, assesses the current status of these schemes, and identifies opportunities for their future development, using rural livelihood as the central theme. The paper's main focus is Mansomini irrigation scheme, weighing the impact of irrigation scheme comparing with dry land in the livelihood of Maphumulo rural community. Its main objective is to determine the performance of irrigation schemes in uplifting the livelihood of smallholder sugarcane production.

Four distinct irrigation scheme development eras were identified and these were linked to the political history of the country. The analysis showed that irrigated farming had diverse roles in the livelihood of plot holders, ranging from being the primary livelihood activity to complementing livelihoods based on other sources or activities.

This role diversity of farming was expressed in different farming styles, which had specific characteristics pertaining to choice of crop, crop husbandry, attitude towards risk, allocation of produce and marketing practices. The paper makes the argument that diversity in livelihood and farming on smallholder irrigation schemes is a natural socio-economic phenomenon that has evolved historically and that is expected to persist.

Diversity in livelihood and farming among plot holders should, therefore, institutional flexibility on smallholder irrigation schemes in order to create the necessary social room for plot holders to pursue their particular farming objectives. Endogenous development innovations that may lead to improved economic performance of smallholder irrigation schemes overall were also identified.

5.2.2 Literature review

The literature review of this study looked at five different subtopics. The first subtopic looked at the current status of smallholder irrigation schemes globally, Africa, Southern Africa and in South Africa. The concepts reviewed include the current status of poverty, livelihoods, efficiency, food security, Institutional development for improved access to land, water and the challenges and constraints of irrigation development.

Literature review revealed that rural areas are more exposed to poverty. Rural poverty is continuing in South Africa to show higher incidence of poverty and Kwazulu Natal is the one province that lives under poverty line. In most developing countries, like South Africa agriculture and agriculture-related activities used to provide most of the employment in rural areas.Communities in developing countries (South Africa) are characterized with high population, poor infrastructure, meaning that there is great lack of resources and money to better their living standards.

For a family to be engaged in agriculture as an important livelihood activity it needs to be dependent on lot of the personalities of the household members, but it is also connected to family size. This poverty gap meant a lot to the livelihoods of the rural poor, causes men to leave their homes and go look for an employment in other industries to raise income and that income is not enough for their livelihood expenses.

Sugarcane productions in communal areas are a significant contribution to formal agricultural output and are mainly confined to the eastern and northern part of the country. In South Africa the term smallholder or small-scale irrigation is mainly used when referring to irrigated agriculture practiced by black people. South African smallholder irrigation schemes are multi-farmer irrigation projects larger than 5 ha in size that were either established in the former homelands or in resource-poor areas by black people or agencies assisting their development.

Most smallholder irrigation schemes are found in the former homelands of South Africa, where the incidence of poverty peaks. In these particular socio-economic environments smallholder irrigation schemes present an attractive opportunity for the development of local livelihoods. They can be used to increase and diversify the livelihood activity of plant production, resulting in improved livelihood outcomes, either directly in the form of food or income for plot holders, or indirectly by providing full or partial livelihoods to people who provide goods and services in support of irrigated agriculture on these schemes

5.2.3 Methodology

This section summarizes techniques and processes that were followed during the data collection. The selected town was Mphumulo which is under the Maphumulo local municipality at ILembe district municipality and the villages that were interviewed are Mansomini and Its dry land location. Primary data was used to collect data and types of questions that were used are close-ended questions.

A structured questionnaire was used to attain further information about irrigation scheme and sugarcane production in rural livelihoods through the interviews and the number of the interviewee was 100. The study makes use of graphs, tables and descriptive statistics to analyze data. Descriptive statistics is used in the analyses of demographic information and socio economical factors while graphs and tables are also used to analyze other relevant information stochastic frontier analysis (SFA) was used to determine the contribution of sugarcane production to household income and food security.

5.3 Conclusion

The results of the study conducted at Maphumulo (Mansomini irrigation scheme) shows that most of the rural people were old, married, uneducated and unemployed. This has a huge impact on managing the irrigation scheme and production of sugarcane because most of them have no knowledge about better farming and this affects the performance of irrigation scheme. The results show that sugarcane production makes important contributions to the economy and is vital to livelihoods. All the households that were interviewed has sugarcane plot and most of them has irrigating their sugarcane plots while few doesn’t. But all household were marketing their sugarcane produce at Gledhow mill which is about the same distance for both of them.

Only few household were employed, most of the household were solely dependent on pension and social grants. The study reveals that small-scale farmers from Mansomini and its dry land have the lack of inputs and government funding. It is also revealed that Mansomini irrigation scheme household’s gets more profit from their sugarcane production even though they have to pay for water and electricity but they make 40tons more than its dry land. Challenges for both villages are:

(1) fails to use their land to its maximum
(2) Fails to control the contractors
(3) Fails to use the benefit of the size of their household (as extra labour)

5.4 Recommendations

Rural areas, in general, continue to experience tough economic times in poverty levels, income, employment, education, and other indicators of well-being. Farmers’ markets especially sugarcane may offer a community economic development tool to help close those gaps. Local development officials can play a major part in supporting these facilities. Maphumulo has a population of 194 908 with a sex rate of 46 male and 54 female. Unemployment rate of 49.3% including youth unemployment of 59.9% with a growth of 0.3%. irrigating sugarcane is always advisable.

Smallholder farmers have inadequate knowledge about marketing. This discourages farmers because they have insufficient knowledge on how markets operate. If the farmers can have adequate knowledge on how markets work, this will improve the quality of their produce. Therefore the government should provide farmers with training about marketing of their products and producing high quality sugarcane.. In communities that do have marketing facilities, most of them are in poor state due to inability of farmers to collaborate in maintaining them (Frisch, 1999). Rural farmers have poor negotiating skills, these constraint farmers to make contractual arrangement with their buyers. The farmers should improve their negotiating skills as that will make them to be able to negotiate prices and how much quantities they should supply their buyers.

Extension officers must also play a role using the recent extension approach of participatory rural appraisal through discussing with farmers and empowering the farmers in identification of sugarcane marketing problems and solutions. Marketing agents should provide information related to price and market demand to farmers directly or indirectly through extension officers. Small-scale farmers should make sure that farmers contact with Extension workers. If they do so, they are standing at a better chance of being assisted by the government in terms of funding their infrastructure and production inputs. The solution to the challenges that face small-scale farmers and their support service providers is to consolidate farming efforts and provide a unified support service.

To this end the Kwazulu Natal provincial Department of Agriculture and Environmental Affairs (DAEA) and the South African Sugarcane Research Institute (SASRI) have for the past 10 years participated in a ‘Joint Venture’ (JV) partnership in providing services and information to farmers. According to Owens and Eweg (2002), “The JV is not pushing sugar, it is pushing development. Professional and well-informed extension workers are able to improve the awareness and increase the knowledge base of the emerging farmer.

The Joint Venture’s main objective is to facilitate the speedy dissemination of information on new research to the growers. The extension officers act as a bridge between the researchers and the farmers. Since SASRI conduct researches on new technology aimed at improving the productivity of sugarcane, any new innovation that is shown to make a difference to sugarcane farmers is then delivered to farmers through extension officers.

To improve the technology from small scale growers' point of view, extension officers from different areas that produce sugarcane are scheduled to attend Refresher Courses at SASRI to train them on different aspect of sugarcane production. When there is newly established technology, such as invention of a new variety of sugarcane that is resistant to drought and diseases. This helps small scale growers to improve the quality of their sugarcane and increases the yield.

LIST OF REFERENCES

ADAMS D.W & FICHETT D (1992). Informal finance in Low-income countries, Westview press, Colarado

ADAMS D.W (1988). The conundrum of successful projects in floundering rural financial markets. Economic development and cultural change, 8:347 – 366.

ADESINA A.A. AND BAIDU-FORSON J. (1995). Farmers‟ perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics 13: 1–9.

ADESINA A.A. AND ZINNAH M.M. (1993). Technology characteristics, farmers‟ perceptions and adoption decisions: A Tobit model application in Sierra Leone. Agricultural Economics 9: 297–311. Accessed 6 June 2009. Africa. 29 pp.

African Economy. University of Natal Press, Scottsville, South Africa. 47-62.

African Society for Agricultural Extension. South African Society for Agricultural Extension, University of Pretoria, South Africa. 221-228.

ALIBER M (2003) Chronic poverty in South Africa: incidence, causes and policies. World

ALIBER M (2003) Chronic poverty in South Africa: incidence, causes and policies. *World Development***31** (3) 473-490.

ALIBER M and HART T (2009) Should subsistence agriculture be supported as a strategy to support rural food insecurity? *Agrekon***48** (4) 434-458.

Alice, South Africa. 547 pp.

ALING JM (1995) Access to land: getting the right mix and suggestions for making it happen. In: SINGINI R and VAN ROOYEN J (eds.) *Serving small-scale farmers: An* *evaluation of the DBSA's farmer support programmes*. Development Bank of Southern Africa, Halfway House. 147-158.

Altman, Nathaniel Altman& Mitchell Zuckoff (2009) – Palmistry: The Universal Guide

ARCUS GIBB (2004) Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes. Year 1 Progress Report, WRC Project No. K5//1463/4. Arcus Gibb, Berea, East London. 26pp.

ARCUS GIBB (2005) A comparative analysis of South African and international irrigation revitalisation approaches. Report No 10 (draft) of WRC Project K5/1464//4. Arcus Gibb, Berea, East London. 33pp.

ARCUS GIBB (2005) RESIS – The Limpopo program for the revitalisation of smallholder irrigation schemes: a description and critique. Report No 5 (draft) of WRC Project K5/1464//4. Arcus Gibb, Berea, East London. 77pp.

AVERBEKE VAN W AND TB KHOSA, 2007.The contribution of smallholder agriculture to the nutrition of rural households in a semi-arid environment in South Africa.Tshwane University of Technology, South Africa

AYALEW D, S. DERCON S, & GAUTAN M (2005). Property Rights in a Very Poor Country: Tenure Insecurity and Investment in Ethiopia. Global Poverty Research Group Working Paper, GPRG-WPS-021.

Bacha & Jasper Stromback (2011) – Materials Development in Language Teaching

Bacha ., 2011; Principles, approaches and guidelines for the participatory

BACKEBERG GR (2003) Water usage and irrigation policy. In: NIEUWOUDT L and GROENEWALD J (eds.) *The challenge of change: Agriculture, land and the South African economy*. University of Natal Press, Pietermaritzburg.149-170.

BACKEBERG GR (2003) Water usage and irrigation policy. In: Nieuwoudt L and Groenewald J (eds.) *The Challenge of Change:Agriculture, Land and the South African Economy*. University of Natal Press, Scottsville, South Africa. 149-170.

BACKEBERG GR (2006) Reform of user charges, market pricing and management of water: problem or opportunity for irrigated agriculture.*Irrig. Drain*. **55** 1-12.

BACKEBERG GR (2006) Water institutional reforms in South Africa.*Water Pol.* **7** 107-123.

BACKEBERG GR (2006a) Reform of user charges, market pricing and management of water: problem or opportunity for irrigated agriculture? Irrigation and Drainage **55** (1) 1-12.

BACKEBERG GR (2006a) Reform of user charges, market pricing and management of water: problem or opportunity for irrigated agriculture? *Irrigation and Drainage***55** (1) 1-12.

BACKEBERG GR (2006b) Personal e-mail communication from Dr GR Backeberg, Programme Director Agricultural Water at the Water Research Commission, Rietfontein, Pretoria, 26 October.

BACKEBERG GR and GROENEWALD JA (1995) Lessons from the economic of irrigation development for smallholder settlement in South Africa. *Agrekon* **34** (3)167-171.

BACKEBERG GR and GROENEWALD JA (1995a) A market directed approach for the efficient and equitable rehabilitation of government water schemes. In: *Proc. Southern African Irrigation Symp.* 4-6 June 1991, Durban. WRC Report No. TT 71/98. WatResearch Commission, Pretoria, South Africa. 371-380.

BACKEBERG GR and GROENEWALD JA (1995b) Lessons from the economic history of irrigation development for smallholder settlement in South Africa. *Agrekon* **34** (3) 167-171.

BACKEBERG GR, BEMBRIDGE TJ, BENNIE ATP, GROENEWALD JA, HAMMES PS, PULLEN RA and THOMPSON H (1996) *Policy proposal for irrigated agriculture in*

South Africa. WRC Report KV96/96. Water Research Commission, Rietfontein, Pretoria.

BACKEBERG GR, BEMBRIDGE TJ, BENNIE ATP, GROENEWALD JA, HAMMES PS, PULLEN RA and THOMPSON H (1996) Policy Proposal for Irrigated Agriculture in South Africa.

BARAU, A.D., T.K. ATALA AND C.I. AGBO (1999). Factors affecting efficiency of resource use under large scale farming: A case study of dadin kowa irrigation project, Bauchi State. Nig. J. Rur. Econ. Soc., 1: 1-6.

BARRETT, C.B., T. REARDON, AND P. WEBB. 2001. "Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications", Food Policy, 26(4): 315-331.

BARRETT, J.C 1992. The economic role of cattle in communal farming systems in Zimbabwe. ODI Pastoral Development Network, ODI, London Paper 32b, Overseas Development Institute, London.

BATES R AND SOKHELA P (2003) The development of small-scale sugar cane growers: A success story? In: NIEUWOUDT L and GROENEWALD J (eds.) *The challenge of change: Agriculture, land and the South African economy*. University of Natal Press, Pietermaritzburg. 105-118.

BAYER W, ALCOCK R, GILLES P (2004). Going backwards? – Moving forward? – Nguni cattle in communal Kwazulu-Natal. “Rural poverty reduction through research for development and transformation”. A scientific paper presented at a conference held at Agricultural and Horticultural Faculty, Humboldt-Universität zu, Berlin. p.1-7.

BAYER WOLFGANG, RAURI ALCOCK, PETER GILLES 2006. Going Backwards? – Moving Forward? – Nguni Cattle in Communal Kwazulu-Natal. Available online on

BEARD, V.A. (2005) Individual determinants of participation in community development in Indonesia. Environment and Planning C: Government and Policy, 23(1), pp. 21–39.

BEHNKE, R.H 1985. Measuring the benefits of subsistence versus commercial livestock development in Africa, *Agricultural Systems* 16 . 109–135

BEINART W (2001) *Twentieth-century South Africa*. Oxford, Oxford University Press. 414pp.

BEINART W (2001) *Twentieth-Century South Africa*. Oxford University Press, Oxford. 414 pp.

BEKELE W AND DRAKE L (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area, *Ecol. Econ.* 46 (2003), pp. 437–451

BEMBRIDGE T (2000) Guidelines for Rehabilitation of Small-Scale Farmer Irrigation Schemes in South Africa. WRC Report No. 891/1/00. Water Research Commission, Pretoria, South Africa. 163 pp.

BEMBRIDGE T.J (1987). Agricultural Development Problems in Three Rural Areas of Ciskei. University of Fort Hare Press.

BEMBRIDGE TJ (1984) A Systems Approach Study of Agricultural Development Problems in Transkei. Ph.D. thesis, University of Stellenbosch, Stellenbosch, South Africa. 685 pp.

BEMBRIDGE TJ (1987) Requirements for successful irrigation projectswith special reference to the Tyefu Irrigation Scheme. *Ciskei*BEMBRIDGE TJ (1988) Considerations for successful irrigation schemes in developing areas. *Ciskei Agric. J*. **8** 15-20.

BEMBRIDGE TJ (1997) Small-scale farmer irrigation in South Africa: Implications for extension. *South African Journal of Agricultural Extension***26** 71-81.

BEMBRIDGE TJ (1997) Small-scale farmer irrigation in South Africa: Implications for extension. *S. Afr. J. Agric. Ext*. **26** 71-81.

BEMBRIDGE TJ (2000) Guidelines for rehabilitation of small-scale farmer irrigation schemes in South Africa. WRC report No 891/1/00. Water Research Commission, Pretoria. 163pp.

BEMBRIDGE TJ and SEBOTJA I (1992) A comparative evaluation of aspects of the human impact of three irrigation schemes in Lebowa. *S. Afr. J. Agric. Ext*. **21** 30-41.

BESLEY T (1995). Property Rights and Investment Incentives: Theory and Evidence from Ghana. *Journal of Political Economy* 103(5): 903-937.

BESTER J, MATJUDA L.E., RUST J.M. AND FOURIE H.J. 2003. The Nguni: case study In: FAO Community-based management of animal genetic resources – proceedings of the workshop held in Mbabane, Swaziland 7-11 May 2001. Rome: UNDP, GTZ, CTA, FAO. 45-68

BESTER, B.J., BELETE, A., & DONI, T.M., 1999. Application of Probit analysis to factors affecting small scale farmers' decision to participate in the farmer support program. A case study in the Eastern Cape of South Africa. Agrekon volume 38(1): 48-56.

BLANC C (2005) *Investigating the relationship between production and marketing in smallholder irrigation farming: A case study in Mpumalanga, South Africa.* CIRAD-Tera No 22/05. Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Pretoria. 69pp.

BLESS, C. & SMITH, H. C. (2000). Fundamentals of Social Research Methods: An African Experience (3rd Edition). Juta, Cape Town.

BOLDING A (2004) In Hot Water: A Study on Sociotechnical Intervention Models and Practices of Water Use in Smallholder Agriculture, Nyanyadzi Catchment, Zimbabwe. Ph.D. thesis, Research School for Resource Studies for Development, Wageningen University, Wageningen, The Netherlands. 398 pp.

BONABANA-WABBI, JACKLINE (1998). Assessing Factors Affecting Adoption of Agricultural Technologies: The Case of Integrated Pest Management (IPM) in Kumi District, Eastern Uganda. MS thesis, Virginia Polytechnic Institute and State University.

BOWEN, J.R. (1986). On the political construction of tradition: Gotong Royong in Indonesia. Journal of Asian Studies, 45(3), pp. 545–561. 112

BOYLES, S. 2002. Livestock and Water: Beef Information. Available on http://beef.osu.edu/library/water.html .Accessed on 20 December 2010.

BRASSELLE A, GASPART F, & PLATTEAU J (2002). Land tenure security and investment incentives: puzzling evidence from Burkina Faso. *Journal of Development Economics* 67: 373-418.

BRATTON M (1994). Land redistribution, 1980 – 1990. In Rukuni M & Eicher C.K (Ed.). Zimbabwe‟s Agricultural Revolution. University of Zimbabwe Publications. Harare, pp 70-88.

BRINK H.I (1996). Fundamentals of research methodology for health care professionals. Juta, Cape Town.

BRUWER J and VAN HEERDEN P (1995) Spotlights on irrigation development in RSA: the past, present and future. In: Southern African irrigation symposium, Durban, 4-6 June. WRC Report No. TT 71/95. *Proceedings.* Water Research Commission, Pretoria. 3-10.

BRUWER J and VAN HEERDEN P (1995) Spotlights on irrigation development in RSA: The past, present and future. In: *Proceedings of the Southern African Irrigation Symposium, 4-6 June 1991,*

BUNDY C (1988). *The rise and fall of the South African peasantry*. 2nd ed. David Philip, Cape Town. 276pp.

CAMPBELL B.M,DORE, D LUCKERT M, AND GAMBIZA, J. 1998. Economic comparisons of livestock production in communal grazing lands in Zimbabwe, Institute of Environmental Studies, University of Zimbabwe, Harare (1998).

Cape, South Africa. *Afr. J. of Agric. Res.* **4** (8) 689-694.

Carruthers & Kahn (1997) Developing Academic Literacies

CENTRAL STATISTICAL OFFICE (CSO), (1997). Statistical yearbook. Government Printers, Harare.

CENTRAL STATISTICAL OFFICE (CSO), (2002). Census 2002. Zimbabwe Preliminary Report. Government Printers, Harare.

CHAMBERS R and CONWAY G (1992) *Sustainable rural livelihoods: practical concepts for the 21st century*. IDS Discussion Paper 296. Institute of Development Studies, University of Sussex, Brighton. 28pp.

CHAVES B. & RILEY J (2001). Determination of factors influencing integrated pest management adoption in coffee berry borer in Colombian farms. *Agriculture, Ecosystems, and Environment* 87: 159-177.

CHIANU J.N & TSUJII H. (2004). "Determinants of farmers‟ decision to adopt or not adopt inorganic fertilizer in the savannas of northern Nigeria." *Nutrient Cycling in Agroecosystems* 70: 293–301

CHIMONYO M, KUSINA NT, HAMUDIKUWANDA H, NYONI O (1999). A survey on land use and usage of cattle for draught in a smallholder farming area of Zimbabwe. J. Appl. Sci. Southern Afr. 5(2): 111-121

CHIRON D (2005) Impact of the small-scale irrigated sector on household revenues of the rural community of Ga Mampa Valley. M Sc. Dissertation, University of Limpopo, Turfloop. 149pp.

COLLINS J (1995) Farm size and non traditional exports: Determinants of participation in world markets. *World Dev*. **23** (7)1103-1114.

COMMISSION FOR THE SOCIO-ECONOMIC DEVELOPMENT OF THE BANTU AREAS WITHIN THE UNION OF SOUTH AFRICA (1955) *Summary of the Report*. The Government Printer, Pretoria, South Africa.

CONRADIE B, ECKERT J, KLEYNHANS T and GRISSEL H (1996) Apple production systems by small-scale farmers in the Western Cape. *Agrekon* **35** (1) 1-11.

COUSINS, B 1994 . Livestock production and Agrarian reform in South Africa. In: R. Levinand and D. Weiner, Editors, *Community Perspectives on Land and Agrarian Reform in South Africa*, Macarthur Foundation, Chicago

CRAIS CC (1992) *The making of the colonial order: white supremacy and black resistance, 1770-1865*. Cambridge University Press, Cambridge. 284pp.

CROSBY CT, DE LANGE M, STIMIE CM and VAN DER STOEP I (2000) *A review of planning and design procedures applicable to small-scale farmer irrigation projects*. WRC Report No. 578/2/00. Water Research Commission, Pretoria. 241pp.

CROSBY CT, DE LANGE M, STIMIE CM and VAN DER STOEP I (2000) A Review of Planning and Design Procedures Applicable to Small-Scale Farmer Irrigation Projects. WRC Report No. 578/2/00.

DAVIS S (2003). Umthombo grower of the year awards. South African Sugar Journal86(3):6-7.

DE LANGE M (1994) *Small scale irrigation in South Africa*. WRC Report 578/1/94. Pretoria: Water Research Commission. 29pp.

DE LANGE M (1994) Small Scale Irrigation in South Africa. WRC Report No. 578/1/94. Water Research Commission, Pretoria, South

DE LANGE M, ADENDORFF J and CROSBY CT (2000) Developing Sustainable Small-Scale Farmer Irrigation in Poor Rural Communities: Guidelines and Check Lists for Trainers and Development Facilitators. WRC Report No. 774/1/00. Water

De SOUZA FILHO, YOUNG H.M.T & BURTON M.P (1999). Factors Influencing the Adoption of Sustainable Agricultural Technologies Evidence from the State of Espírito Santo, Brazil. *Technological Forecasting and Social Change* 60: 97-112.

DE WET C (2011) Where are they now? Welfare, development and marginalization in a former Bantustan settlement in the Eastern Cape, post-1994. In: Hebinck P and Shackleton C (eds.) *Reforming*

DEININGER K (2003). Land Policies for Growth and Poverty Reduction. A World bank Policy Research Report. Washington, DC: World Bank; Oxford and New York; Oxford University Press

DELGADO, C.L., ROSEGRANT, M., STEINFELD, H., EHUI, S. & COURBOIS, C. (1999). Livestock To 2020: The Next Food Revolution. Food, Agriculture And The Environment Discussion Paper 28. Washington, DC: IFPRI.

DENISON J & MANONA S, (2007). *Smallholder Irrigation;* The Water Wheel. http://www.wrc.org.za/Pages/DisplayItem.aspx?ItemID=6113&FromURL=%2fPages%2fK113

DENISON J (2006) *Data base on smallholder irrigation schemes in South Africa developed for* WRC Project No. K5//1463/4. Pretoria, Water Research Commission.

DENISON J and MANONA S (2007a) Principles, Approaches and Guidelines for the gParticipatory Revitalisation of Smallholder Irrigation Schemes: Volume 1 – A Rough Guide for Irrigation

DENISON J and MANONA S (2007b) Principles, Approaches and Guidelines for the Participatory Revitalisation of Smallholder Irrigation Schemes: Volume 2 – Concepts and Cases. WRC Report

DEPARTMENT OF AGRICULTURE (South Africa). 2006. 2006 s*trategic plan for the Department of Agriculture*. The Department, Pretoria. 86pp.

DERESSA T, HASSAN R AND POONYTH D (2005). Measuring the impact of climate change on South African agriculture: the case of sugar-cane growing regions, Agrekon, 44 (4): 524–542.

Development Practitioners. WRC Report No. TT 308/07. Water Research Commission, Pretoria, South Africa. 114 pp.

Development: Approaches and Lessons from Developing and Transitional Countries. Earthscan, London. 93-109.

DOSS C.R. & MORRIS M.L. (2001). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. Agricultural Economics 25(1):27–39.

DOVIE DBK, WITKOWSKI ETF and SHACKLETON CM (2003) Direct-use value of smallholder crop production in a semi-arid rural South African village. *Agricultural Systems* **76** 337-357.

DU PLESSIS FJ and VAN DER STOEP I (2001) Evaluation of the Appropriateness and Management Requirements of Micro-Irrigation Systems in Small-Scale Farming. WRC Report No. 768/1/01. Water Research Commission, Pretoria, South Africa.167 pp.

DU PLESSIS FJ, VAN AVERBEKE W and VAN DER STOEP I (2002) *Micro-irrigation for smallholders: guidelines for funders, planners, designers and support staff in South Africa*. WRC Report TT 164/01. Water Research Commission, Pretoria. 68pp.

DU PLESSIS FJ, VAN AVERBEKE W and VAN DER STOEP I (2002) Micro-Irrigation for Smallholders: Guidelines for Funders, Planners, Designers and Support Staff in South Africa. WRC Report No. TT 164/01. Water Research Commission, Pretoria, South Africa. 67 pp.

Durban. WRC Report No. TT 71/98. Water Research Commission, Pretoria, South Africa. 3-10.

DUVEL G.H and Afful, D.B 1996. Socio cultural constraints on sustainable cattle production in some communal areas of South Africa, *Development Southern Africa* 13 (1996) (3), pp. 429–440.

DYKE LS, FISCHER EM AND REUBER AR (1992). An inter-industry examination of the impact of owner experience on firm performance. Journal of Small Business Management, 30(4): 72-87.

Earthscan, London, UK. 353-394.

EWEG M (2002). A public/private partnership for extension delivery in South Africa. Available on line: www.fao.org/sd/2002/kn1203a. Accessed on 20 / 08/ 2011.

FABIYI Y.L., IDOWU E.O. AND OGUNTADE A.E. (1991). Land tenure and management constraints to the adoption of alley farming by women in Oyo State of Nigeria. The Nigerian J. Agric. Ext. 6: 40–46.

FANADZO M, CHIDUZA C and MNKENI PNS (2009) Comparative response of direct seeded and transplanted maize (*Zea mays* L.) to nitrogen fertilization at Zanyokwe irrigation scheme, Eastern

FANADZO M, CHIDUZA C, MNKENI PNS, VAN DER STOEP I AND STEVENS J (2010) Crop production management practices as a cause for low water productivity at Zanyokwe Irrigation Scheme. *Water SA* **36** (1) 27-36.

FAURÈS, J-M, SVENDSEN, M and TURRAL, J (2007). Reinventing irrigation, In: Molden, D (ed.) *Water for Food Water for Life: A Comprehensive Assessment of Water Management in Agriculture*.

FEDER G (1985) The relationship between farm size and farm productivity: The role of family labour, supervision and credit constraints.*J. Dev. Econ*. **18** (2-3) 297-313.

FEDER G (1987). Land ownership security and farm productivity: Evidence from Thailand. *Journal of Development Studies 24(1):16-30.*

FEDER G, JUST E.R, & ZILBERMAN D (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change* 33:255-298.

FEDER, G. & SLADE R. (1984). The acquisition of information and the adoption of new Technology. *American Journal of Agricultural Economics (*66):312-320.

FEYNES D AND MEYERS F (2005). Attributes of small scale sugar cane contractors that influence their service quality in KwaZulu Natal. Agrekon 44(3): 402-422.

FOOD AND AGRICULTURAL ORGANISATION STATISTICS (FAOSTAT) (2002). FAO Statistical Databases. http://apps.fao.org/default.htm, Accessed 23 June 2008.

FOOD AND AGRICULTURE ORGANISATION (FAO), (1997a). *Smallholder irrigation and poultry development in Zimbabwe: A brief general overview.* A paper prepared by R.J. Chitsiko for the FAO.

FOOD AND AGRICULTURE ORGANISATION (FAO), (1997b). Summary of findings of missions in selected countries in East and Southern Africa. *Irrigation technology transfer in* 114

FOOD AND AGRICULTURE ORGANISATION (FAO), (2000). Socio-economic impact of smallholder irrigation development in Zimbabwe: Case studies of ten irrigation schemes. Food and Agriculture Organisation of the United Nations (FAO) Sub-Regional Office for East and Southern AfriCA (SAFR), Harare, Zimbabwe.

FOOD AND AGRICULTURE ORGANISATION (FAO), (2001). *International e-mail conference on irrigation management transfer.* INPIM/FAO, FAO Land and Water Digital Media Series No. 17. Rome.

FOOD AND AGRICULTURE ORGANISATION (FAO), (2002). Water Source of Food Security. E-mail conference organized by Land and Water Development Division, 13 September - 1 November 2002. Rome.

FOOD AND AGRICULTURE ORGANISATION (FAO), (2006). Fertilizer use by crop in Zimbabwe. Rome, Italy.

FORSON, J.B., (1999). Factors influencing adoption of land-enhancing technology in the Sahel: lessons from a case study in Niger. Agric. Econ. 20, 231–239.

FORTMANN L. (1998). Why Woman‟s Property Rights Matter. In Proceeding of the International Conference on Land Tenure in the Developing World. Cape Town: University of Cape Town.

GAVIAN S & FAFCHAMPS M (1996). Land Tenure and Allocative Efficiency in Niger. American Journal of Agricultural Economics, 78(2):460 – 471. 115

Gebregziabher, Morgan, Rohatgi & Waxman (2009) – Disparities in Myeloma

GIBB ARCUS (2004) Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes. Year 1 Progress Report, WRC Project No. K5//1463/4. Arcus Gibb, Berea, East London. 26pp.

GLADWIN, C.H., PETERSON, J.S. & UTTARO R. (2002). Agroforestry Innovations in Africa: Can They Improve Soil Fertility on Women Farmers‟ Fields? African Studies Quarterly 6: no 1&2. Internet site: http://web.africa.ufl.edu/asq/v6/v6i1a10.htm. (Accessed 06 June 2009).

GOULD B.W., SAUPE W.E. AND KLEMME R.M. (1989). Conservation tillage: the role of farm and operator characteristics and the perception of erosion. Land Economics 65: 167–182.

GOVERNMENT OF ZIMBABWE (GoZ) (2000). “The Accelerated Land Reform and Resettlement Implementation Plan (Fast Track).” Harare: Ministry of Lands, Agriculture, and Rural Resettlement.

H_DocumentsList.aspx%3fsu%3d7%26ct%3d2%26ms%3d2%253b63%253b.
Accessed 30 November 2009

HEBINCK P and MONDE N (2007) Production of crops in arable fields and home gardens. In: Hebinck, P and Lent PC (eds.) *Livelihoods and Landscapes: The People of Guquka and Koloniand Their Resources*. Afrika-Studiecentrum Series Vol. 9. Brill, Leiden, The Netherlands. 181-220.

HEBINCK P and VAN AVERBEKE W (2007) Rural transformations in the Eastern Cape. In: Hebinck, P and Lent PC (eds.) *Livelihoods and Landscapes: The People of Guquka and Koloni and Their Resources*. Afrika-Studiecentrum Series Vol. 9. Brill, Leiden, The Netherlands. 33-66.

HOLBROOK G (1996) Lessons to be learned from two irrigation schemes. *Dev. S. Afr*. **13** (4) 601-610.

HOLBROOK G (1998) Shoring up hydraulic despotism: Class, race and ethnicity in irrigation politics in the Eastern Cape Province, South Africa. *J. Contemp. Afr. Stud*. **1998** 117-132.

HOPE RA, GOWING JW and JEWITT GPW (2008) The contested future of irrigation in African rural livelihoods – Analysis from a water scarce catchment in South Africa. *Water Pol.* **10** 173-192.

HOUGHTON DH (1955) Life in the Ciskei: A Summary of the Findings of the Keiskammahoek Rural Survey 1947-51. SA Institute of Race Relations, Johannesburg, South Africa. 72 pp.

Howe, Laure Kirszner & Stephen Mandell (2012) – The wodsworth handbook

http://dx.doi.org/10.4314/wsa.v37i5.17 Available on website http://www.wrc.org.za

http://www.tropentag.de/2004/abstracts/full/326.pdf Accessed on 07 Dec. 10

HUSSAIN SS BYERLEE D AND HEISEY PW (1994). Impacts of the training and visit extension systems on farmers, knowledge and adoption of technology. Agricultural Economics, 10(1): 39-47.

INOCENCIO A, SALLY H and MERREY DJ (2003) Innovative Approaches to Agricultural Water Use for Improving Food Security in Sub-Saharan Africa. IWMI Working Paper 55.International Water Management Institute, Colombo, Sri Lanka.18 pp.

IPTRID (2000) Affordable Irrigation Technologies for Smallholders: Opportunities for Technology Adaptation and Capacity Building. FAO, Rome. 35 pp.

ISENEKE DEVELOPMENTS (2004) Potential of Sustainable Irrigation in Black Development Communities. WRC Report No.1138/1/04. Water Research Commission, Pretoria, South Africa.

ISSN 0378-4738 (Print) = Water SA Vol. 37 No. 5 WRC 40-Year Celebration Special Edition 2011

ISSN 1816-7950 (On-line) = Water SA Vol. 37 No. 5 WRC 40-Year Celebration Special Edition 2011 807 Research Commission, Pretoria, South Africa. 59 pp.

KAMARA A, VAN KOPPEN B and MAGINGXA L (2001) Economic viability of small-scale irrigation systems in the context of state withdrawal: The Arabie scheme in the Northern Province of South Africa. In: *Proc. Second WARSFA/Waternet Symposium:Integrated Water Resource Management: Theory, Practice, Cases*.October 30-31, 2001, Cape Town, South Africa. 116-128.

KEETELAAR EG (2004) *Combining approaches to assess economic viability and institutional arrangements in smallholder irrigation schemes: A case study in the Mauluma Irrigation Scheme, Limpopo Province, South Africa*. CIRAD-Tera No 02/05. Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Pretoria. 144pp.

KHOSA TB (2003) Evaluation of the Drum and Drip micro-irrigation system for vegetable production in home gardens. M-Tech dissertation, Technikon Pretoria. 265 pp.

KHUVUTLU I and LAKER MC (1993) Identifying constraints and opportunities for farmers at middle Letaba Irrigation Project using a low cost appraisal approach. *FSR-E S. Afr. Newsletter* **5** 6-16.

KIRSTEN JF AND VAN ZYL J (1998). Defining Small-scale Farmers in the South African Context. Agrekon, 37(4):560-570.

KUNKEL PL, PETERSON JA AND MITCHELL JA (2009).Financing the Farm Operation. Available online at:http://mn4h.com/distribution/businessmanagement/ pdf. accessed on 10 September 2011.

LAHIFF E (2000) *An apartheid oasis? Agricultural and rural livelihoods in Venda*. Frank Cass Publishers, London. 320pp.

LAHIFF E (2000) *An Apartheid Oasis? Agricultural and Rural Livelihoods in Venda*. Frank Cass Publishers, London. 299 pp.

LAKER MC (2004) Development of a General Strategy for Optimizing the Efficient Use of Primary Water Resources for Effective Alleviation of Rural Poverty. WRC Report No.KV149/04. Water Research Commission, Pretoria, South Africa.187 pp.

LAKER MC (2004) *Development of general strategy for optimizing the efficient use of primary water resources for effective alleviation of rural poverty*. WRC Report No KV149/04. Water Research Commission, Pretoria. 187pp.

LAKER, MC (2005) Best management practices for small-scale subsistence irrigation farming through participatory adaptive research: Report on a visit to Dzindi Irrigation Scheme. WRC project K5/1464//4. Department of Crop Sciences, Tshwane University of Technology, Pretoria.

Land and Resource Use in South Africa: Impacts on Livelihoods. Routledge, Milton Park, Abingdon, UK. 294-314.

Land Management for Sustainable Irrigated Agriculture. 4-8 April 2006, Cukurova University, Adana, Turkey. [CD ROM].

LANKFORD BA (2004) Irrigation improvement projects in Tanzania:Scale impacts and policy implications. *Water Pol.* **6** 89-102.

LANKFORD BA and GILLINGHAM P (2001) The impacts of irrigation improvement programmes. Paper presented at the 1st National Irrigation Conference, Morogoro, Tanzania. 20-22 March, 2001.

LE GAL S AND REQUIS G (1999). Sugarcane development scenario in KwaZulu Natal. Available on line: www.sasa.org.za/uploads/sasri. Accessed on 27/ 07/ 2011.

LEGOUPIL JC (1985) Some Comments and Recommendations about Irrigation Schemes in South Africa: Report of Mission, 11 February - 3 March 1985. Water Research Commission, Pretoria,

Legoupil, Oral Buyukozturk, Mehmet Ali Tasdemir & Oguz Gunes (2012) – Nondestructive Testing of Materials & Structurs

LETSOALO SS and VAN AVERBEKE W (2005) Sharing the water: institutional and organisational arrangements at Dzindi Irrigation Scheme in South Africa. South African Journal of Agricultural Extension **34** (1) 34-43.

LETSOALO SS and VAN AVERBEKE W (2005a) Sharing the water: Institutional and organisational arrangements at Dzindi Irrigation Scheme in South Africa. *S. Afr. J. Agric. Ext*. **34** (1) 34-43.

LETSOALO SS and VAN AVERBEKE W (2005b) Strategies for successful smallholder farmers' collective action: Case of DzindiIrrigation Scheme. In: *Proc. 39th Annual Conference of the South*

LETSOALO SS and VAN AVERBEKE W (2006a) Infrastructural maintenance on smallholder canal irrigation schemes in the north of South Africa. *Proc. International Symposium on Water and*

LETSOALO SS and VAN AVERBEKE W (2006a) Water management on a smallholder canal irrigation scheme in South Africa. In PERRET S, FAROLFI S and HASSAN R (eds.) *Water governance for sustainable development: Approaches and lessons from developing countries*. Earthscan, London. 93-110.

LETSOALO SS and VAN AVERBEKE W (2006b) Infrastructural maintenance on smallholder canal irrigation schemes in the north of South Africa. In: YAZAR A, GENÇEL B and TEKIN S (eds.) International Symposium on Water and Land Management for Sustainable Irrigated Agriculture, Adana, Turkey, Cukurova University, 4-8 April 2006. *Proceedings* [CD-Rom). Cukurova University, Adana, Turkey, no page numbers.

LETSOALO SS and VAN AVERBEKE W (2006b) Water management on a smallholder canal irrigation scheme in South Africa. In: Perret S, Farolfi S and Hassan R (eds.) *Water Governance for Sustainable*

LETSOALO SS and VAN AVERBEKE W (2006c) Community-based routine maintenance of smallholder canal infrastructure: achievable goal or pipe dream? Paper presented at the 2nd SANCID symposium, 15-17 November 2006, Swadini Aventura.

LIPTON M (1996) Rural reforms and rural livelihoods: The context of international experience. In: Lipton M, De Klerk M and Lipton M (eds.) *Land, Labour and Livelihoods in Rural South Africa, Volume*

MACHETE CL, MOLLEL NM, AYISI K, MASHATOLA MB, ANIM FDK and VANASSCHE F (2004) Smallholder Irrigation and Agricultural Development in the Olifants River Basin of LimpopoProvince: Management Transfer, Productivity, Profitability and Food Security Issues. WRC Report No. 1050/1/04. Water Research Commission, Pretoria, South Africa. 112 pp.

Machete,Christopher Robichaud & Mireya Mayor (2011) – The walking Dead & Philosophy

MAGINGXA LL, ALEMU ZG and VAN SCHALKWYK HD (2009) Factors influencing access to produce markets for smallholder irrigators in South Africa. *Dev. S. Afr.* **26** (1) 47-58.

Magingxa, Dr W. Bleek, H. D. van Schalkwyk, & Jan A. Groenewald (2009) – Unlocking Markets to Smallholders.

MAKHURA M and MOKOENA M (2003) Market access for small-scale farmers in South Africa. In NIEUWOUDT L and GROENEWALD J (eds.) *The challenge of change: Agriculture, land and the South African economy*. University of Natal Press, Pietermaritzburg. 137-148.

MALCOM W (1999). Best management practice for small scale sugarcane growers. Agrekon 42 (4): 235-242.

MALOA MBJ (2001). Sugarcane, acase as development crop in South Africa. Available on line: http://www.sarpn.org.za/EventPapers/Land/200106. Accessed on 23/08/2011.

MANONA S, DENISON J, VAN AVERBEKE W and MASIYA T (2010) Proposed land tenure and land administration interventions to increase productivity on smallholder irrigation schemes in South Africa. Paper presented at 'Overcoming Inequality and Structural Poverty in South Africa: Towards Inclusive Growth and Development', 20-22 September 2010, Birchwood Hotel and Conference Centre, Johannesburg. URL: http://www.phuhlisani.com/oid%5Cdownloads%5CManona%20et%20al.pdf (Accessed 15 September 2011). 23 pp.

MASHATOLA MC (2003). Attributes of small scale sugarcane contractors that influence their service quality in Kwazulu Natal. Agrekon 44 (3): 402-422.

Matshe, Elizabeth Fensham, Margo Lanagan & Oscar Wilde (2009) – Tender Morsels

MAY J (2000) The structure and composition of rural poverty and livelihoods in South Africa. In: Cousins B (ed.) *At the crossroads: Land and agrarian reform in South Africa into the 21st century*. PLAAS, University of the Western Cape, Belville. 21-34.

MNKENI PNS, CHIDUZA C, MODI AT, STEVENS JB, MONDE N,VAN DER STOEP I and DLADLA RW (2010) Best Management Practices for Smallholder Farming on Two Irrigation Schemeshttp://dx.doi.org/10.4314/wsa.v37i5.17 Available on website http://www.wrc.org.za ISSN 0378-4738 (Print) = Water SA Vol. 37 No. 5 WRC 40-Year Celebration Special Edition 2011 808 ISSN 1816-7950 (On-line) = Water SA Vol. 37 No. 5 WRC 40-Year Celebration Special Edition 2011 in the Eastern Cape and KwaZulu-Natal through Participatory Adaptive Research. WRC Report No. TT 478/10. Water Research Commission, Pretoria, South Africa. 359 pp.MOHAMED SS (2006) Livelihoods of Plot Holder Homesteads at the Dzindi Smallholder Canal Irrigation Scheme. D. Tech. (Agric.) thesis, Tshwane University of Technology, Pretoria, South Africa.

MOHALE S (2008) Sugarcane small-scale farmers in South Africa. Available on line: http://foodbusinessinafrica-sugarcane-sugar.html. Accessed on 03/ 09/ 2011.

MOHAMED SS (2006) Livelihoods of plot holders on a smallholder canal irrigation scheme. D Tech. Agric. Thesis, Department of Crop Sciences, Tshwane University of Technology. 275pp.

Molden, Robert G., Weiner & Shelly E. B. (2007) – In the Peanut Gallery with Mystery Science

MONDE N (2003) Household food security in rural areas of central Eastern Cape: the case of Guquka in Victoria East and Koloni in Middledrift Districts. PhD Thesis, Department of Agricultural Economics, Extension and Rural Development, University of Fort Hare, Alice. 263pp.

MOOR B (2003). Strategic Plan for Value Chain Improvement Programme: Report 1. South African Cane Growers' Association working document.

Namara, Avant L'Amour, Apress L'Amour, Naidor & Samar (2008) – International Who's who of Authors & writers

No. TT 309/07. Water Research Commission, Pretoria, South Africa. 67 pp.

One: Western Cape. Indicator Press, Dalbridge, Durban, South Africa.

ORNE-GLIEMANN M (2008) Water users' associations from the users' perspective: Local water management at Thabina Irrigation Scheme, Limpopo, South Africa. *J. Transdisciplinary Res. S. Afr.*

ORTMANN G and MACHETE C (2003) Problems and opportunities in South African agriculture. In: Nieuwoudt L and Groenewald J(eds.) *The Challenge of Change: Agriculture, Land and the South*

OWENS ME AND EWEG MJ (2002). Extension Delivery for Small-scale Sugarcane Growers in South Africa: A Review of the Joint Venture. Case Study for the World Bank. Agrekon 29(1):3-9.

PERRET S (2002) Water policies and smallholding irrigation schemes in South: Africa: A history and new institutional changes. Water Policy **4** (3) 283-300.

PERRET S and TOUCHAIN E (2002) *SMILE:* A Simulation-Based Approach to Assess the Economic Viability of Smallholding Irrigation Schemes in South Africa: Conceptualisation and First Implementation. CIRAD –Tera num 02/02. University of Pretoria,South Africa. 24 pp.

RAMABULANA TR (2011) The rise of South African agribusiness:The good, the bad and the ugly. *Agrekon* **50** (2) 102-109.

REINDERS FB, VAN DER STOEP I, LECLER NL, GREAVESKR, VAHRMEIJER JT, BENADÉ N, DU PLESSIS FJ, VANHEERDEN PS, STEYN JM, GROVÉ B, JUMMAN A and ASCOUGH G (2010) Standards and Guidelines for Improved Efficiency of Irrigation

Water Use from Dam Wall Release to Root Zone Application: Guidelines. WRC Report No. TT 466/10. Water Research Commission, Pretoria, South Africa. 209 pp.

ROBINSON R AND SEXTON W (1994). On sources of measured technical efficiency: the impact of information. Agrekon 56(4): 730-738.

ROSSOUW JG (1989) The Impact of Imposed Technology on a Traditional Rural Society in Transkei: An Evaluation of the Ncora Irrigation Scheme. D.Sc. Agric. thesis, University of Fort Hare,

SCOTNEY DM and VAN DER MERWE AJ (1995) Irrigation: Longterm viability of soil and water resources in South Africa. In:*Proceedings of the Southern African Irrigation Symposium*. 4-6June 1991, Durban. WRC Report No. TT 71/98. Water ResearchCommission, Pretoria, South Africa. 50-60.

SHAH T, VAN KOPPEN B, MERREY D, DE LANGE M and SAMAD M (2002) *Institutional alternatives in African smallholder irrigation: Lessons from international experience with irrigation management transfer*. Research Report 60. International Water Management Institute, Colombo. 24pp.

SHAH T, VAN KOPPEN B, MERREY D, DE LANGE M and SAMAD M (2002) Institutional Alternatives in African

Shah, Stuart McClure, Saumil Shah & Shreeraj Shah (2002) – Web hacking

Smallholder Irrigation: Lessons from International Experience with Irrigation Management Transfer. IWMI Research Report 60. International Irrigation Management Institute, Colombo, SriLanka. 24 pp.

SOKHELA P, LOUW C AND HASTINGS H (1998). Support programme for cane contractors: Progress Report No 1, Report for the South African Cane Growers. Association, by the Institute of Natural Resources (INR), Pietermaritzburg, South Africa. South Africa. 35 pp.

South Africa. *Agric. Syst.* **98** 31-39.

SPEELMAN S, D'HAESE M, BUYSSE J and D'HAESE L (2008) A Measure for the efficiency of water use and its determinants, a case study of small-scale irrigation schemes in North-West Province,

SPEELMAN S, FRIJA A, PERRET S, D'HAESE M, FAROLFI S and D'HAESE L (2011) Variability in smallholders' irrigation water values: Study in North-West Province, South Africa. *Irrig. Drain.*

STATISTICS SA (2011) Consumer Price Index (PO141) Metropolitan Areas – All Items. URL: www.statssa.gov.za/keyindicators/cpi.asp.

Statistics SA (2011).

support of food security. Proceedings of an FAO sub-regional workshop, Harare, Zimbabwe. 14 - 17 April 1997, prepared by A. Kandiah.

THE COMMISSION OF ENQUIRY OF ENQUIRY APPOINTED BY THE EASTERN CAPE PROVINCE TO LOOK FOR SUSTAINABLE SOLUTIONS TO THE PROBLEMS OF LARGE EASTERN CAPE IRRIGATION SCHEMES (1996) Ncora Irrigation Scheme: Summary Report. Faculty of Agriculture and ARDRI, University of Fort Hare, Alice, South Africa. 16 pp.

TLOU T, MOSAKA D, PERRET S, MULLINS D & WILLIAMS CJ (2006) *Investigation of different farm tenure systems and support structures for establishing small-scale irrigation in long term viable conditions*. WRC Report No 1353/1/06. Water Research Commission, Rietfontein, Pretoria. 174 pp.

TLOU T, MOSAKA D, PERRET S, MULLINS D and WILLIAMS CJ (2006) Investigation of Different Farm Tenure Systems and Support Structure for Establishing Small-Scale Irrigation Farmers in Long Term Viable Conditions. WRC Report No. 1353/1/06.

TURRAL H, SVENDSEN M and FAURES JM (2010) Investing in irrigation: Reviewing the past and looking to the future. *Agric.Water Manage*. **97** 551-560.

UMHLABA (2010a) Smallholder Irrigation Development Guidelines.WRC Report No. TT 449/10, Water Research Commission,Pretoria, South Africa.

UMHLABA (2010b) A Review of Experiences of Establishing Emerging Farmers in South Africa: Case Lessons and Implications for Farmer Support within Land Reform Programmes. FAO, Rome,Italy. 81 pp.

ÜNLÜ M, KANBER R, CAKMAK EH and TÜZÜN M (2006) Evaluation of irrigation system performances in Turkey. In: Yazar A, Gençel B and Tekin S (eds.) International Symposium on Water and Land Management for Sustainable Irrigated Agriculture, Adana, Turkey, Cukurova University, 4-8 April 2006. *Proceedings* [CD-Rom). Cukurova University, Adana, Turkey, no page numbers.

VAN AVERBEKE W & MOHAMED SS (2006) Smallholder farming styles and development policy in South Africa: the case of Dzindi Irrigation Scheme.*Agrekon***45** (2) 136-157.

VAN AVERBEKE W & MOHAMED SS (2006) Smallholder farming styles and development policy in South Africa: the case of Dzindi Irrigation Scheme.*Agrekon***45** (2) 136-157.

VAN AVERBEKE W (2006a) Land tenure and land exchange on smallholder irrigation schemes: Dzindi, Khumbe and Rabali. In: Van Averbeke W (Comp.). Best management practices for small-scale subsistence irrigation farming through participatory adaptive research. WRC project K5/1464//4, Annual report 2005/06. Centre for Organic and Smallholder Agriculture, Department of Crop Sciences, Tshwane University of Technology, Pretoria. 97-109.

VAN AVERBEKE W (2006b) How do poor South African irrigators cope without a public land preparation service? In: YAZAR A, GENÇEL B AND TEKIN S (eds.) International Symposium on Water and Land Management for Sustainable Irrigated Agriculture, Adana, Turkey, Cukurova University, 4-8 April 2006. *Proceedings* [CD-Rom). Cukurova University, Adana, Turkey, no page numbers.

VAN AVERBEKE W (2008) Best Management Practices for Sustainable Subsistence Farming on Selected Irrigation Schemes and Surrounding Areas through Participatory Adaptive Research in Limpopo Province. WRC Report No. TT 344/08. Water Research Commission, Pretoria, South Africa. 318 pp.

VAN AVERBEKE W and MEI P (1998) *Evaluation of Masizakhe Agricultural Project: an irrigated community garden in Lingelihle Township, Cradock*. ARDRI Report 1/98. Agricultural and Rural Development Research Institute (ARDRI), University of Fort Hare, Alice. 54pp.

VAN AVERBEKE W and MOHAMED SS (2006) Smallholder farming styles and development policy in South Africa: The case of Dzindi irrigation scheme. *Agrekon* **45** (2) 136-157.

VAN AVERBEKE W, LETSOALO SS and MOHAMED SS (2006) Khumbe and Rabali. In: Van Averbeke W (Comp.). Best management practices for small-scale subsistence irrigation farming through participatory adaptive research, WRC project K5/1464//4: Annual report 2005/06. Centre for Organic and Smallholder Agriculture, Department of Crop Sciences, Tshwane University of Technology, Pretoria. 8-33.

VAN AVERBEKE W, M'MARETE CK, IGODAN CO and BELETE A (1998) An investigation into food plot production at irrigation schemes in central Eastern Cape. WRC Report 719/1/98. Water Research Commission, Pretoria. 206pp.

VAN AVERBEKE W, M'MARETE CK, IGODAN CO and BELETEA (1998) An Investigation into Plot Production at Irrigation Schemes in Central Eastern Cape. WRC Report No. 719/1/98.Water Research Commission, Pretoria, South Africa. 206 pp.

VAN DER STOEP I (2011) Irrigation Water Measurement – From Voluntary Management to Pending Regulations. Paper presented at

VAN ROOYEN CJ and NENE S (1996) What can we learn from previous small farmer development strategies in South Africa? *Agrekon***34** (4) 325-331.

VERMILLION DL (1997) *Impacts of irrigation management transfer: A review of evidence*. Research Report 11. International Water Management Institute, Colombo. 35pp.

Water Research Commission, Pretoria, South Africa. 174 pp.

Water Research Commission, Pretoria, South Africa. 240 pp.

WHITESIDE M (1998). Encouraging Sustainable Smallholder agriculture in Southern Africa in the Context of Agricultural Services Reform: Available online at: http://www.odi.org.uk/resources/download/2116.pdf. Accessed on 16/ 09/ 2011.

World Bank (1994, cited in Cousins, 2012)

WRC Report No. KV96/96. Water Research Commission, Pretoria,South Africa. 119 pp.

YOKWE SCB (2004) Investigation of the economics of water as used by smallholder irrigation farmers in South Africa. M Inst. Agrar. Dissertation, Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Pretoria. 71pp.

Zeiton, Diana K. Schwam & Robert O. B. (2011) – Frommer's New Orleans

Appendix 1 Questionnaire

UNIVERSITY OF FORT HARE,

DEPARTMENT OF AGRICULTURAL ECONOMICS

Assessment of the performance of smallholder irrigated sugarcane farming in Maphumulo municipality of KwaZulu-Natal Province

QUESTIONNAIRE FOR THE SMALL-SCALE SUGARCANE FARMERS

All information provided will be treated as STRICTLY CONFIDENTIAL

Questionnaire number Name of Interviewer Local Municipality

Village [ ] Smallholder irrigation farmer [ ] smallholder dryland farmer [ ]

A.HOUSEHOLD DEMOGRAPHIC INFORMATION

1. What is the size of your household? [ ]

2.Household composition

	Sex 1.-Male 2.-Female	**Age**	**Marital status** 1- Single 2-Married 3-Divorced 4-Widow	**Education level** 1-No formal Education 2-Primary 3-Secondary 4-Tertiary 5-Others	**Years spent at school**	**Occupation category** 1Retired 2-Unemployed 3- Farmer 4- Employee 5- Self employed 6- School/ pre-school	Specify Occupation type	Years of employment
Head								
Spouse								
Children								

B. LAND USAGE

1. How many years have been in farming?

2. Characteristics of the Land

3. What size of land is?

<table>
<tr><td rowspan="2">Type of plot
1-Homestead
(Water
source – e.g. tap at home,
communal tap,
borehole
spring etc)
2-Irrigated land
(fields)
(Water source,
reliability,
quantity, timing)
3-Dry land</td><td rowspan="2">Size and number
(Hectares,
acres,
square meters</td><td rowspan="2">Tenure system
1-PTO (communal)
2-Freehold
3-Quitrent
4-Lease
5-Other (e.g. share-cropping)
(Specify whether written agreements)</td><td rowspan="2">Time for which tenure has been held</td><td colspan="2">Fees
(For water, for land.
Specify how much and to whom)</td><td rowspan="2">Ploughing
1-Own tractor (specify whether hire it out, price, average income)
2-Hire tractor, price,
3-Hand tools
4-Employ labour (specify times, number of people and rates)</td></tr>
<tr><td>water</td><td>land</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
</table>

Currently irrigated		Extra land that can be irrigated		Available for further development	

C. WATER USAGE AND IRRIGATION

6. Are you are member of an irrigation scheme? Yes ☐ No ☐

7. Where do you obtain water for irrigation? a. Dam ☐ b. River ☐ c. Borehole ☐ d. taps? ☐

e.Harvested water ☐ f. Individual tanks ☐

8.What other source do you use besides the one above a. Dam ☐ b. River ☐ c. Borehole ☐ d. Taps ☐

e.Harvested water ☐ f. Individual tank. ☐

9. Do you pay for water a.Yes ☐ b. No ☐

10. If yes, how much are the rates ☐

11. Which type of irrigation do you use a. Sprinkler ☐ b. Drip irrigation ☐ c. Furrowing irrigation ☐
d. Pivot ☐

e. Others (specify) ☐

D. PRODUCTION INFORMATION

1. Fill in the following information on production

Crop name and	Area Planted (ha, square metres, acres…..)	Quantity harvested (Specify unit; tons, kg, bags	Unit price	Quantity sold (Specify unit Price/Unit	Quantity consumed, bartered or donated – specify which	Market outlet 1-local 2-shop 3-neighbours 4-hawkers, 5-contractor, 6-other	Season Planted 1-Summer 2-Autumn 3-winter 4-spring	Times Planted a year
1-Sugarcane								
2-Maize								
3-Carrots								
4-Cabbage								
5-Tomatoes								
6-other								

2. Who performs harvesting activity?

Harvesting contractor	1	Employ own labour	2

3. If harvesting contractor, is he/she doing a satisfactory job?

Yes	1	No	2

4. What are the harvesting contractor's shortcomings?..

They possess inefficient worn out machinery	1
They are not reliable	2
They are greedy	3
They lack business skills	4
Their service rates are overrated	5

5. How is the infrastructure?

Good condition	1	Reasonable condition	2	Bad condition	3
Road					
Water supply					
Electricity					
Other					

6. How many tons/ha sugarcane did you produce over the past 5yrs?.

Year	**Tons/ha**
2007	
2008	
2009	
2010	
2011	

7. Do you have any sugarcane production training or experiential training?..................................

Diploma in Agriculture	1
Senior Certificate in Sugarcane	2
Junior Certificate in Sugarcane	3
Short courses in sugarcane	4
Experiential training	5
No training	6

9.What other sources of income and how much a. Remittances [ ] b. off farming [ ] c .on farming [ ]

10. Fill in the input information

Crop name	**Input type**	**Quantity**		**Unit price**	**Source** Supplier (Specify) 1.Local shop 2.Store in town 3.Co-operative 4.Individual (friend, neighbour…) 5.Donation	Harvesting and marketing costs 1.Labour 2.Transport 3.Other
		purchased	**used**			
Sugarcane	1.Fertilizer					
	2.Seeds					
	3.Herbicides					
	4.Pesticides					
	5.Tillage					
	6.Labour					
	7.Other					

E. INSTITUTIONAL SUPPORT SERVICES

1**.** Is there any help from government?

Yes	1	No	**2**

2. If yes, what is he providing you with?

Provide fertilizer and herbicide	
Compensation for drought	
Compensation for run away fires	
Provides transport for cane haulage	
Subsidize new cane varieties	

3**.** Do you receive extension services?

Yes	1	No	2

4. If yes, from who provide extension service?

Government Extension Officers	1
Mill Extension Officers	2
South African Sugar Research Institute	3
South African Sugarcane Growers	4
Fellow Commercial Farmers	5

5. How often do you see the extension worker per week?...

6**.** What services does he/she provide?

Advice on crop production	1
Advice on Marketing	2
Advice on record keeping	3
Other (specify)	4

7. Do you use the advices you given by the extension workers?..

Yes	1	No	2

F. MARKETING INFORMATION MODULE

1. Who facilitates the sugarcane deliveries?...

2. Do you get updated about your sugarcane deliveries?

Yes	1	No	2

3. Who is responsible for giving updates?..

Government Extension Officers	1
Mill Extension Officers	2
Sugarcane Farmers Association	3
South African Sugarcane Growers Association	4
Sugarcane Development Officers	5
Mill Cane Committee	6

4. Do you receive market information prior to sales?

Yes	1	No	2

5. If yes, what is/are your source(s) of information?

Government Extension Officers	1
Mill Extension Officers	2
Sugarcane Farmers Association	3
South African Sugarcane Growers Association	4
Sugarcane Development Officers	5
Mill Cane Committee	6
Other (specify)	7

6. How long does it take to get the revenue from cane deliveries?...

Thank you for participating in this survey, your information is much appreciated.