

**Evaluation of the socio-economic performance of smallholder irrigation schemes  
in Idutywa village of the Eastern Cape Province**

**By**

**Phiwe Jiba (201000984)**

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**University of Fort Hare**  
*Together in Excellence*

**DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION**

**SCHOOL OF AGRICULTURE AND AGRIBUSINESS**

**FACULTY OF SCIENCE AND AGRICULTURE**

**UNIVERSITY OF FORT HARE (ALICE)**

**SOUTH AFRICA**

**Supervisor:**

**Prof Ajuruchukwu Obi**

**June, 2017**

## DECLARATION

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I hereby certify that this dissertation is the result of 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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## **DEDICATION**

I dedicate this dissertation to my family (mother, sisters, brothers, relatives and my late father).

## ABSTRACT

*South Africa and other African countries are faced with high levels of food insecurity and poverty levels as a result of slow growth of the macro economy and weak or sluggish rural development. Irrigation scheme development is seen as an important strategy to address the challenges faced by households in rural areas and restores growth and enhanced livelihoods. While the international experience shows that Irrigation schemes are potentially transformative of poor communities and have been operational for many years now, there is no marked improvement in living conditions of rural households in terms of livelihoods and income. This raises the question as to whether or not the schemes are viable from a socio-economic perspective and whether or not there are reasons for concern and revision of the policy framework for smallholder irrigation schemes. As a result of that, the broad objective of the study was to evaluate the contribution of smallholder irrigation schemes to household income and food security of rural households in Idutywa village of the Eastern Cape Province in South Africa. Specifically, this research investigated the major factors that influence their performance, impact of irrigation farming on rural livelihood and household food security as well as identifying the possible opportunities of production that would improve their performance*

*The study was carried out in Idutywa villages of the Eastern Cape Province in South Africa and employed survey data obtained from 107 households. The study employed a cross-sectional research design and the study employed stratified random sampling. The study made use of descriptive and inferential statistics to estimate the central tendency and dispersion as well as testing the hypothesis that there is a difference in the contribution between irrigators and non-irrigators using STATA and SPSS. Probit regression model was used to estimate factors that influenced the performance of smallholder irrigation schemes.*

*The descriptive statistics employed included means, percentages and frequencies on the socio-economic characteristics of households in the study areas. The results show that females were dominant with a representation of 66.7%. The majority of households*

were aged and the mean age was 65 years. High level of illiteracy in the project area was revealed by the data. The average number of years households spent in school was between 6 years to 10 years in school. Farming was found to be the major agricultural economic activity. Sixty-three (63%) were full time farmers. The results further show that household size ranges between 1 to 5 persons. The households were shown to be mostly dependent on social grant with household income hovering around R 1 000.

The results from propensity score matching revealed that irrigation exerts a positive impact on household income. This provides sufficient evidence that irrigation schemes do make a contribution to rural livelihoods through their effect on household income and food security. This implies that government should continue investing in irrigation schemes as part of a strategy to grow the rural economy and improve rural livelihoods. This is in line with the Agricultural Policy Action Plan (APAP) and National Development Plan (NDP) of South Africa. Probit analysis suggests that age of the households, household size and market were some of the key determinants that positively influenced households' decision to participate in smallholder irrigation schemes while access to credit had significant but negative effect on households' decision to participate in smallholder irrigation schemes.

Based on the findings highlighted above, it is recommended that addressing such barriers may create enabling conditions that would encourage households to access and participate more effectively in smallholder irrigation schemes. The implementation of policies that promote female participation in irrigation farming, equip farmers with entrepreneurial skills, and facilitate farmers' membership of associations will enhance the contribution of irrigation schemes to rural livelihoods. Moreover the study contributes further to knowledge on the importance of smallholder schemes to rural livelihoods.

**Key words:** Irrigation schemes, rural livelihood, participation, food security and household income

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## **LIST OF ACRONYMS AND ABBREVIATIONS**

ATE	Average Treatment Effect
ARDC	Agricultural and Rural Development Corporation
CBD	Central Business District
DAFF	Department of Agriculture, Forestry and Fisheries
DORA	Division of Revenue Act
DRDAR	Department of Rural Development and Agrarian Reform
FAO	Food and Agricultural Organization
FPSSI	Farmers Participating in Small Scale Irrigation
IMT	Irrigation Management Transfer
NFPSSI	Farmers not participating in small scale irrigation
PGDS	Provincial Growth and Development Strategy
PSM	Propensity Score Matching
SA	South Africa
SIS	Smallholder Irrigation Scheme
SPSS	Statistical Package for Social Sciences
WRC	Water Research Council

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background of the study**

Irrigation scheme can be defined as an agricultural project involving multiple holdings that depend on a shared distribution system for access to irrigation water and in some cases, on a shared water storage or diversion facility. The term irrigation scheme is also used more broadly to refer to a multitude of entities that correspond to this definition, when these entities share the same bulk transportation system (Van Averbeké *et al.* 2011). There is a perception that irrigation is a first step in promoting development in impoverished rural areas. In South Africa like in many other countries smallholder irrigation farming has long tradition; farmers primary used rivers and streams as a source of water to irrigate small plots for cultivation of grain crops and vegetables for home consumption (Ntsono, 2005). This is applied in the context not only of large schemes but also in the establishment of landless people as emergent farmers and the creation of plots and community gardens to promote food security both in deep rural areas and adjacent to major population centers.

The term smallholder or small-scale irrigation in South Africa specifically is used when referring to irrigated agriculture practiced by black people. According to Averbeké and Mohamed (2013) smallholder irrigation schemes have been categorized into four groups which are farmers on irrigation schemes, independent irrigation farmers, community gardeners and home gardeners. The water deficit caused by low and unreliable rainfall and high evaporative demand limits dry land crop production in most of South Africa. Irrigated agriculture presents an attractive alternative under these conditions. Irrigation refers to the artificial application of water to land for the purpose of enhancing plant production. It reduces or removes water deficit as a limiting factor in plant growth and makes it possible to grow crops where the climate is too dry for this purpose and to increase crop yields where plant available soil water is a yield limiting factor during parts or all of the growing season.

Smallholder irrigation schemes were developed in former homeland areas of South Africa during the apartheid era, mostly for community food supply purposes, (Perret 2002). Similarly study that was conducted by Hussain and Hanjra (2004) which point out that agricultural water/irrigation has been regarded as a powerful factor for providing food security, protection against adverse drought conditions, increased prospects for employment and stable income, and greater opportunity for multiple cropping and crop diversification.

In general small-holder farmers have limited access to resources (such as water and land) as a result of huge impact on low production hence they are still living under poverty line. In addition although irrigation is perceived as a method of boosting agricultural production many of smallholder irrigation schemes in South Africa are performing poorly. Namara *et al.* (2010) added that access to good irrigation allows poor people to increase their production and income, and enhances opportunities to diversify their income base, reducing vulnerability caused by the seasonality of agricultural production as well as external shocks. Thus, access to good irrigation has the potential to contribute to poverty reduction and the movement of people from ill-being to well-being. This study also seeks to analyze the contribution of smallholder irrigation schemes in Idutywa villages. In addition knowledge of such factors could assist effective location and design of new schemes. Before focussing on the study itself, it was deemed important to provide a background to African smallholder agriculture in South Africa in general and smallholder irrigation scheme development in particular.

## **1.2 Problem statement**

South Africa and other African countries are faced with high levels of food insecurity and poverty as a result of slow growth of the macro economy and sluggish rural development. As a result, irrigation scheme development is seen as an important strategy to address the challenges faced by households in rural areas and to restore growth and enhanced livelihoods. On other hand, international experience indicates that Irrigation schemes are potentially transformative of poor communities and have been operational for many years now. However there is no marked improvement in

living conditions of rural households in terms of livelihoods and income. The poor performance of many smallholder irrigation schemes in terms of productivity and economic impact in household food security and income has been largely attributed to socio-economic, political, climatic, edaphic and design factors, as well as lack of farmer participation (Fanadzo *et al.*, 2010). Gomo (2010) mentioned that major factors influencing welfare of smallholder irrigation schemes are their inability to quality produce to the markets; poor infrastructure; lack of production techniques as well as limited access to resources such as water and land. The constraints that impede the growth of smallholder irrigations schemes have also been attributed to lack of access to markets and technical expertise.

The poor performance of the existing irrigation schemes means that the objective of improved food security and welfare in rural livelihoods through irrigated agriculture is yet to be met. This raises the question as to whether or not the schemes are viable from a socio-economic perspective and whether or not there are reasons for concern and revision of the policy framework for smallholder irrigation schemes. High costs, imperfect access to information; services, suitable technology and capital costs are major constraints impending smallholder welfare in developing countries specifically, South Africa. The absence of innovative production implements which are needed in-order to increase yield of commodity produced and poor entrepreneurial skills which are important and required to make the efforts of farmers to be a success

South Africa has invested substantially in smallholder irrigation to benefit smallholder farmers in the less developed areas. There are more than 200 smallholder irrigation schemes in South Africa irrigating about 50 000 hectares and providing income to over 37 000 farmers (Machethe *et al.*, 2004). 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. With the economic value of water increasing, the need to meet environmental river basin requirements and to alleviate poverty, smallholder irrigation must be more productive. A key emerging strand in the development of smallholder agriculture in South Africa is the effort to integrate smallholders into corporate food retail value chains (Aliber *et al.*, 2013). On this



concept the private sector and government have a mutual agenda, which is to build a commercial smallholder class that does not require on-going financial support for survival, but which is able to stand on its own feet and compete in the market.

The general problem is the low performance of smallholder irrigation schemes, and the subsistence basis that prevents farmers from increasing their cash income, whereas cash cost are generally high (Ntsonto, 2005). It is often claimed that the evidence for this is the lack of access to markets which is considered to explain the apparent lack of positive response to economic incentives in the rural communities (Obi *et al.* 2015). This raises the question as to whether or not the schemes are viable from a socio-economic perspective in rural livelihood.

### **1.3 Research objectives**

The overall objective of this study is to analyze the socio-economic performance of smallholder irrigation schemes in Idutywa villages. The specific objectives are as follows:

- To assess the impact of access to land, capital and market on the performance of smallholder irrigation farmers
- To examine the impact of smallholder irrigation farming on rural livelihood
- To assess the impact of water and land availability on the future of smallholder irrigation farming

### **1.4 Research questions**

- What is the impact of smallholder irrigation schemes on rural livelihood
- What are the major impacts of smallholder irrigation farming on rural livelihood?
- What are the impact of water and land availability in smallholder irrigation schemes

## **1.5 Research hypotheses**

- Limited land, Lack of capital, access to markets access to incubation are the major factors that influences smallholder irrigation farming performance
- Access to water and markets are the major impact in smallholder irrigations
- Unavailability of dams and land are major impact

## **1.6 Justification of the study**

The study is important since it determines whether or not contributions by the irrigation schemes. If they are contributing to the economy, then the department can consider in the expansion or investing in smallholder irrigation schemes and also develop policies on financial assistance to irrigation schemes such as DORA. This study seeks to establish if the amount was worth it as far as contribution is concerned. The assumption is that irrigation schemes were also assisted with the irrigation equipment's as well as mechanization (tractors and trailers for spraying and transportation of the produce to the packing house. This study will establish if the financial and technical assistance towards these irrigation schemes yielded any contribution , as the projects only benefited few members of the community (as participants in the irrigation schemes). The study was also motivated by the following facts as reported in literature;

- The smallholder irrigation schemes have been criticized by economists because of their invisibility to rural households (Nilsson, 2001).
- Agricultural cooperatives are important rural organizations supporting livelihood development and poverty reduction (Getnet, 2012).

Against this background the study was therefore conducted to answer the following objectives; Limited land, Lack of capital, access to markets access to incubation are the major factors that influences smallholder irrigation farming performance, examine the impact of smallholder irrigation farming on rural livelihood and assess the impact of water and land availability on the future of smallholder irrigation farming

. The overall objective of this study is to analyse the contribution of the smallholder irrigation in rural livelihood of Idutywa villages.

### **1.7 Delimitations and limitations of the research**

The study was limited to Idutywa locations in the Eastern Cape Province due to lack of financial resources.

The study focused on these locations only and it will be focusing only on smallholder irrigation schemes. In addition there were no other factors that were considered on the villages beside the main key purpose of the study. However demographic profile of each household was forming of the interview questionnaire.

### **1.8 Organisation of the research**

This study consists of five chapters. The first chapter shows the background of the study and defining the problem statement, overall and specific objectives, research questions, research hypothesis and significance of the study. The literature review is presented in chapter two with relevant sub-headings which narrate more on the specific objectives. Chapter three consists of the description of the study area and the methodological approach used to achieve the set overall and specific objectives that are also narrated on the literature review. The chapter further gives more detail on data collection methods, fitted models and other analytical procedures. The presentation of results and discussion of the findings are done in chapter four. Lastly chapter five summarizes the study and provides conclusions and policy recommendations of the study.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The chapter is based on reviewing the studies which were conducted on similar titles to this study. Findings of such studies will also be indicated and discussed and fill the gaps. Such findings include the fact that, performance of irrigation schemes has the huge influence to rural livelihoods. However, it considers even if it doesn't have the influence or impact to the rural livelihoods when it comes to income and food security

#### **2.2 Overview of irrigation schemes in international**

According to Gomo *et al.* (2014), internationally, irrigation performance has been the subject of research in the agricultural sector for more than five decades. However the research that was conducted had a little impact to date, due to lack of collaborative implementation of recommendations on the part of irrigation stakeholders, among them farmers, policy makers and donors. Research has done in the point of view of the various stakeholders, yet the performance of irrigation schemes, especially in the communally-owned or managed smallholder schemes, has remained low. The performance of irrigation schemes of smallholder irrigation schemes is affected by a complex set of factors. An understanding of these variables can contribute towards enhancing the performance of smallholder irrigation schemes, improving the livelihoods of the rural poor and ensuring sustainability of the schemes.

In West Africa, the urban population is taking over the rural areas. In addition informal irrigation in urban and peri-urban areas taking advantage of the growing urban markets and the common lack of refrigerated transportation and storage complements rural agriculture in feeding the cities with fresh vegetables; this provides a state of the art overview on irrigated urban agriculture in the West Africa sub-region. In some countries, like Ghana, informal irrigation in the rural-urban

interface covers an area greater than the area under formal irrigation in the whole country (Drechsel *et al.*, 2006). This calls for a policy shift as informal irrigation receives so far little recognition and is facing many constraints. Especially in urban areas, tenure security is usually low and investments in infrastructure, minimal. Manual water fetching with watering cans is most common. Appropriate sites with access to safe irrigation water are rare, particularly in and downstream of the cities. Many farmers are poor migrants from rural areas where groundwater is not accessible.

## **2.3 Overview of irrigation schemes in South Africa**

### **2.3.1 Status of smallholder irrigation scheme**

The objective of this dissertation was to assess the current status of these schemes, using livelihood as a cross-cutting theme. 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 (Averbeke and Mohamed, 2013). In addition smallholder irrigators have been categorised into four groups, namely; farmers on irrigation schemes, independent irrigation farmers, community gardeners and home gardeners. Most smallholder irrigation schemes are found in the former homelands of South Africa, where the incidence of poverty peaks (May, 2000; Aliber, 2003). In these particular socio-economic environments smallholder irrigation schemes present an attractive opportunity for the development of local livelihoods. When viewed from this livelihood perspective, smallholder irrigation schemes are assets. 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. Averbeke and Mohamed (2013) estimated the number of South African smallholder irrigators to range between 200 000 and 250 000, most of smallholder irrigation schemes were farming very small plots, primarily to provide food for home consumption.

### **2.3.2 Role of irrigation schemes**

Investing in smallholder irrigation is one of the most effective ways to develop smallholder agriculture and thus contribute to poverty alleviation. According to Machethe *et al.* (2004), the contribution of irrigation schemes to poverty alleviation has been demonstrated in countries such as Bangladesh where growth in public sector funded canal irrigation and private sector funded tube-well irrigation have played a major role. Machethe *et al.* (2004) also concluded that smallholder agriculture intensification by improving the management and productivity of land and water in a sustainable manner is a solution for both poverty reduction and agriculture growth in sub-Saharan Africa

In spite of such a relatively small contribution, it is believed that those schemes could play an important role in rural development, since they can potentially provide food security, income and employment opportunities. Moreover, their location in remote, poor, semi-arid areas represents a potential for poverty alleviation and food security in such areas, even though they represent a small percentage of irrigated land at country level. The poor performance of smallholder irrigation schemes means that farmers have not been able to produce enough yields to match the demand for food. In order to match the demand for food, it will be necessary to increase the productivity because of the scope for increasing food production by increasing the area under cultivation is limited. The growing scarcity of water will make it extremely difficult to expand food production by increasing the area under irrigation

### **2.4 The structure of production of land**

Increased pressure on agricultural land for use other than agriculture makes it very important to protect more especially high potential agricultural land for the exclusive use by agriculture. This is especially important if one takes into consideration the harsh environmental conditions of South Africa and the fact that only about 4% of the country's land is regarded as high potential agricultural land. It should also be emphasised that a large percentage of the high potential agricultural land in the

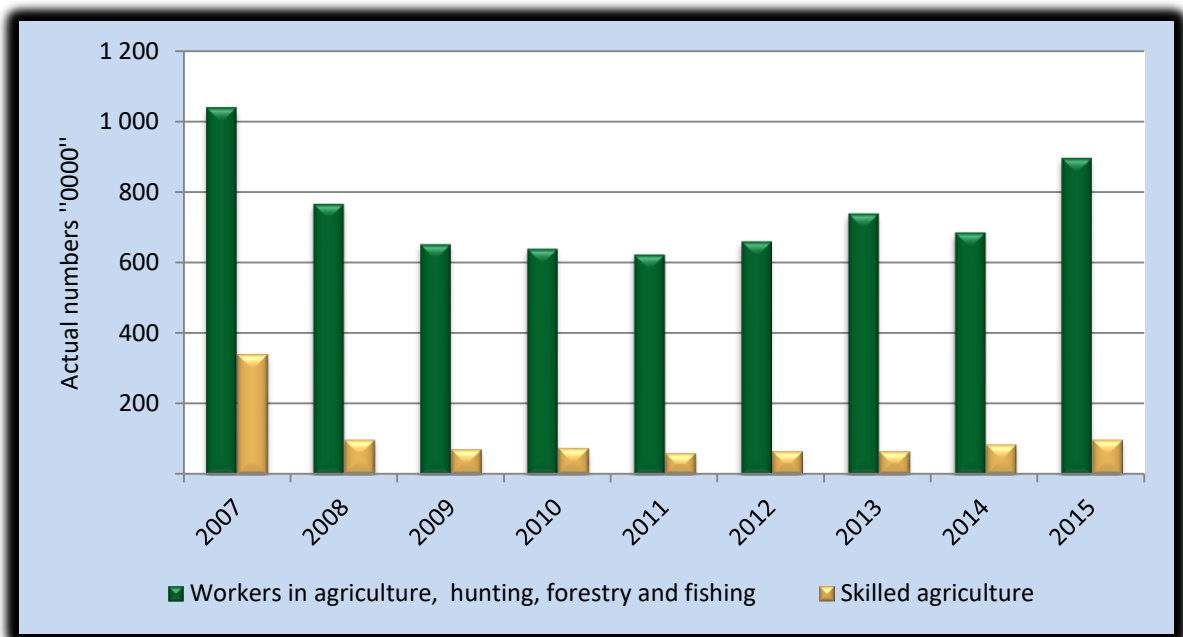
country has already been lost to other land uses and is therefore no longer available to agriculture (DAFF, 2011).

## **2.5 Opportunities and benefits of irrigation scheme's**

According to Machete *et al.* (2004) agricultural projects have been regarded as the most appropriate tools for promoting rural development in developing countries. These agricultural project approaches has been embraced in many developing countries including South Africa. In particular, smallholder irrigation projects were established in the former homelands to promote food self-sufficiency and to contribute to rural development. In addition to creating employment opportunities, it was hoped that smallholder farmers would improve their productivity and, thus, produce not only for home consumption but also for the market. Although there have been some successes, the overall record of smallholder irrigation projects in achieving their intended objectives in the former homelands has been disappointing. Famanda (2014) indicated that irrigation can transform the land and landscape of the society. In addition research has traced the development and social impacts of community irrigation schemes, attitudes and adaptations for farm families and subsequent ownership changes and it is also indicated by farm technology.

### **2.5.1 Employment formation**

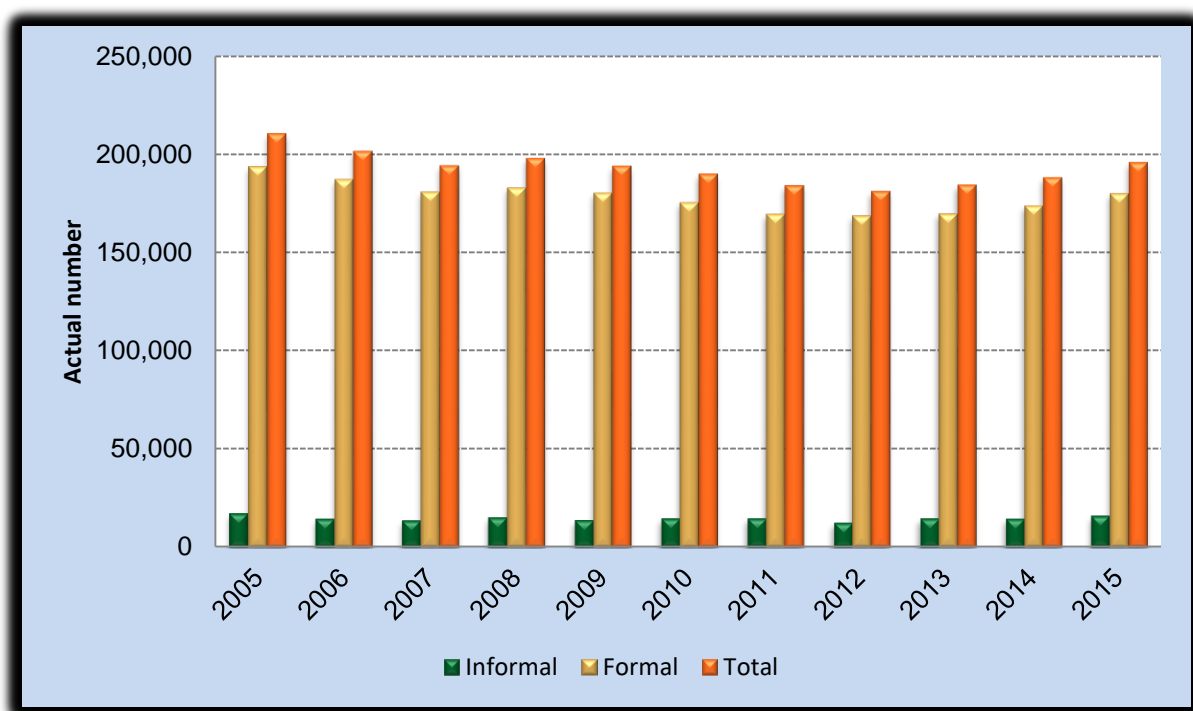
Famanda (2014) indicated that the objective of the government for establishing the irrigation schemes was to settle farmers in order to promote the development of entrepreneurial skills of the farmers, optimal utilization of existing infrastructure and the generation of socio-economic benefits for the communities adjacent to the schemes. The tangible objectives are to provide employment, generate income for the local communities, thereby alleviating poverty and stimulating economic growth and development.



**Figure 2.1: Employment status in Agriculture**  
**Source: SAGIS, 2017**

Figure 2.1 depicts the employment in agriculture, hunting, forestry and fishing in South Africa from the period of 2007-15. The skilled labour showed moderation by 15% in 2015 following a growth of 28% in the previous year. However workers in agriculture, hunting, forestry and fishing rebounded by 30% in 2015 following a contraction of 7,2% in 2014. Furthermore the overall figure showed a fluctuation over the given period but showing positive record. The employment status of residents provides information about the numbers of residents of a particular area who is wage and salary earners, employers, self-employed and unpaid family workers. This information can be used to assess changes in the scale of local enterprises and to ascertain if more jobs are being generated in the area whether they are on farm or in agricultural support industries.





**Figure 2.2: Distribution of number of employment on food products**  
**Source: Quantec EasyData (2017)**

Owing to a significant growth output and export, jobs were created in the food division during 2015. Total employment on agricultural food products (formal and informal) increased modestly by 4,0% following a growth of 2,1% in the previous year. Similarly formal employment alone also increased modestly by 3,5% from a 2,4% growth in 2014 (see Figure 2.3).

### **2.5.2 Infrastructure development for improving smallholder irrigation**

According to Bembridge (2000) and Crosby *et al.* (2000) rehabilitating the irrigation infrastructure, providing effective extension services and facilitating access to information are public interventions that will undoubtedly be of benefit to smallholders and they will not be discussed any further. Instead, the focus will be on selected opportunities for improvement that have received less attention. 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, adequacy of land and water, agricultural traditions, historical involvement, institutional arrangements and social organisation, to name but a few. The opportunities for improvement of smallholder irrigation schemes need to be considered within the context of diversity among schemes.

### **2.5.3 Institutional development for improved access to land and water**

There is 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 (Tlou *et al.*, 2006). 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

### **2.5.4 Land preparation**

Mechanisation is an important concern on smallholder irrigation schemes, particularly to farmers primarily engaged in farming for own consumption, because they invest cash, mostly obtained from sources other than farming, to produce food. In the past, smallholder irrigators had access to public tractor services, which may not have been particularly efficient, but they were cheap (Lahiff, 2007). When this service was withdrawn, mechanised land preparation services were only available from private providers. For various reasons, including the rise in the cost of fuel, the relative contribution of mechanised land preparation to total variable costs of production (excluding labour) on smallholder schemes has increased substantially

## **2.6 Factors that influence the performance of smallholder irrigation farming**

Smallholder irrigation schemes also face conflicting roles in trying to control and provide direction, these roles involve the boards behaving in a different way and the role requires the board to ensure that the organization acts in the interest of its members but the performance role requires them to improve (Nkhoma, 2011). Agriculture is a key sector in the economy because it contribute immensely to agriculture sector itself have been circumvented in the vicious cycle of poverty as they face various agricultural production and marketing challenge (Matabi, 2012). However smallholder farmers have been encouraged to embrace agribusiness various political and economic areas. Similarly agricultural cooperatives have confidence in the cooperative model in improving their livelihoods, they are however displeased with their own poor performance and worried of the high probability of their un-sustainability, specifically agricultural cooperatives worsening performance depict that member have control management and accumulated investment are below the economic optimum.

### **2.6.1 Access to water**

The word irrigation refers to applying water artificially to land aiming at increasing production yield. Irrigation decreases and or eliminates water shortage as a restraining factor in development of the plant and enables crop production areas of drought and to increase crop harvests in areas where the water in the soil is not enough for plant growth and also extend growing season. According Van Averbek *et al.* (2011) smallholder irrigation is approximately 0.1 m in ha (+/- 8%) of the overall land under irrigation in South Africa. The water shortage is the result of little and unpredictable rainfall and too much water loss evaporating to the air restrict dry-land crop production in most parts of South Africa.

According to Namara *et al.* (2010) having access to use water for irrigation increases size of land that is being cultivated, ensure crop strength for survival and reduce losses in crop production. In addition to that Hussain and Wijerathna (2004) say that irrigation helps to reduce poverty through increasing the chances of getting high and steady profits and through growing many different crops. Denison and

Monona,(2007) further state that the ability that irrigated agriculture have on decreasing food insecurity has encouraged the government of South Africa to make development of irrigation a priority.

The management of water in South Africa has shifted from water supply management to pay more attention to management of water demanded. This means that smallholder irrigation schemes have to make sure about the suitable water utilization technique so as to eliminate being required to pay for water. The increase of water prices on irrigation schemes will ensure that water is used more efficiently. However, the increase will make it difficult for farmers to keep up a high value crops for economic production.

### **2.6.2 Inefficient management of smallholder irrigation schemes**

Albinson and Perry (2002), argue that smallholder irrigation schemes are facing problem of management within the schemes. This problem is persistent in areas where there is inability to access water and in areas where water required exceeded available water. They further state that, water delivery is seen to be a problem on scheme management level in SIS. Failing to manage the scheme properly had repeated disorder that involved unlawful tempering with water delivery structures and water shortages at different parts within the scheme (Albinson and Perry 2002), consequently having a bad effect on the performance of irrigation. Arguing on the same point Gomo *et al.* (2014) added that, the developing world are the ones' that mostly face these kinds of challenges because the majority of farmers there have no access to improved technologies that is used to get a flow of water deliveries for the crops that they grow.

Shah *et al.*, (2002) stated that in South Africa, smallholder irrigation schemes were controlled in the Northern Province by intervention of government agencies such as the Agricultural and Rural Development Corporation (ARDC). Ever since the 1950s, governments across the world succeeded with smallholder irrigation schemes its full economic involvement and other organization, and farmers were just seen as farm workers regardless of the fact that, these farmers should pay for the facilities

rendered by the organizations. Perret, (2002) mentioned that the improvement of the irrigation schemes accomplishments is an important Irrigation Management Transfer (IMT) goal for the reform process; this can be achieved through giving the land to be owned and managed by the farmers and letting farmers to participate and be hands on the farming will motivate the sense of being in charge and responsible thereby improving the better utilization of resources. This was seen when some governments in Sub-Saharan Africa passed over smallholder irrigation scheme to be managed by the farmers in the face of irrigation management transfer , financial reprioritization together with the necessity of Irrigation Management Transfer in the end of 1900 years ago, in South Africa, monetary provision to manage, operate, as well as to maintain the smallholder irrigation scheme got reversed and the right of owning the land and being fully responsible for it the government gave them to farmer that are still growing.

### **2.6.3 Infrastructure**

Averbeke and Mohamed (2013) stated that factors that contributed to the modest performance of smallholder irrigation schemes in South Africa were poor infrastructure, poor knowledge of crop production among smallholders, poor farmer participation in the management of water, lack of extension and mechanisation services and lack of reliable markets and effective credit services. According to Bembridge (2000), the majority of smallholder irrigation schemes were facing the same challenges which were the constraints that included absence of fences, farm produced being stolen, maintenance infrastructure that is in a bad condition, poor road conditions, access to water due to bad transportation methods.

High operation costs is added as one of the key aspects limiting the progress of smallholder agriculture in African countries and this can largely be attributed to poor infrastructure. An analysis of the experience of any country that has developed its agriculture successfully will continuously find that the provision of good infrastructure as a requirement for reaching higher levels of agricultural productivity and profitability. Similarly, insufficient physical infrastructure in rural areas, particularly in the former homeland areas, is still a major problem to smallholder agricultural growth

in South Africa. According to Everatt and Zulu (2001) government can improve the value and number of infrastructure in the rural areas through initiating programmes such as community based public works programme, consolidated municipal infrastructure programme, and poverty relief and Infrastructure, investment fund, however the impact on the lives of majority of people living in rural areas has been restricted.

The investments have been made in areas with smallholder irrigation schemes in the former homelands of South Africa but majority of the irrigation schemes are not working out productively (Machethe *et al.*, 2004). In addition, when the provincial governments withdrew provision of services and the parastatals failing to continue taking responsibility of operating and maintaining irrigation infrastructure threatened the capability of the production. In Limpopo Province, the provincial department of agriculture has initiated a process of rehabilitation of the irrigation schemes and intends to hand over the management of the schemes to smallholder farmers once the process is complete.

#### **2.6.4 Access to markets**

In most rural areas, lack of access to market has been the result of other factors such as poor road infrastructure, lack of communication between buyers and sellers, inability of buyers to market or advertise their products and so on. Poor road infrastructure tends to be a very popular and is also a factor that cannot be solved by the farmer. In theory the provision of rural infrastructure has enabled small-scale farmers to have better access to markets. According to Department of Economic Development and Environmental Affairs (2009) close to 36% of cooperatives in Eastern Cape stated that they have no market for their products. Van der Heijden and Vink (2013) argued that lack of access to markets is thought to increase household vulnerability; rural households that are for one reason or another, are unable to interact with these markets are prevented from adopting diverse livelihood strategies; and indeed, in many parts of the world, rural poor people often mention the reasons that makes them to not improve their living standards; which includes difficulties in accessing markets.

Pote (2008) notes that a lack of formal markets along with inadequate transportation for farming products is one of the top two problems facing smallholder farmers in South Africa. Marketing and transportation systems have been seen as a pulse of economic development. Constraints that obstruct smallholders from greater market access to agro-food output markets are associated primarily with underdeveloped infrastructure, ranging from the nonexistence of local market spaces to unreliable sources of market information.

However, as highlighted by the Phillip (2011), institutional arrangements along the value chain and policies rarely prioritize the needs of smallholders and thus effectively heighten the barriers to access markets. The government first may need to examine and assess the structure and organization of the regional and local administrations to see how they should be organized to help smallholder agriculture during improvement. Smallholders usually need to rely on public transport to bring their output to the market. Transport contractors are reluctant to provide their service to smallholders due to the poor quality of access roads in rural villages.

Earlier publications from research among smallholder woolgrowers in the north-western part of the Eastern Cape which were studied by Nel and Davies (1999) show they need transport wool over large distances to access the market in Port Elizabeth. In addition their counterparts who concentrate on a meat-sheep variety seem to rely exclusively on white commercial farmers and 'speculative bulk buyers-farmers' to deliver their stock for sale to the big auction in Bloemfontein at a considerable cost deducted from the sale price. A related issue is the degree of participation of the smallholders in contract farming South African smallholders to be poorly integrated in contract farming value chains. Among the reasons that account for this 'discrimination against' smallholders are, larger farmers are preferred because they are perceived to have greater management coordination, higher transaction costs are associated with smallholders.

### **2.6.5 Lack of Information**

Small-scale farmers in South Africa are largely concerned only with producing their crops or animals without having sufficient knowledge of what consumers really want. By and large, small-scale farmers in the country, as pointed out by Pote (2008), are not concerned with meeting consumers' needs and they often are price-takers.

According to Mokhahlane (2009), information access to information among smallholders is generally poor and is compounded by the lack of reliable and efficient means of disseminating information. Recent field evidence in a study among small-scale sheep farmers in Eastern Cape is a case in point to illustrate the need for public support for a reliable market information dissemination mechanism. Both woolgrowers and meat-sheep farmers get their information on market prices, In addition he further highlighted a combination of three main sources: networking with white commercial farmers and 'speculative bulk buyers-farmers', an early-morning radio show in local languages and cell phones.

### **2.6.6 Fluctuating of market prices**

Price fluctuation is a frequents rise and fall of commodity prices in the market as a result of changes in the market situations, price fluctuation can be seasonal whereby prices of commodities changes during certain season of the year due to the increase in supply and demand (Huka *et al.*, 2014). In addition this was caused by the following factors changing petroleum prices which result to high translation of food price like transportation cost, crop yield, food stock levels as stock fall price rise, change exchange rate especially of major exporting countries, trade policies, drought, low technology, demand of food is in elastic as small changes in supply can cause big change is in prices, the role of speculation purpose and seasonal production

Therefore various methods which can be adopted by the government and other stake holders in order to reduce price fluctuation of agricultural product, effective of market management and high investment in agriculture sectors particularly in research development and infrastructure that promote irrigation.



### **2.6.7 Access to credit**

Credit is one of the most essential and significant bases of capital generation and may be viewed as a device for facilitating the temporary transfer of buying power from one individual or organization to another. According to Kimemia (2004) credit is also well presented as a key factor which can affect farmers' decision to purchase inorganic fertilizers, where in farmers will be able to afford the high prices imposed on fertilizers for their production.

Credit is one of the most significant bases of capital accumulation and may be viewed as a device for facilitating the temporary transfer of purchasing power from one individual or organization to another. It provides the basis for increased production efficiency through a specialization function. Christian (2014) pointed out that it provides the basis for increased production efficiency through a specialization function and further mentioned that the small-scale farmers in communal areas of South Africa have limited access to factors of production, credit and information, and markets are often constrained by inadequate property rights and high transaction costs. Despite these problems, some small-scale farmers have managed to produce food for own consumption and for the market.

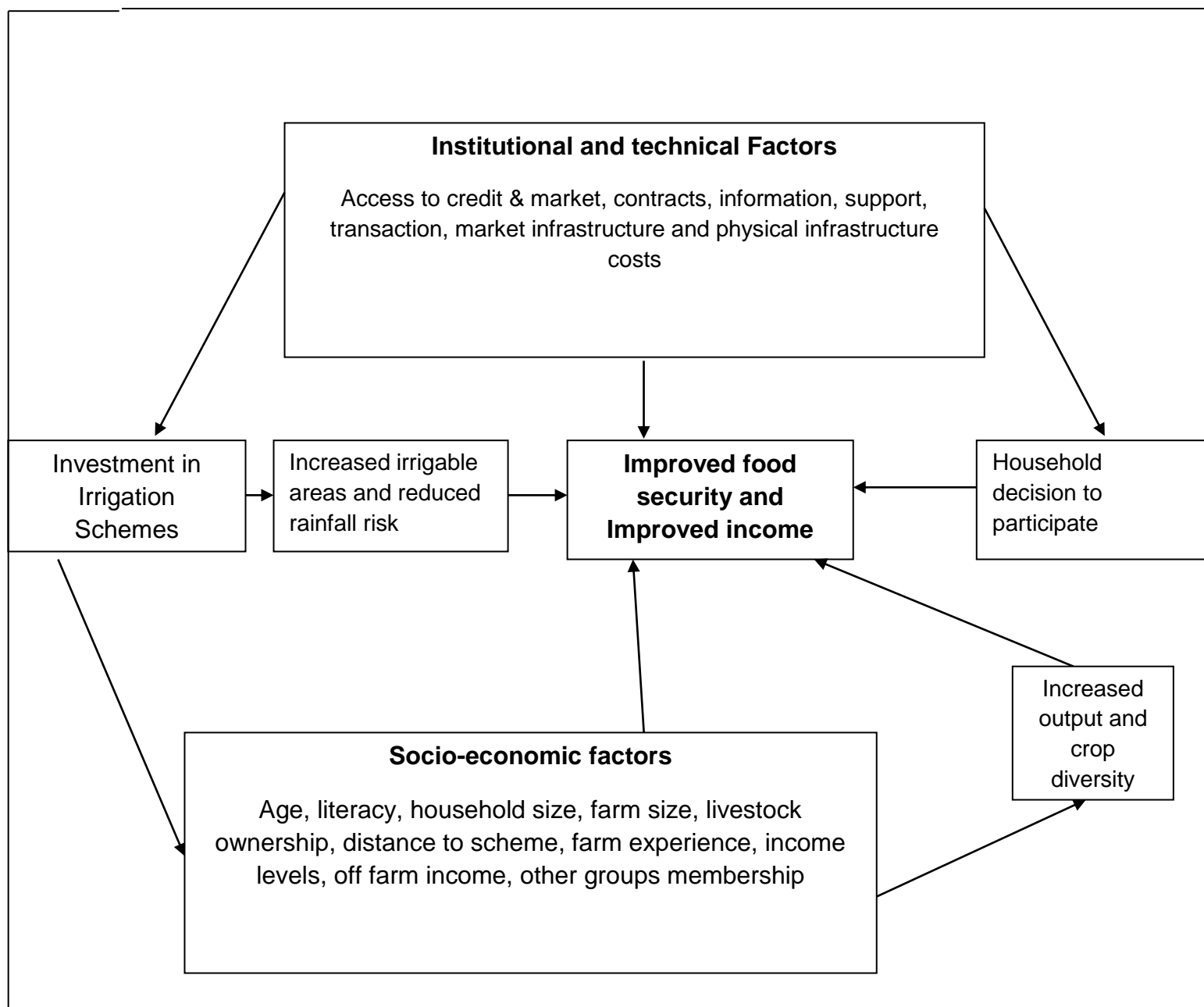
### **2.6.8 Lack of human capital**

It has also been found to be a serious constraint for smallholder farmers. According to DAFF (2012) they are often illiterate with poor technological skills, which can be serious obstacles in accessing useful formal institutions that disseminate technological knowledge. The majority of smallholder farmers are not capacitated with financial and marketing skills and are unable to meet the quality standards set by fresh produce markets and food processors. Lack of production knowledge leads to lower quality in production. As a result of low endowment in production factors, such as land, water and capital assets, the majority of smallholder farmers produce low quantities of products that are equally of poor quality, which leads to their products being neglected by output markets. Increasing concentration in the food value chain is a global trend, caused by increasingly demanding consumers and concerns about food safety, which tend to make it very difficult for smallholder

irrigation schemes to enter high-value markets in light of the low quantity and poor quality of their products (DAFF, 2012).

## **2.7 Conceptual framework**

The concept of viability can be defined at different levels and in various contexts. In the context of the study, it includes the ability of the scheme to generate sufficient income to add value on economical and expectations of the irrigators, and cover basic operational and maintenance costs of the irrigation infrastructure, while not mining the natural resources (Ntsonto, 2005). In the previous studies it was discovered that the major determinants of farmers choices to participate in smallholder irrigation schemes is mainly due to socio-economic dimensions of households, the institutional and technical factors (Nokuphiwa *et al.*, 2014). Conceptual framework below shows that the government policy towards investment in irrigation schemes increasing output by increasing irrigable area, reducing rainfall risk, improves productivity through multi-cropping and use of high variety crops. However the household's decision to participate is influenced by socioeconomic, institutional and technical factors.



**Figure 2.3: Conceptual framework**  
**Source: Sithole *et al.*, 2014**

According to Nnenna (2011) the small-scale farmers live in rural areas where there is a lack of basic infrastructure such as telephones, electricity and good road networks. Small-scale farmers rely on poorly developed road networks and telecommunications (Ortmann, 2005). Most of the small-scale farmers cannot read, write and speak any other language except their home language. This can create some difficulties when small-scale farmers have to communicate with extension

officers (Nnenna, 2011); lastly the infrastructure for small-scale farmers of South Africa is poor especially in former homelands of rural areas (See Figure 2.1).

## **2.8 Chapter Summary**

A lot has been done in sub Saharan Africa to address the issue of food security in communal areas. The escalating literature on the subject suggests that irrigation is one of the key indicators in addressing household income and food security as it brings a number of benefits to the households. The theoretical and conceptual, as well as policy, arguments are compelling. However South African government and private sectors need to come together and assist smallholder farmers in improving irrigation technologies to improve the situation of economic growth and development in the communal areas. Irrigation development in rural areas can hold the key to household food security and improved incomes as highlighted in this chapter

## **CHAPTER 3**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

This chapter will include the description of the study area, where the area in which the study has been conducted will be described in terms of its location, physical settings and topography, socio-economic settings, economic activities especially agricultural crops grown and livestock kept in Eastern Province and also supplying the map of the area. In addition the following instruments methods will be described; research design, model (descriptive, probit and propensity score matching model), and data, sampling method from the purposes of collecting the data, data collection and lastly data analysis.

#### **3.2 Description of the study area**

Mbhashe Local Municipality is situated in the South-Eastern parts of the Eastern Cape Province, and is bound by the coastline flowing from the Qhora River in the South to the Mncwasa River in the North along the Indian Ocean. It borders the following municipalities. It earned its name from the beautiful river called Mbhashe, which flows through Dutywa (previously Idutywa), Mbhashe Municipality's geographic area consists of 305,009 hectares, and it constitutes the northern boundary of the Amathole District Municipality in the Eastern Cape Province. This area has a population size of 25, 909 persons out of which 53.90% constitute the working population of men and women between the ages of 15 and 64 years old.. It has approximately 60, 124 households with an average household size of 4 persons.

Idutywa is located in the Eastern boundary of the Mbhashe Local Municipality about 30km North of Butterworth on the N2, and serves as the business hub for the surrounding rural areas. Idutywa is situated at the latitude of 32.1000<sup>0</sup>S and the longitude of 28.3000<sup>0</sup>E. Municipal and other Government Departments have offices in the town. It has a population of approximately 6 000 people of which majority lives in the surrounding rural neighbourhood of Idutywa living with no access to basic

infrastructure such as water, sanitation and electricity. The roads to the villages surrounding this town are gravel and poorly maintained. Most rural villagers are subjected to poor accessibility if the weather conditions are bad. The majority of land within the Idutywa Central Business District (CBD) is registered by way of title deeds in the name of private individuals and the land surrounding the town and township falls under commonage area registered in the name of the municipality and state. Cattle and sheep farming are prominent. The area is comprised of villages and their distances as follows: Lingeletu Coop in Tshazibana (15 km), Sirhosheni, Hlobo community garden (15 km), Ziqhamqaneni, Nomzamo project (15 km). A careful observation of these villages show that a premium is placed more on livestock (especially sheep). Moreover, even elderly women are involved in farming activities as men engage in maize and vegetable cultivation. The topography of the community have gentle gradient that lends itself to cultivation of different crops. The river that flows through the villages is seasonal and dissipates during winter. Similarly, the roads are graveled like other villages, without being hampered by the movement of vehicles.



**Figure 3.1: Map that shows study area**  
**Source: ECDC, 2012**

### **3.2.1 Climate conditions**

Idutywa normally receives about 534mm of rain per year, with most rainfall occurring mainly during summer. It receives the lowest rainfall of 7mm in June and the highest of 77 in March. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Idutywa range from 18.3°C in July to 25°C in February. The region is the coldest during July when the mercury drops to 5.1°C on average during the night. Consult the chart below (lower right) for an indication of the monthly variation of average minimum daily temperatures

### **3.2.2 Agro-ecological**

Commercial agriculture dominates the land use at Idutywa. Agriculture is a significant contributor to the local area's economy. Although commercial forestry has traditionally been a significant land use in the region, several types of agricultural practices have been introduced to enhance this sector. The Provincial Growth and Development Strategy (PGDS) also identified Agriculture and manufacturing as an area for competitive investment. Substantial progress has been made with the implementation stages of various projects.

### **3.3. Research design**

The research was focusing on economic performance and factors that influence their performance in the province of Eastern Cape in rural areas of Idutywa and by looking at different irrigation schemes. The research was composed and relies on the questionnaires that were distributed to irrigators and non-irrigators, and data was also acquired from nearby research locations.

A mixed method research approach was adopted for the proposed study. This means that the researcher was used both the quantitative method and the qualitative method of research. The researcher used a combination of the two research paradigms for the proposed study because by doing so it will provide a better understanding of the research problem than either method by itself. The weakness of one method was nullified by the strengths of the other (Creswell, 2008). The quantitative approach to research involves the researcher gathering numerical data

that can be readily manipulated through statistical methods of data analysis. Quantitative data is more objective than qualitative data. According to Taylor (2005), the major purpose of quantitative research is to make valid and objective descriptions on phenomena and on other hand qualitative research involves the researcher collecting verbal data that provides insight into the opinions and feelings about research participant's experiences. Qualitative data is therefore more subjective than quantitative data. Qualitative researchers study phenomena in their natural settings, attempting to make sense of or interpret and phenomena in terms of the means people bring to them (Taylor 2005).

### **3.6 Sampling procedure**

There are two types of sampling methods namely, probability and non-probability sampling procedures. For this research, most suitable sampling procedure that was used is purposive sampling which is part of the non-probability sampling method. The advantage for using this non-probability sampling procedure is that it does not require population data. Therefore, the sample selected may not necessarily be representative of the population.

Purposive sampling is a sampling method whereby the researcher uses his or her judgment to select members of a population of interest for inclusion in a sample then the multistage allows the research to combine the stages in the sampling process and we use both purposive, stratified and simple random sampling. By combining different sampling methods we are able to achieve a rich variety of probabilistic sampling methods that can be used in a wide range of social research contexts.

To expand the list by identifying more schemes will stretch the time and financial budgets of the study and will require the support of the Department of Rural Development and Agrarian Reform (DRDAR). It will be helpful if such support can be obtained freely and in a timely manner. At the beginning of the project in 2011, contact was established with the unit responsible for irrigation development and management which provided guidance in the identification of the irrigation schemes to which government is devoting attention at that time.



A list of villages of scheme farmers is the village sample frame for each scheme. Four villages were selected randomly from the list. This will permit comparative study of scheme and non-scheme farmers per village. The catchment area of each scheme in terms of surrounding villages from which farmers can be constitute a more comprehensive sample frame and would permit comparative study among villages exposed to the irrigation scheme with those not so exposed but such a list is wide and difficult to define objectively.

A total number of 107 households were obtained from all villages; it was compiled with the assistance of the Chief in each village. The list was stratified into 12 groups based on participation/non-participation in the irrigation scheme, male or female headed, and income group (Table 3.1). One household was selected by a random method from each of the 12 strata. Households were placed in income groups by the Chief of the village based on local criteria which include housing, number of children graduated from or studying at different stages of school education. This means that income groups are not unique across villages. A study that employed the same method in West Africa produced a consistent result of income effect across different villages (Nweke, Aidoo and Okoye 2012).

**Table 3.1: Strata of sample households per village**

<b>Stratum</b>	<b>No of Household</b>
Scheme participant/Male headed household/Upper income	1
Scheme participant/Male headed household/Medium income	1
Scheme participant/Male headed household/Low income	1
Non-scheme participant/Male headed household/Upper income	1
Non-scheme participant/Male headed household/Medium income	1
Non-scheme participant/Male headed household/Low income	1
Scheme participant/Female headed household/Upper income	1
Scheme participant/Female headed household/Medium income	1
Scheme participant/Female headed household/Low income	1
Non-scheme participant/Female headed household/Upper income	1
Non-scheme participant/Female headed household/Medium income	1
Non-scheme participant/Female headed household/Low income	1
No. of households per Village	12

**Source: Based on field data, 2017**

### **3.7 Data collection**

In collecting data the structured questionnaires was distributed to the respondents. Both quantitative and qualitative approaches were used to collect data using a self-administered questionnaire. The researcher chose to use a combination of the two research paradigms for the proposed study because doing so it provided a better understanding of the research problem than either method by itself. The weakness of one method was nullified by the strengths of the other (Creswell, 2008). The quantitative approach to research involves the researcher gathering numerical data that can be readily manipulated through statistical methods of data analysis.

Quantitative data is more objective than qualitative data. According to Taylor (2005), the major purpose of quantitative research is to make valid and objective descriptions on phenomena. Qualitative research, on the other hand, involves the researcher collecting verbal data that provides insight into the opinions and feelings about research participant's experiences. Qualitative data is therefore more subjective than quantitative data and the questionnaire included factual questions and closed questions. The factual questions request objective information about respondents such as social background of cooperative and closed question is where the respondent is given limited answers such as yes/no or not sure. The questionnaire was semi structured and also designed to capture demographic information

### **3.8 Data analysis and expected outcomes**

This section seeks to answer the major objectives of the study, whose aim is to evaluate the economic performance of smallholder irrigation schemes in the Eastern Cape Province. Data analysis techniques adopted shall give a detailed coverage of to analyse the impact of irrigation schemes on income and food security, assess the status of smallholder irrigation schemes, and identify factors that influence their production level and opportunities of production and supply of the commodity to the market. After collecting and gathering data, it was captured and encoded in the form of spread sheets in Microsoft Excel and exported to SPSS software.

**Table 3.2: Description of variables, unit and expected sign**

Variable	Description	Unit	Expectation sign
Income (Dependent variable)	Total amount of crop sales of the scheme	Rand	+
<b>INDEPENDENT VARIABLES</b>			
Age	Age of responded	Years	+-
Gender	Gender of household head	Dummy	+-
Education	Education level of respondents	Years	-
Access to credit	Closed question	Dummy	+
Occupation	Closed question	Dummy	-
Household size	Closed question		+
Distance to water point	Closed question	Dummy	—
Market access	Closed question	Dummy	-

**Table 3.3: Objectives, Research questions, hypotheses and methodology**

OBJECTIVES	RESEARCH QUESTIONS	HYPOTHESIS	METHODOLOGY
<ul style="list-style-type: none"> <li>▪ To assess the impact of access to land, capital and market on the performance of smallholder irrigation farmers</li> </ul>	<ul style="list-style-type: none"> <li>▪ What is the impact of smallholder irrigation schemes?</li> </ul>	<ul style="list-style-type: none"> <li>➤ Limited land, Lack of capital, access to markets access to incubation are the major factors that influences smallholder irrigation farming performance</li> </ul>	Probit model
<ul style="list-style-type: none"> <li>▪ To examine the impact of smallholder irrigation farming on rural livelihood</li> </ul>	<ul style="list-style-type: none"> <li>▪ What are the major impacts of smallholder irrigation farming on rural livelihood?</li> </ul>	<ul style="list-style-type: none"> <li>➤ Smallholder irrigations brings change to rural livelihood</li> </ul>	Propensity score matching model
<ul style="list-style-type: none"> <li>▪ To assess the impact of water and land availability on the future of smallholder irrigation farming</li> </ul>	<ul style="list-style-type: none"> <li>▪ What are the impact of water and land availability in smallholder irrigation schemes</li> </ul>	<ul style="list-style-type: none"> <li>➤ Access to water and land are the possible opportunities</li> </ul>	Descriptive statistics



### 3.4 Model specification

#### 3.4.1 Descriptive statistics

Descriptive is defined as a set of brief descriptive statistics that summarize a given set of data, which can either be an illustration of the entire population or a sample. Measures that descriptive statistics uses to describe the data set are measures of central tendency and measures of variability or dispersion, where by measures of central tendency comprises while measures of variability consist of the number of cooperatives, standard deviation, minimum, maximum, mean as well. Descriptive statistics grants a useful summary of safety returns when performing empirical and analytical analysis. Mostly the descriptive statistics are commonly used to describe the basic features of the data in a study. It provides simple summaries about the sample and the measures (Research Methods Knowledge Base, 2008).

#### 3.4.2 Probit and propensity score matching

This analytical method was used in this study to answer the factors affecting performance and impact on smallholder irrigation schemes on income and food security, a way to obtain robust impact assessments is to compute the Average Treatment Effect on the Treated (ATT). The objective of the study is to assess the impact of irrigation farming on rural livelihood and household food security. Accordingly, the study assesses whether or not the smallholder irrigation farming brings change to the current situation in terms of household income, total expenditures and household consumption. In order to achieve this, the study developed stochastic model following:

$$Y_i = a_0 + \sum_{i=1}^n \beta_i X_i + \mu \dots\dots\dots (1)$$

Where,  $Y_i$  is the dependent variable meaning household food security (household income, total expenditure, household assets and household consumption).

$X_i$ 's are the independent variables of the study (e.g. Social grants, involvement in crop production and sales, Livestock ownership, Non-farm activities and remittances).

In this case, there is an endogeneity problem since irrigation is one of the observed characteristics. The question is to estimate the treatment effect of this observational (non-experimental) study by comparing the average treatment effect between the irrigation farmers and non-irrigation farmers of the study. And it can be expressed as follows:

$$ATT_i = E \{Y_{1i} - Y_{0i} / D = 1, P(X_i)\} \dots\dots\dots (2)$$

Where, ATT = Estimation of Average Treatment Effect between the treated and control using predetermined variable ( $X_i$ ).

$Y_{1i}$  &  $Y_{0i}$  = Potential outcomes of the treated and untreated.

Since there might be bias problem, the study used propensity score matching wherein it selects a control group that don't participate in irrigation to be similar to them with the treated group on the basis of similarity in the observed data. Because, the ATT might not be observed for some respondents, propensity matching method sets a conditional independency assumption that all relevant differences between the two groups be captured by their observable variables ( $X_i$ ). Both FPSSI and NFPSSI are matched on the basis of propensity scores.

$$Y_i^0 \perp X \rightarrow E(Y_i^0 / P_i = 1, X_i) = E(Y_i^0 / P_i = 0, X_i) \dots\dots\dots (3)$$

The propensity match can use different models to estimate the propensity score. The study uses the probit model because participation in irrigation agriculture is not random rather affected by observed, unobserved or both factors. The irrigation participation model estimates the level of participation in the irrigation program and can be expressed as follows:

$$P(D_i = 1 / X_i) = \Phi(f(X_i) = a_0 + \sum_{i=1}^n \beta_i X_i + \mu \quad \mu \approx N(0, \delta^2) \dots\dots\dots (4)$$

Where,  $\Phi$  denotes the normal cumulative distribution function and  $f(X_i)$  represents a specification of the respondent practicing irrigation farming ( $D_i = 1$  for those who participate in irrigation farming) determinants ( $X_i$ ) of which includes all the observed covariates as linear terms without interaction of higher orders terms that have effect on the tendency to participate irrigation farming and household food security. Every sampled participants and non-participant have an estimated propensity score, which is a continuous variable and can be expressed as follows.

$$\hat{z}(X_i / T = 1) = \hat{z}(X_i) \dots\dots\dots (5)$$

the difference between the average outcomes of the two groups is the estimated effect of the access to irrigation if the resemblance is satisfactory (Caliendo and Kopeinig, 2008). For the matching of participants to non-participants on the basis of the propensity score, there are four alternatives: nearest-neighbor, calliper (radius), stratification (interval) and kernel matching that are used to calculate a weight for each matched participant-non participant set. The stratification method divides the strata into five strata because five subclasses are often sufficient to remove 95% of the bias associated with one single covariate (Stern et al., 2012).

Accordingly, the impact of the irrigation is the mean difference in the outcomes between the treated and untreated group for each stratum. In each stratum or block, the average difference between outcomes of treated observations and control observations is estimated as follows:

$$AD^s_q = \frac{\sum_{i \in I(q)} Y_i^T}{N_q^T} - \frac{\sum_{j \in J(q)} Y_j^C}{N_q^C} \dots\dots\dots (6)$$

Where,  $AD^s_q$  is the average difference block q,

$I(q)$  is the set of units in a bloc q;  $N_q^T$  and  $N_q^C$  are the number of treated control units in the block (q).

Consequently, the estimator of ATT is computed as an average of each AD (UNDP, 2009) and is given by the following equation: where, Q is the total number of blocks.



$$ATT = \sum_{q=1}^Q AD_q^s \frac{\sum_{i \in t(q)} D_i}{\sum_{i \in c} D_i} \dots\dots\dots (7)$$

The kernel matching method used weighted averages of all individuals in the comparison group to make the counterfactual effect. The weights are calculated based on the distance between each individual from the comparison group and the treated observation of which the counterfactual is estimated (Caliendo and Kopeining, 2008). The Kernel matching ATT estimator is given by:

$$ATT = \frac{1}{N^T} \sum_{i \in IT} \{ Y_i^T - \frac{\sum_{j \in C} Y_j^C G(\frac{P_j - P_i}{h_n})}{\sum_{k \in C} G(\frac{P_k - P_i}{h_n})} \} \dots\dots\dots (8)$$

Where G, is the Kernel function and  $h_n$  is a bandwidth parameter. The choice of bandwidth parameter is more important because it defines the fitness and the variance between the estimated and true underlying the density function. After the matching process and producing significant propensity scores, the study will then compare the average outcomes of the matched respondent groups (treated vs control) based on some comparable variables (such as total expenditures, household assets, consumption, and household incomes) to estimate whether there is a statistically significant effect of the treated on the outcome.

The study considers the selection bias as a sample selection problem and applies propensity score matching (PSM) to estimate the average treatment effect (ATE) of irrigators and non-irrigators. PSM refers to the pairing of treatment and control units with similar values on the propensity score, and possibly other covariates, and the discarding of all unmatched units. It is primarily used to compare two groups of subjects but can be applied to analyses of more than two groups.

Generally, if a treated subject and a control subject have the same propensity score, the observed covariates are automatically controlled for. Therefore, any differences between the treatment and control groups will be accounted for and will not be a result of the observed covariates. Following the notation in the evaluation literature, let:

$Y_0$  = Non-treated subject

$Y_1$  = Treated

It is also important to define the following two treatment status variables for the same population unit:

$D_0$  = if the irrigators do not receive treatment

$D_1$  = if the irrigators receive treatment

For each group of farmers, we have  $D_0 + D_1 = 1$  because each group of farmers can only receive one treatment at the same time. Hence,

$$D_0 = 1 - D_1$$

It is important to note that the two potential outcomes, and defined above are not simultaneously observable for any given group of farmers. Only the potential outcome that corresponds to the treatment status which has its value equal 1 is observed. What one always observes unconditionally for any given population unit are the three treatment status variables  $D_0$  and  $D_1$  and the outcome variable  $Y$ . However the observed outcome variable  $Y$  can be written as a function of unobserved potential outcome variables and the treatment status variables

$$Y = D_1 Y_1 + (1 - D_1) Y_0 \dots \dots \dots (9)$$

The differences  $Y_1 - Y_0$  give us the unit level impacts of cooperative membership. Since two of the potential outcomes (the counterfactuals) are always missing, one cannot compute the unit level treatment effects. However, it is possible to estimate the mean of the distribution of each unit level treatment effect of the farmers. This mean is referred to in the literature as average treatment effects (ATE).

The following two average treatment effects parameters measure respectively the mean impact of cooperative membership compared to non-membership. See equation 2 below.

$$ATE\ 1 \rightarrow 0 = E(Y_1 - Y_0) \dots \dots \dots (10)$$

For this study, kernel matching methods was used in the analysis of the data. In this method, every treated subject is matched with the weighted average of the control subjects. The weights are inversely proportional to the distance between the treated (members of cooperative) and control group's (non-members) propensity scores.

The essence is to explore impact assessment where it exists. The main aim was to identify the average treatment effect on the treated (i.e., the effect of cooperative membership on farm performance).

$$\Delta = E(Y_1 - Y_0 // D = 1) = E(Y_1 // D = 1) - E(Y_0 // D = 1) \dots \dots \dots (11)$$

The first term on the right hand side of equation 3 is observable. However, the second term on the right hand side cannot be observed (i.e., what the members of cooperative would have experienced had they not been members and received support). Matching was used to estimate  $E(Y_0 // D = 1)$ . However, for matching to be valid, certain assumptions must hold. The fundamental assumption underlying matching estimators is ignorable treatment assignment (Rosenbaum and Rubin, 1983). This assumption is represented by

$$(Y, Y) \perp D // X^* \dots \dots \dots (12)$$

Where  $X^*$  is a vector of variables that are unaffected by the treatment. This assumption states that, conditional on a set of observables  $X^*$ , the respective treatment outcome of actual treatment status. In empirical work,  $X^*$  usually contains pre-treatment variables and time-invariant individual characteristics. Since the study was estimating the average treatment effect on the treated, condition (3.2) can be weakened to the following mean independence assumption involving only  $Y_0$ .

$$E(Y_0 // X^*, D) = E(Y_0 // X^*) \dots \dots \dots (13)$$

**Counterfactual.** What would have happened to the participants' group had they not participated? The key assumption of this framework is that individuals selected into treatment and non-treatment groups have potential outcomes in both states: the one

in which they are observed and the one in which they are not observed (Rubin, 1978).

Propensity score is the probability of taking treatment given a vector of observed variables.

$$P(x) = Pr [D = 1|X = x] \dots\dots\dots (14)$$

Individuals with the same propensity score, and divide them into two groups (those who were and were not treated), the groups will be approximately balanced on the variables predicting the propensity score.

**Confoundedness Assumption.** This implies that the treatment (membership in cooperative) is random conditional on some set of observed characteristics ( $X$ ). this allows for “selection on observables”. The common support assumption guarantees that each treated unit (a participant/member) can be matched with a corresponding control unit (non-participant/ non-members). The average treatment effect is then calculated as the mean within-match difference in the outcome variable between the treated and untreated units.

The determinants of smallholder irrigation scheme were modelled on socio-economic and farm characteristics. Data collected were analysed using the probit regression model to determine factors influencing performance of smallholder irrigation scheme. The response variable  $Y$  is *binary* that is it can have two possible outcomes which was denoting as 1 for participating and 0 for not participating i.e.  $Y$  will represent whether or not participates in the irrigation scheme. We also have a vector of regression  $X$ , which are assumed to influence the outcome  $Y$ . Specifically; we assume that the model takes form:

$$Pr(Y = 1|X) = \Phi (X\beta) \dots\dots\dots (15)$$

$$P (Y_i = 1) = P (Y_i \geq 0) \dots\dots\dots (16)$$

Where,

$Pr$  Denotes probability,

Where  $i = 1, 2 \dots n$

$\beta$  = A Factor of unknown coefficients,

$\Phi$  Is the Cumulative Distribution Function (CDF) of the standard normal distribution.

$Y$  Is the probability whether the farmer participates in the scheme. 1=participating; 0=not participating.

$X_1$ = Age (years)

$X_2$ = Gender (female=1, male=0)

$X_4$ =Household size

$X_5$ =Educational status (years spent at school)

$X_6$ =Access to credit (yes=1, no=0)

$X_7$ = occupation (farming, wage, unemployment and employment)

$X_8$  = Access to market (yes=1, no=0)

$X_9$ = Sales in crop income (Rand)

#### **3.4.2.2 Nearest-neighbour matching**

Each treated observation is matched with a control observation that as the closest propensity scores. In the nearest neighbour matching, it is possible that the same household in the control group can neighbour more than one household in the treatment group. Therefore, after matching, the difference between their incomes is calculated as the average effect of contract participation on the household income (ATT).

#### **3.4.2.3 Kernel matching method**

All treated observations are matched with households in the control group based on the weighted average. The weighted average is inversely proportional to the distance between the propensity scores of the treated and control groups. It is important to note that each matching method has its own strengths and weakness. Using a combination of different matching methods has the advantage of testing the

robustness of impact estimates (Caliendo and Kopeinig, 2005 and Khandker *et al.*, 2010).

### **3.5 Data and variable measurements**

#### **3.5.1 Gender**

Gender is a variable that determines whether household is a male or female. According to (FAO, 1995) in rural areas females are more likely to participate in subsistence crop farming as compared to males.

#### **3.5.2 Age**

This is the actual number of years of the household head. Age is an important variable that determines the commitment of the household to agricultural practices. The older the farmers, the wealthier they might be, and hence, the more productive resources they have at their disposal (Obi and Pote, 2010). Sometimes age is linked to experience and thus, older farmers are more likely to face fewer risks than young farmers.

#### **3.5.3 Educational level**

The variable was recorded according to the number of years an individual spent in school. Education is important to farmers because it determines the ability of a farmer to adjust to new innovations. However most information in farming and training manuals is presented in English, therefore, for the farmers to access this information they need education

#### **3.5.4 Occupation**

This variable measures whether household heads are employed or not employed. Employment has an effect on agricultural practices, because households do not devote sufficient time to agriculture due to their unavailability. This variable is divided into two categories, namely, the formal and the non-formal employment. Employment status enables one to capture the various sources of income, and whether these incomes have a positive impact on rural livelihoods.

### **3.5.5 Household size**

This variable refers to the total number of people that are residing on a each household. Household size has the impact on the amount of the produce because the larger the household size, the higher the production level.

### **3.5.6 Distance to water**

Farm implements are determined by this variable. Farm implements play an important role in agricultural production. It is always predicted that the more the farmers access farm implements, the higher they produce in a timely manner.

### **3.5.7 Household income**

This is the total amount of money in rand's; a household receives per month, whether it is from social grants, remittances or non-farm income and crop sales income. This variable also measures total income levels, and food security in terms of quantity of farm output produced per annum. An understanding of livelihood outcomes is anticipated through a participatory enquiry. A range of outcomes improves the standard of living and reduces poverty in its broadest sense

### **3.5.8 Crop Produced**

It is a continuous variable that shows the amount of crop produced, consumed, sold by the household and also produces they wish to sell. The amount of crop produced is another determinant of the food security status of households and determine the income from the crop sales. Rural households produce crops for different purposes either for marketing and consumption, marketing or consumption only. The variable is measured by a quantity of a given crop per hectare.

### **3.5.9 Market access**

This variable focuses on whether the farmers have market access or not and whether the respondents participate or not in the market. Small-scale producers generally lack knowledge, information and resources to meet quality standards and formal markets' specifications such as poor processing machines, unskilled labour,

### **3.5.10 Access to irrigation**

Access to irrigation is expected to have a positive relationship with household food security (Burton *et al.*, 2005). Farmers with plots on the irrigation schemes are expected to be able to grow crops throughout the year and meet household food requirements than those on dry land farming. A dummy variable is used. Those farmers on the irrigation schemes take the value of one and those not on the irrigation schemes take the value of zero

## **3.9 Ethical issues**

### **3.9.1 Informed Consent**

In this case participants have right to know what the research is all about, how will affect them, the risks and benefit of participation and the fact that they have the right to decline to participation at any time during the process if they don't feel comfortable to collect data . Therefore in my research it will be vital to make sure that a sample information sheet is provided, as well as a range of alternative information that could be included depending on the research. It is important that the information included be sufficiently clear so that my target group can understand what they are being asked to do.

### **3.9.2 Confidentiality and Anonymity**

Confidentiality and anonymity are the ethical requirement in most research. Information provided by participants particularly sensitive and personal information, should be protected and not made available anyone other than the research. Thus the data collect from participants should at all times be kept under secure conditions.

### **3.9.3 Prohibited potential for harm**

There are a number of ways in which participants can be harmed Such as physical harm, psychological harm, emotional harm, embarrassment (social harm) and so on. It is important for me to identify any potential for harm and determine how this potential for harm can be overcome.



### **3.10 Chapter summary**

The first part of the study has focused on the description of the study which has highlighted the area where the study was conducted, crops that are cultivated in the three irrigation schemes and lastly, the number of beneficiaries. The design of the study has described the approach used during the study as well as the method applied in collecting data. The data collection has covered the instrumentation method applied in collecting data and how it was analysed to achieve the objectives of the study. The technique and procedures used to secure appointments were fully covered. Lastly, the issue of ethics applied throughout the study has been explicitly explained.

## **CHAPTER 4**

### **PRESENTATION OF RESULTS**

#### **4.1 Introduction**

This chapter presents the findings of the study that was conducted. In addition this chapter also seeks to answer the overall objective of the study which is to analyze the socio-economic performance of smallholder irrigation; furthermore it will also focus and answer the specific research objectives. To achieve these objectives the following techniques will be considered; a detailed descriptive statistics and inferential analysis will be considered. Moreover descriptive analysis includes graphical and numerical summaries to give a picture of a data set. In addition inferential involves fitting model and uses an analytical framework that address specific objectives

#### **4.2 Demographic and socio-economic characteristics**

Table 4.1 outlines the socio-economic characteristics of all sampled irrigation schemes and non-schemes. The following continuous or scale variables were considered comparing both irrigation and non-irrigation schemes namely; household size, age, number of years spent in school using the following statistical methods sum, minimum, maximum, mean and standard deviation. In addition the nominal variables such as gender, occupation were also considered to get the statistical method of frequency distribution.

**Table 4.1: Analysis on demographic and socio-economic characteristics**

Irrigation scheme (n=50)			Non-irrigation scheme (n=57)	
Variables	Frequency	Total percentage	Frequency	Total percentage
<b>Household size</b>				
1 - 5	19	70.4	48	60.0
5 - 10	6	22.2	25	31.3
10 - 15	2	7.4	7	8.8
Total	27	100.0	80	100.0
<b>Household income</b>				
0 - R1000	13	48.1	48	60.0
R1000 - R2000	5	18.5	5	6.3
R2000 >	9	33.3	27	33.8
Total	27	100.0	80	100.0
<b>Years spent at school</b>				
0 - 5	11	40.7	19	23.8
6 - 10	12	44.4	46	57.5
11 - 15	3	11.1	14	17.5
16 - 20	1	3.7	1	1.3
Total	27	100.0	80	100.0
<b>Age</b>				
20 - 35	1	3.7	3	3.8
36 - 45	1	3.7	11	13.8
46 - 55	2	7.4	12	15.0
65 >	23	85.2	54	67.5
Total	27	100.0	80	100.0
<b>Gender</b>				
Female	48	60.0	18	66.7
Male	32	40.0	9	33.3
Total	80	100.0	27	100
<b>Occupation</b>				
Farmer	51	63.8	17	63
Wage employment	7	8.8	2	7.4
Unemployment	21	26.3	8	29.6
Total	80	100	27	100

**Source: Based on SPSS processing of field data, 2017**

#### **4.2.1 Distribution of household head by level of education**

A poor education system was identified as the primary inhibitor of high technology entrepreneurial activity (GEM Report, 2012). Education is a critical source of skills, problem solving abilities and knowledge (Ucbasaran, Westhead and Wright, 2009). Education provides the basis for analytical problem solving and competencies required to cope with the rigorous demands and requirements of entrepreneurship (Barreira *et al.*, 2011).

Table 4.1 reveals both irrigation and non-irrigation schemes were knowledgeable as indicated by 44.4% and 57.5% respectively. The results suggest that education level attained by non-irrigators could have exposed more of them to the scheme compared to the irrigators; in addition education has the potential to assist individuals to escape poverty, subject to education system being accessible to appropriate smallholder farmers at the right time and with appropriate content. However Randela *et al.*, (2008) mentioned that traditionally women have been associated with lower levels of education including human capital; levels of education provide an indication of the capacity and ability of smallholder farmers to process and interpret information, resulting in a better understanding and reduced transaction cost.

#### **4.2.2 Distribution of household head by household income**

Farm incomes include income derived from the sale of the farm produce and non-farm sources such as pension, remittance, wages and salaries and other sources. Table 4.1 shows that the majority of respondents were earning R1000 and less for both irrigators and non-irrigators. The results imply that farming is also vital source of income confirming its importance as a contributor to household income. Similar study conducted by Tekana and Oladele (2011) which revealed that agriculture plays an important role in poverty reduction and food security in rural areas. In addition farming alone is not adequate source of household income for all farmers regardless of farm size.

### **4.2.3 Distribution of household head by age**

From the point of view of experience and decision making ability, age counts as one of the most important variables in the analysis of smallholder households. The older farmers would behave differently from younger farmers in respect to actions that either enhance or hinder the transition from homestead gardening to market-oriented crop production based on irrigation water use. According to the FAO (1983), age influences the interests and attitudes of farmers. Similarly, the way a person is treated often has a bearing on his or her age; younger people may be treated with less respect than older people.

Table 4.1 shows that the majority of respondents for both irrigator and non-irrigators between the age of sixty five and above were ranging at 85.2% and 67.5% respectively. The results also suggest that non-irrigators are old compared to irrigators. However the majority of people who retired at work or pensioners, they usually start farming in rural based areas for their consumption or sells their produce to local markets.

### **4.2.4 Distribution of household size**

Household hold size has a significant influence on farming in both labour intensive and extensive. According to Christian (2014) large household size discourages selling because they have a large household, therefor the majority of them farm for home consumption. In addition the lack of food security has been identified as the big problem in rural areas; it is for the reason that most people from rural are farming. However the majority of them don't have access to land.

Table 4.1 shows a substantial difference between the percentage value of irrigators and non-irrigators; this therefore means irrigators are not labour intensive. A large family has the variety of labour, either childhood, adults and elders house/family members. Labour is one the most vital factor of production in smallholder farmers because they are labour intense than capital intense.

#### **4.2.5 Distribution of household head by gender**

Gender is one of the indicators for the factors that play a vital role in determining the attitude and acceptance of youth towards entrepreneurship (Silva *et al.* 2010). However gender did not significant impact on work performance.

Table 4.1 reveals that women's were more involved on the irrigation schemes compared to men's as indicated by 60% of females. In addition it also indicated that there were more women's in non-irrigators. Similar study that was conducted by Samah (2010) which reveals that; between irrigator and non-irrigators, women's were found to have negative attitude towards contract farming compared to men's

#### **4.2.6 Distribution of household head by occupation**

The occupational preferences of the survey households are the only way to use in order to gain better understanding of the rural communities and survey. Therefore the employment preferences and choices of people define the economic possibilities and pressures of the area and the nature of the incentives they respond to. It is also important in understanding the nature of the motivation of the people in their pursuit of opportunities to address their most pressing constraints and whether or not they are prepared to take advantage of the available opportunities

This information was sought for both household heads and the other members of the households and the question was framed in an open-ended fashion so that respondents could mention anything they wished. The responses are summarized in Table 4.1 and suggest that the household members are engaged in a wide variety of activities. For instance, the occupational categories mentioned by the respondents included: farming, mining, wage employment (which incorporates a wide range of activities such as domestic work, security guarding, store attendant, etc), schooling, and unemployed and pensioner.

**Table 4.2: Distribution of years of schooling disaggregated by gender**

Years of schooling	Gender		Total
	Female	Male	
0 - 5	17	13	30
6 -10	38	20	58
11 -15	10	7	17
16 - 20	1	1	2
Total	66	41	107

**Source: Based on SPSS processing of field data, 2017**

Table 4.2 shows that most of the farming population is generally literate, with only few who have attended formal education. In addition the rest of the enumerated households are headed by persons with high educational level. From the standpoint of the need to deal with farmers who are enlightened and open to new ideas and can respond positively to incentives, it would seem as if the survey farmers are exactly what would be expected to support a rapid transition to from homestead, virtually subsistence undertaking to more commercialized and surplus-oriented and business-like farming

Education provides the basis for analytical problem solving and competencies required to cope with the rigorous demands and requirements of entrepreneurship (Thindisa 2014). Education has the potential to assist individuals to escape poverty, subject to education system being accessible to appropriate smallholder farmers at the right time and with appropriate content. Furthermore levels of education provide an indication of the capacity and ability of smallholder farmers to process and interpret information, resulting in a better understanding and reduced transaction cost.

Education plays a vital role in farming and a crucial variable for farm decisions is educational attainment .Theoretically, persons with higher educational attainment will be more receptive of new ideas embodied in extension messages targeting farmers

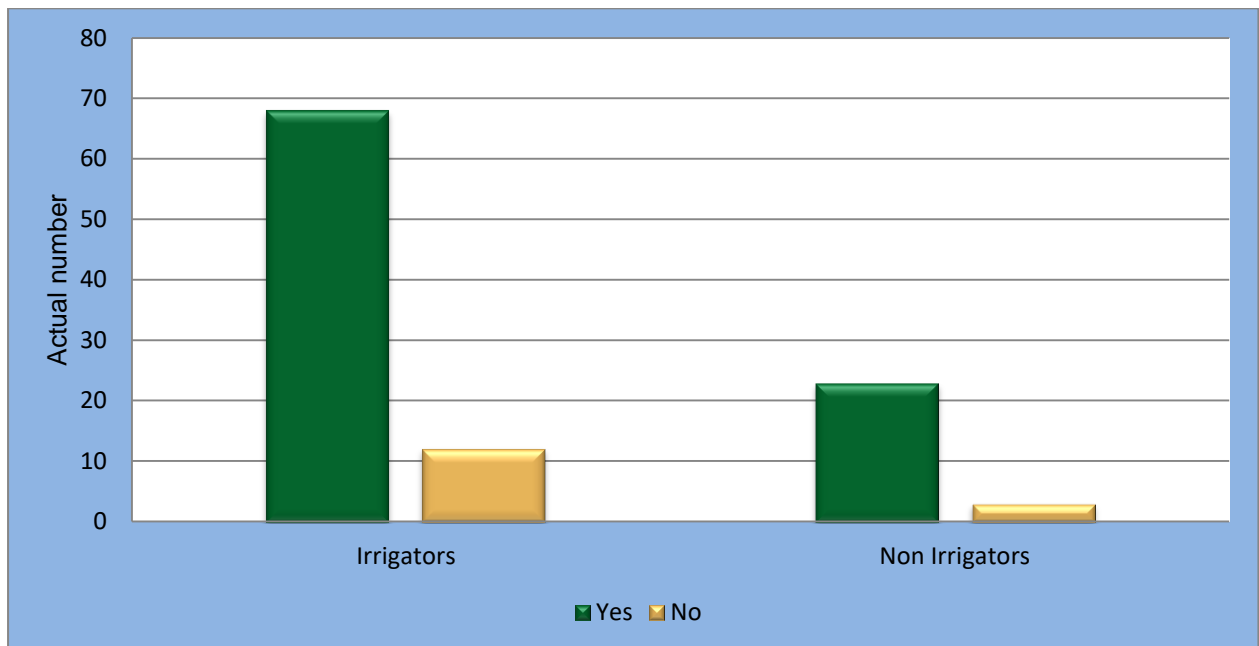
to influence adoption decisions. This study obtained information from the household heads as to what educational levels they attained or how many years they spent in formal schooling. The results are presented in Table 4.2

#### **4.1.1 Distribution by access to market**

The South African agricultural sector was deregulated with the enactment of the Marketing of the Agricultural Products Act (Act No. 47 of 1996). The passing of this legislation provided for a limited government intervention in the marketing of agricultural products. The use of control boards to intervene in the marketing of agricultural products was ceased in 1996 (DAFF, 2013). The deregulation process entailed the removal of retail price controls, import and export control, and the removal of fixed price single channel marketing. The results of the deregulation process meant South African producers were suddenly exposed to global markets (Louw *et al.*, 2013).

Markets are critical for sustainability and profitability of smallholder farmers because they act as a medium of exchange. Market participation by smallholder farming entrepreneurs is critical because they derive a livelihood, income and opportunities for exploitation (Makhura, 2001). Marketing activities such as cleaning, grading, storage, transportation and selling has the potential to increase profitability and sustainability of smallholder farmers. Access to market is the big problem to farmers failing to sell their produce. This is due to the advanced technology and government does not support farmers with enough technology or train them on how to operate the machines in order to produce quality products (Figure 4.1)



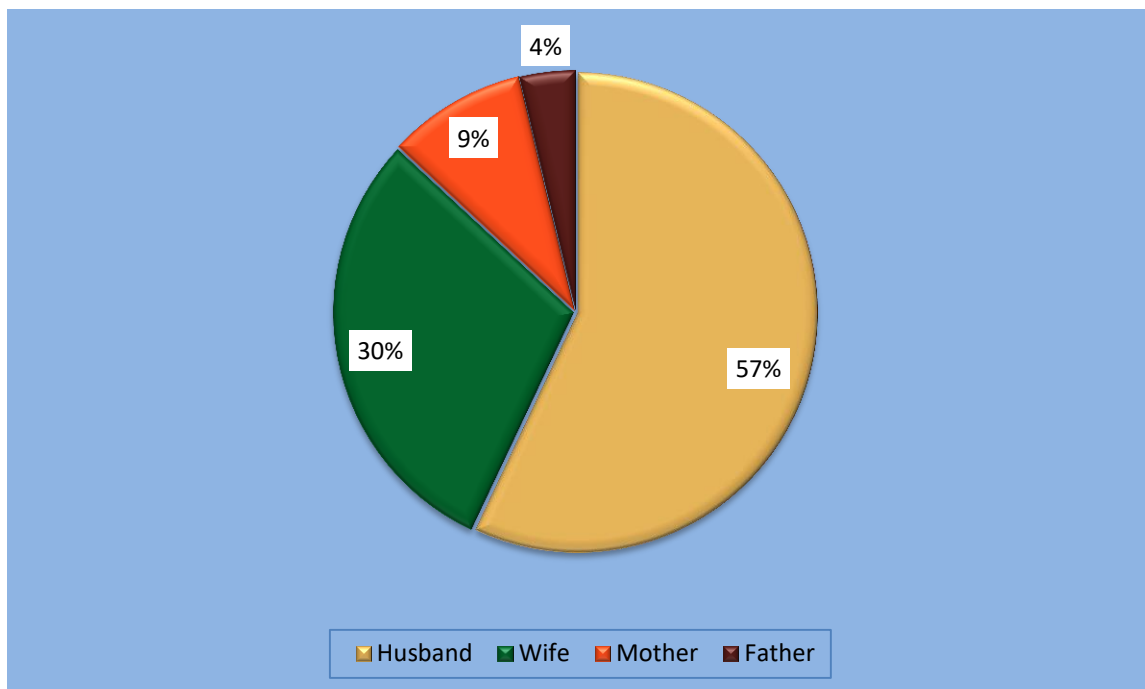


**Figure 4.1: Distribution by access to markets**

**Source: Based on SPSS processing of field data, 2017**

#### **4.2.1 Distribution of household by household members**

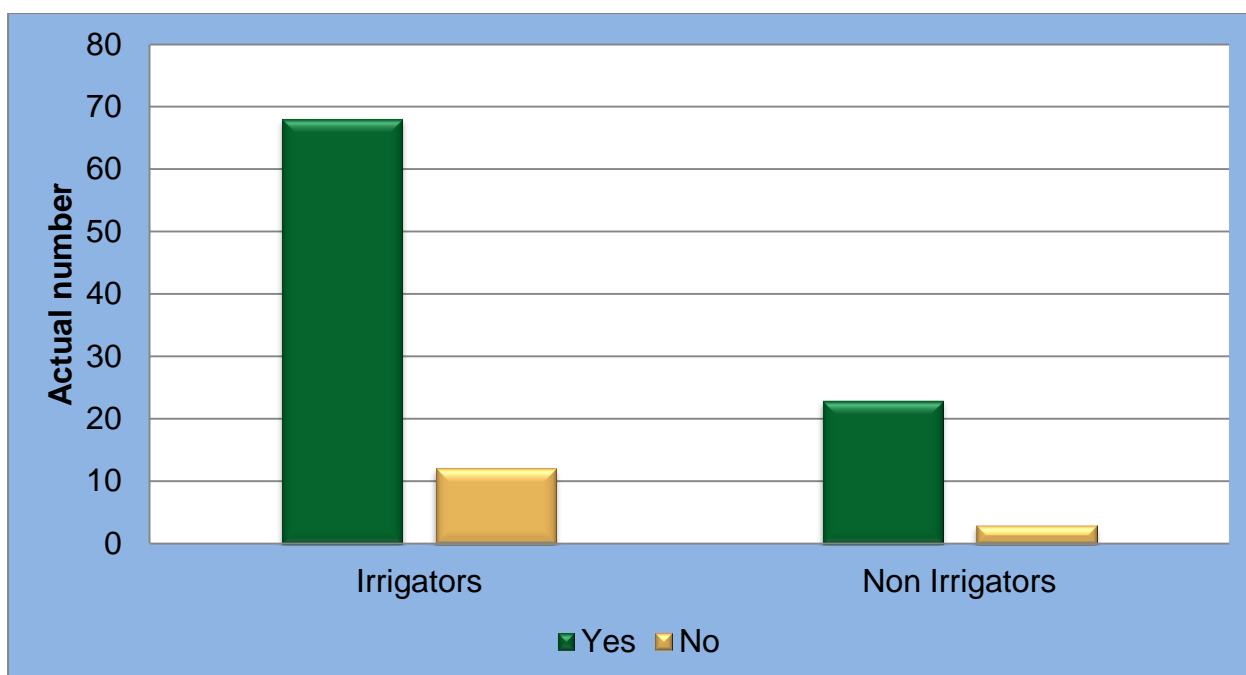
Figure 4.2 represents the distribution of households by the household head. The number of males is larger than the one for females, this shows that the majority of males retired from work because of age. However females used to be in charge in the household in the absence of the males. In addition women were dominant as household heads as the majority of the menfolk worked as miners and migrant labourers in other parts of the country while their spouses took charge of the homes. In recent years, the mines and white farms that were the major employers have been undergoing far-reaching transformations in ways that have reduced the role of black labour.



**Figure 4.2: Distribution by household members**  
**Source: Based on SPSS processing of field data, 2017**

#### **4.3.1 Distribution of household by access to credit**

Figure 4.3 represents access to credit of irrigation schemes and non-irrigation schemes. The irrigators and non-irrigators that have access to credit are shown by 68 and 23 respondents respectively. In addition only three respondents from non-irrigations scheme have access to credit and 12 of irrigators who do not have access. The results show that majority of people who are farming are willing to take credit but few who do not take credits, these are farmers who are working independently or have generated a lot of income. Despite these problems, some small-scale farmers have managed to produce food for own consumption and for the market.



**Figure 4.3: Distribution of households by access to credits**  
**Source: Based on SPSS processing of field data, 2017**

#### **4.3.1 Relationship between age group and gender of household head**

Age also plays an important role in the aims, aspirations, expectations, and restrictions of different age groups (FAO, 1983). The results of the grouping of the households into age classes in relation to the gender of the household heads are shown in Table 4.3.

**Table 4.3: Relationship between age group and gender of household head**

AGE	FEMALE	MALE	TOTAL
20 - 25	3	1	4
36 - 45	5	7	12
46 - 55	9	5	14
56 - 65	15	12	27
66 - 75	24	11	35
76 - 85	8	5	13
86 - 95	2	0	2
TOTAL	66	41	107

**Source: Based on SPSS processing of field data, 2017**

According to the total results in Table 4.3, majority of farmers are above 27% middle age for both men and women. Even if the situation could have been different in previous years, it makes sense that the older people are situated in the rural areas and engaged in farming activities while the youth are outside the villages, either employed in modern sector jobs or looking for work. Labour mobility increased for the black South Africans and this has manifested in virtual exodus of youth to towns and cities where opportunities for work and schooling opened for them quite dramatically. But while this demographic shift has been phenomenal and evidently important for households, evaluation of the gender effects has not been done and this should be interesting.

**Table 4.4: Chi-Square tests of gender-based differences in age of household heads**

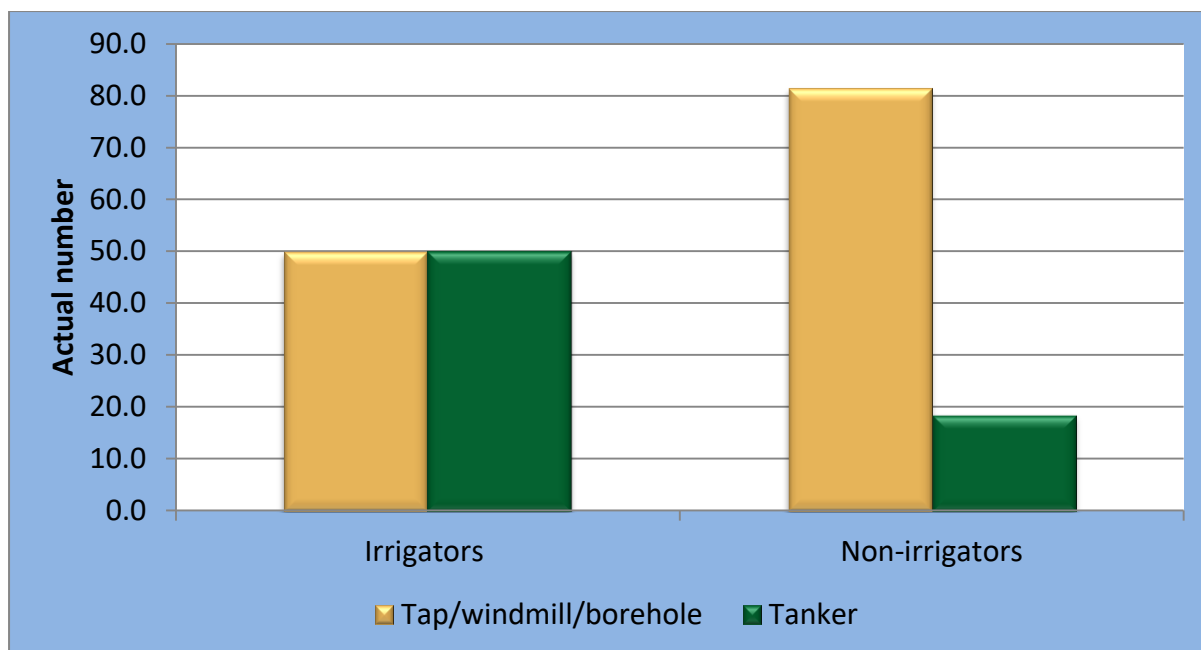
Test statistics	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.854 <sup>a</sup>	3	0.836
Likelihood Ratio	0.851	3	0.837
Linear-by-Linear Association	0.023	1	0.878
N of Valid Cases	107		
a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is .77.			

**Source: Based on SPSS processing of field data, 2017**

A statistically significant t-test result is one in which a difference between irrigator and non-irrigators is unlikely to have occurred because the sample happened to be out of the ordinary. The practical purposes statistical significance suggests that the two larger populations from which we sample are actually different. In this regard, the chi-square test (Table 4.4) does not suggest that women and men behave differently in terms of their involvement in farming. From the point of view of experience and decision making ability, age counts as one of the most important variables in the analysis of smallholder households. Older farmers would behave differently from younger farmers in respect to actions that either enhance or hinder the transition from homestead gardening to market-oriented crop production based on irrigation water use

#### **4.4.1 Distribution of households by water source**

Figure 4.4 reveals that there were only two of these sources which were identified as important sources of water from the respondents; namely tap water and rainwater, with the majority about 48% deriving domestic water from taps whilst 42% are derived from tanks.



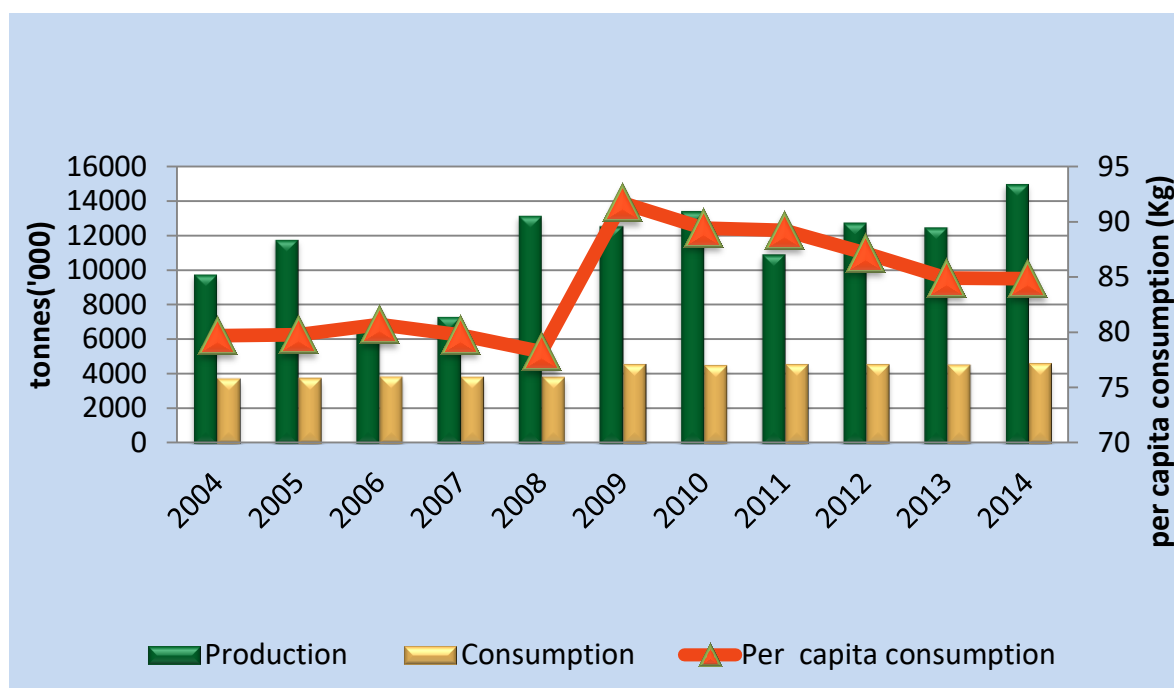
**Figure 4.4: Distribution of household by water source**  
**Source: Based on SPSS processing of field data, 2017**

### 4.3. Description of crop production

The research was not only focusing on socioeconomics which described the demographic of the study but also identified crop production as the potential to alleviate poverty. It also increases subsistence production for poor households, increases food supply and reduces dependency on purchasing foods in contest to food price inflation (Obi, 2012).

#### 4.5.1 Distribution of production, Consumption and consumption per capita

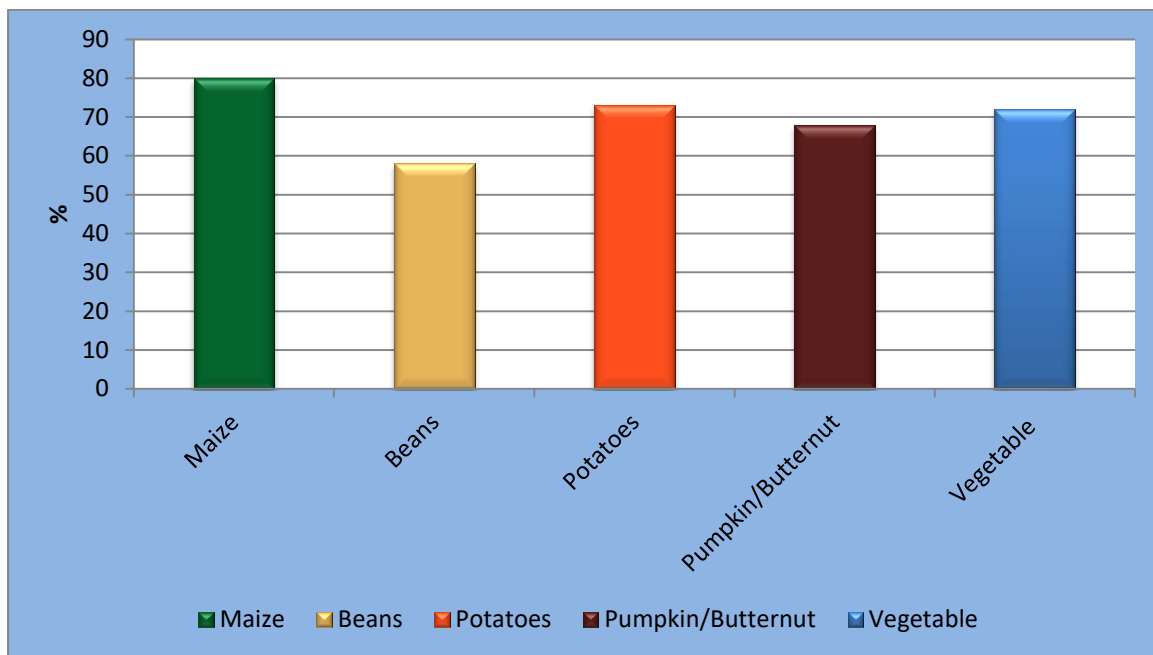
Figure 4.5 shows the production, consumption and per capita consumption of maize over the period of 10 years. The production of maize has continuously fluctuated, which ranged from 6959 to 14982 thousand tons. It was at the lowest and highest respectively in 2007 and 2014. However the consumption of maize has been fairly constant, with a marginally increase subsequent to 2008, but remains below 5000 thousand tons. On the other hand the per capita consumption significantly increased to 91.7 kilograms in 2009, with the lowest point being 78 kilograms tons in 2008



**Figure 4. 5: Production, consumption and consumption per capita, 2004-14**  
**Source: FAO, 2016**

#### 4.6.1 Distribution of crops grown by household head

Maize production in South Africa is set to decline considerably this season of drought owing to a marked reduction in area planted. As Figure 4.6 indicates, the maize crop is the most popular in the farming system. The crop has both high cultural and economic significance within the study area as in the rest of Southern Africa where it features prominently as a key dietary staple. Maize is followed in popularity by potatoes which are another key staple that is widely consumed in the area. Almost all meals are accompanied by vegetables and understandably, one of the farming system features high participation in vegetable production among the smallholders.



**Figure 4.6: Distribution of crops grown by household head**  
**Source: Based on SPSS processing of field data, 2017**

#### 4.5.1 Portion of crop sold

Research conducted by Ortmann and King (2007) reveals that some smallholder farmers have managed to produce food for own consumption and for the market, for example, in two communal areas of the province of KwaZulu-Natal farmers normally sell their produce through informal channels such as neighbours, local shops and monthly pension markets



**Table 4. 5: Descriptive statistics of portions of crop sold**

Variables	N	Mean	Std. Error Mean	Std. Deviation
Portion of maize sold	106	2.28	0.413	4.249
Portion of beans sold	107	0.397	0.1465	1.5152
Portion of potatoes sold	107	4.126	0.9953	10.2957
Portion of butternut/pumpkin sold	107	1.36	0.318	3.286
Portion of vegetable sold	107	3.491	1.8035	18.6551

**Source: Based on SPSS processing of field data, 2017**

Maize is the staple food in South Africa; most people who plant maize, they grow it for different purposes; namely they grow it for cash income, home consumption and for feeding animals. However Table 4.5 indicates that potato is the crop that is sold mostly than any other crop as indicated by mean value of 4.1. The growers of potato would normally be those who grow it primarily for sale and only consume the damaged portions of the harvested crop. It is clear that beans is not grown for the market to the same extent as the other crops, which makes it more of a subsistence crop than the other crops. An area in which the popularity and market possibilities of a crop are demonstrated is the level of investment in the crop.

#### **4.5.1 Comparison of crops sold and what household wished to sell**

Table 4.6 represent households sold and wished to sell crops such as maize, beans, potatoes, butternut/pumpkin and vegetables. It is grouped into five group categories and each phase consists of variables which is sold and wish to sell. In all cases, the mean values sold were less than the mean values the households wished to sell with an exception of mean value for maize. This shows that the households produce were going to be sold if they had enough hectares or land, considering the fact that there were good opportunities to sell their produce and by their own

assessments it was profitable to sell the produce in the local markets or any other markets that are willing to buy their produce.

**Table 4.6: Comparison of crops sold and what household wished to sell**

Pairs compared		N	Mean	Std. Deviation	Std. Error Mean
Phase 1	Maize Sold	106	2.28	4.249	0.413
	Maize wish to sell	107	2.220	4.6247	0.4471
Phase 2	Beans sold	107	0.397	1.5152	0.1465
	Beans wish to sell	107	0.612	2.0880	0.2019
Phase 3	Potatoes sold	107	4.126	10.2957	0.9953
	Potatoes wish to sell	107	6.22	20.577	1.989
Phase 4	Butternut/pumpkin sold	107	1.36	3.286	0.318
	Butternut/pumpkin wish to sell	107	1.02	2.771	0.268
Phase 5	Vegetable sold	107	3.491	18.6551	1.8035
	Vegetable wish to sell	107	3.481	18.7333	1.8110

**Source: Based on SPSS processing of field data, 2017**

The results also indicated that the differences between what is sold and what could be sold are not much in the cases of maize and vegetable. However there is substantial increase between the mean value of beans and potatoes. A narrow gap would mean that farmers see a market opportunity which can be exploited but do not see themselves being able to meet all of that from current production.

#### **4.7.1 Probit model estimation to predict propensity score**

The factors that affect the decision to participate in irrigation scheme are estimated using a probit model. In addition the last column of Table 4.7 indicates changes in the probability of participation in irrigation scheme given one unit of change in the explanatory variables; these are computed from the means of all of the explanatory

variables. However the likelihood ratio statistics of 95.193118 suggests that the estimated model is statistically significant at the 1% level and that the pseudo-  $R^2$  value indicates that the equation explains 63% of the variance in decision-making about whether to participate in irrigation scheme.

**Table 4. 7: Factors influencing performance of schemes (Probit model)**

Variables	Coefficient estimate	Standard error	Z	P> z
Gender	0.1863252	0.2808996	0.66	0.507
Age	0.0241401	0.016988	1.42	0.015***
Education level	0.0796596	0.1322527	0.6	0.547
Household size	0.0695475	0.0583328	1.19	0.033**
Access to market	0.0172293	0.0140277	0.93	0.052**
Occupation	-0.0172293	0.0140277	-1.23	0.219
Credit access	-0.563838	0.3129124	-1.8	0.072*
Distance to irrigation scheme	-0.1519817	0.2778313	-0.55	0.584
constant	-1.688518	0.9266186	-1.82	0.068
Probit model	Sample size			107
	LR Chi2 (09)			66.89
Log of Likelihood =95.193118	$R^2$			0.631

**Source: Based on SPSS processing of field data, 2017**

Significant effects are indicated with probability \*:  $p \leq 0.1$ ; \*\*:  $p \leq 0.05$ ; \*\*\*:  $p \leq 0.01$

Note: \*\*\*, \*\* and \* means sign significant at 1%, 5% and 10% level respectively

The results obtained show that out of nine variables included in the model, only four variables: Age, household size, access to credit and market significantly influenced the household participation in the scheme at 1%, 5% and 10% respectively. Having access to credit facilities is found to reduce household chances of participating in this scheme in this study area. This suggests that having access to credit facilities encouraged to purchase their inputs directly in the open market rather than waiting on the government until subsidized inputs are supplied which is also filled with uncertainties.

Previous empirical studies found a two way relationship between age and participation in irrigation scheme as well as other agricultural technologies. Younger household heads are more dynamic with regards to adoption of innovations than older household heads; however they are usually more occupied with other job opportunities as compared to farming. This implies that older household members are assumed to have more experience in farming and hence an increase in the probability of participation. Therefore, this study did not hypothesize the sign of relationship between age of the household head and participation in irrigation scheme.

Gender of the household head was not a significant determinant of participation in smallholder irrigation schemes because male and female headed households have equal chances to participate or not participating in irrigation scheme. However the result contradicted with the finding of Tekana and Oladele (2011) who stated that male-headed households experienced significant improvements to their household welfare through irrigation farming. Distance from the irrigation scheme, which was represented by the village in which a household is located, had a positive relationship with irrigation farming and was significant at 1% level of significance in explaining participation in irrigation farming. Households located closer to the irrigation scheme tended to participate more in irrigation farming.

Distance to the irrigation scheme is hypothesized to have a negative relationship. However households near to the irrigation scheme are expected to participate more

as compared to households further away, although irrigation water is just one significant factor for improving production; it plays a s important role, since there is no agricultural activity that can take place without water as an input. Access to reliable irrigation water enables farmers to adopt technologies and intensify cultivation, leading to increase in productivity, high production and greater returns from farming.

#### 4.8.1 Impact of scheme on sales crop income (PSM)

The estimates for the average household income earned from irrigation participation range from 6301.7 to 6302.7 in local currency, depending on the matching method used. All estimates are significantly different from zero at 1% critical level. The income effect from PSM is similar to the significant income mean difference between irrigation and non-irrigation scheme as presented in Table 4.8.

**Table 4.8: Impact of scheme on sales crop income (PSM)**

Output variable	Kernel Matching Method		
	ATT	Standard error	t-value
Household income	6301.745	4539.107	0.165*
	Nearest Neighbours Matching Method		
	ATT	Standard error	t-value
Household income	6302.734	3290.636	0.055**
<b>Model Summary</b>	Number of observation =107 Matches requested =5 Treatment model =Probit		

Significant effects are indicated with \*:  $p \leq 0.1$ ; \*\*:  $p \leq 0.05$ ; \*\*\*:  $p \leq 0.01$ .

**Source: Based on Stata (Version 13) processing of survey, 2017**

From these results we conclude that participation in scheme has a significant positive effect on household income. This income effect can be due to the higher price of the advanced technology adopted by irrigation schemes compared to non-

irrigation schemes. The sales price of crop shows significant mean difference at 1% critical level.

#### **4.4 Chapter summary**

This chapter presented and discussed the results from descriptive analysis of the smallholder irrigation scheme. Along the chapter, descriptive statistics analysis was approached by using mean values; frequencies, percentages and graphs of demographic socio-economic characteristics. Socio-economic characteristics such as age, household size, number of years spent at school, gender and other socio-economic variables such as market access, access to credit and access to distance to water supply were considered.

In addition probit regression model was used to estimate factors that influenced the performance of smallholder irrigation schemes. Furthermore the results from propensity score matching revealed that irrigation exerts a positive impact on household income. Moreover this provides sufficient evidence that irrigation schemes do make a contribution to rural livelihoods through their effect on household income and food security

## **CHAPTER 5**

### **SUMMARY, CONCLUSION AND RECOMMENDATION**

#### **5.1 Introduction**

This chapter presents the summary, conclusion and policy recommendations of the study. In addition it is also summarizing the introductory, literature, methodology which include methods that were used to collect, analyse data and procedures that were considered when identifying the unit of analysis, lastly presentation of results.

#### **5.2 Summary**

The research was divided into 5 chapters which include introductory part which included background of the study followed by problem statement, literature review literature which is divided into subheading where authors are contradicting themselves and some instances agreeing among each other, a methodology which covered the description of the study area followed by research instruments such as sample size and sampling method, lastly the presentation of results of the study which include econometric analysis such as descriptive statistics analysis of demographic socio-economic characteristics and probit and propensity score matching regression analysis. Moreover it also summarises and highlighting the main key significant points that were narrated in each of the above chapters.

##### **5.2.1 Background and problem statement**

The background of the study was critical discussed focusing at an international level then it also focused in Africa as a whole; lastly it focused in South Africa. Based on the critical background, the problem statement was identified and it was addressed by the overall objective of the study, thus lead to specific objectives, research questions, hypothesis and significance of the study.

##### **5.2.2 Literature review**

The literature was reviewed to identify gaps based on the previous studies that are similar to smallholder irrigation schemes. The objectives of the study were used as

the subheadings and some other build ups among those subheadings. The reviewed literature suggested that households should adopt the strategy of irrigation because it has potential to contribute to rural livelihood thus eradicating poverty, creating employment and equality. Controversy access to market and other factors were identified as the big problem but still majority of irrigators managed to penetrate to markets under those difficulties

### **5.2.3 Methodology**

The study was conducted in Idutywa village under Mbashe Municipality of the Eastern Cape Province. The sample comprised of 107 households and they were categorised into two groups namely; irrigators and non-irrigators. Non-probability sampling method was considered, therefore means that purposive sampling was used because it was based on the judgement to select members of the population of interest, in addition stratified sampling was also considered because that is where the population was grouped into a group called strata's then the randomly selection was used on those groups. The semi-structured questionnaire was distributed to the respondents which included both closed and open ended questions and ethical issues were observed

### **5.2.4 Presentation of results**

After collecting the data it was coded and presented on excel spread sheet then imported to SPSS version 24. The objectives were attained by using descriptive statistics analysis which was used to analyse demographic socio-economics characteristics of the study; in addition probit regression model was used to analyse the factors that influence smallholder irrigation schemes and obtained only four significant variables out of nine variables were presented. Furthermore propensity score matching was also used to predict the treatment between the categorised group which is irrigators and non-irrigators.

## **5.3 Conclusion**

The government of South Africa has given attention to irrigation schemes so as to reduce the frequent food insecurity. The objective of this study was to evaluate the



impact of smallholder irrigation scheme to the livelihoods of rural household income and household food security, as the select livelihood outcome variables. Multistage sampling was employed and the study purposively selected villages of Idutywa. Two groups of households were compared namely; irrigators and non-irrigators and the sample size were 107 respondents comprising of 50 irrigators and 57 non-irrigators. It may be also concluded that, even though some particular irrigation schemes collapsed but the operational irrigation schemes play an important role in rural livelihoods. It is clear that despite all the challenges faced by the smallholder irrigation schemes, the irrigation schemes are able to contribute positively in rural households income and food security, this being the purpose of their establishment. In addition this provides a strong motivation for continued investing in smallholder irrigation schemes in South Africa as a part of the strategy to improve rural livelihoods and grow the rural economy. However special attention should be given to significant factors that influenced participation in irrigation scheme and factors that significantly distinguished irrigators from non-irrigators.

#### **5.4 Policy recommendations**

Policies that are in support of irrigation would also encourage more schemes to become irrigators are also vital. As independent irrigators benefit more from smallholder irrigation farming, independent irrigation should be promoted as an option for expanding smallholder irrigation farming. Policies for expanding smallholder irrigation schemes should be integrated into the overall strategy of growing the rural economy within the National Development Plan of the country. Therefore, the government must address this critical need and create a marketing mechanism for smallholder farmers.

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**ANNEXURE: QUESTIONNAIRE**

**Evaluation of the socio-economic performance of smallholder irrigation schemes in Idutywa village of the Eastern Cape Province**

BY

PHIWE JIBA (201000984)

**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE  
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN  
AGRICULTURE (AGRICULTURAL ECONOMICS)**



**University of Fort Hare**  
*Together in Excellence*

## A. QUESTIONNAIRE IDENTIFICATION

A.1. Fill in the following blank space and put X where appropriate

Date	
Village	

### A.2. Household Size, Composition and Characteristics

Names of family and other HH members (HHH First)*	Relation to HHH (Code)	Gender (M/F)	Yr. born	No. yrs. spent in school	Occupation. (Code)	If F, No. Children Born	If not born in HH		
							Yr. came	From where (Code)	Province (Code)
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									

- Do not count grandchildren who are not in the HH.

Relation to HHH	Occupation	Where	Province
1. Husband 2. Wife 3. Mother 4. Father 5. Son 6. Daughter 7. Cousin 8. Niece 9. Nephew 10. Uncle 11. Aunt 12. Brother 13. Sister 14. Friend 15. Grandson 16. Grand daughter 17. Grand Father 18. Grand mother 19. Other: specify 20. _____	1. Farmer 2. Wage employment 3. Unemployed 4. Student 5. Pensioner 6. Minor 7. Other	1. Town 2. Township 3. Another village 4. -----	1. Eastern cape 2. Gauteng 3. Northern cape 4. Free state 5. Western cape 6. KZN 7. Limpopo 8. Mpumalanga 9. North west

A.2. What does HH have?

Item	Answer		Codes	
1. House	No. of Houses		<b>House Tenancy</b> 1. Own 2. Rent	<b>Drinking Water</b> 1. Tap/windmill/borehole 2. Tanker 3. River 4. Well 5. Rain 6. Spring/stream
2. Water source (Code)				

A.3. Do you have individual HH RAIN FED plot of any of listed crops (Y/N)? If Y, what are area, rank in terms of cash income (1 most important), rank in terms of food security (1 most important) for each crop?

Crop	Y/N	Area (Ha) planted	Rank in terms of cash	Rank in terms of food
Maize				
Beans				
Potato				
Butternut/Pumpkin				
All other vogs.				
Other1 (sp.				
Other2 (sp.				

A.4. Do you have individual HH IRRIGATED plot of any of listed crops (Y/N)? If Yes, what are area, rank in terms of cash income (1 most important), rank in terms of food security (1 most important) for each crop?

Crop	Y/N	Area (Ha) planted	Rank in terms of cash	Rank in terms of food
Maize				
Beans				
Potato				
Butternut/Pumpkin				
All other vegetables.				
Other1 (sp.				
Other2 (sp.				

A.5. Do you belong to a COOP that grows any of the listed crops in group (Y/N)? If Yes, what area planted of each crop in the current (or last) season; what area would the coop wanted to plant; what is reason, if any difference?

Crop	Y/N	Area (Ha) planted	Area would like to plant	Reason for difference



Maize				
Beans				
Potato				
Butternut/Pumpkin				
All other vegs.				
Other1 (sp.				
Other2 (sp.				

A.6. In the last season, how much of each crop did you harvest from INDIVIDUAL HH plot? How many portions of harvest did you sell?

How many portions would you have wished to sell, what is reason for difference, if any?

Crop	Qty harvested	Measure (Code)	Sold		Wished to sell	
			Portion out of 10	Amt. realized	Portion out of 10	Reason for difference
Maize						
Beans						
Potato						
Butternut/Pumpkin						
All other vegs.						
Other1 (sp.						
Other2 (sp.						

A.7. In the last season, did you use hired labour for any crop in INDIVIDUAL HH plot of any crop (Y/N)? If Y, for what activity (mostly), what gender of hired labour mostly, what source of hired labour? Did you use as much hired labour as you wanted (Y/N)? If No, what is the reason?

Crop	Used hired labour?				Used as much as wanted?		Codes
	Y/	Activi	Gend	Sour	Y/	Reaso	

	N	ty (Code )	er (M/F)	ce (Code )	N	n, if N	
Maize							<b>Activity</b> 1. Land preparation 2. Planting 3. Weeding 4. Harvesting 5. Chemical application 6. Transportation 7. All combined  <b>Source</b> 1. Village
Beans							
Potato							
Butternut/Pumpkin							
All other vegs.							
Other1 (sp.							
Other2 (sp.							

A.8. If you sold any crop in the last 12 months, where did you sell and to whom did you sell mostly?

Crop	Where (Code)	To whom (Code)	Codes
Maize			<b>Where</b> 1. Town 2. Township 3. Village  <b>To Whom</b> 1. Individual 2. Large-scale farmer 3. Middlemen/traders
Beans			
Potato			
Butternut			
Pumpkin			
All other vegs.			
Other1 (sp.			
Other2 (sp.			

A.9. How far is the market in Km.....

A.10. Do you have access to information.....

A.11. Do you use HH labour in production of any crop in INDIVIDAUL HH plot (Y/N)?  
If Yes, which activity do you use HH labour most?

Crop	Y/N	If Y, activity (Code)	Code
Maize			<b>Activity</b> 1. Land preparation 2. Planting 3. Weeding 4. Harvesting 5. Chemical application 6. Transportation 7. All combined 8. 1 to 4 9. 1 to 5 10. 1 to 6
Beans			
Potato			
Butternut/Pump kin			
All other veks.			
Other1 (sp.			
Other2 (sp.			

A.12. If you applied any of listed inputs to INDIVIDAUL HH plot of any crop how much did you spend on each input?

Crop	Hired labor	Seed	Fertiliz er	Chemic al	Other1	Other2
Maize						
Beans						
Potato						
Butternut/Pump kin						

All other vegetables.						
Other1 (sp.						
Other2 (sp.						

A.13. How much farmland by type is available to you to use today, for how long can you use it, how did you acquire it, how much do you pay per period?

Farmland type	Area (Ha)	Available for (Yrs)	Acq. Method (Code)	Payment		Codes	
				Amt. (Rands)	Per period (Code)		
Homestead Garden						<b>Method of acquisition</b> 1. Inheritance 2. Purchased 3. Rented 4. Allocated by chiefs/PTO 5. Communal 6. Tenure	<b>Payment periods</b> 1. Once off 2. Monthly 3. Yearly
Non-homestead field, rain fed							
Non-homestead field, irrigated							
Cooperative field, rain fed							
Cooperative field, irrigated							
Irrigation							

scheme field							
-----------------	--	--	--	--	--	--	--

A.14. What perception do you have about the fertility of your farm land  
(Fertile/Infertile)

A.26. Did you take credit in the last 12 months (Y/N)? if Y, for what purpose, how much, from what source, for what period, and what is interest?

Y/N			<b>Purpose</b> 1. Farming 2. Wedding 3. Funeral 4. Education 5. Building 6. Ritual/sangoma 7. Food 8. Entertainment 9. Transport 10. Furniture 11. -----	<b>Source</b> 1. Stokvel 2. Mashonisa 3. Microlenders—Nerpo 4. Friends/relatives/neighbours 5. -----  <b>Per Code</b> 1. Monthly 2. Annually
Purpose (Code)				
Amount				
Source (Code)				
Period (Code)				
Interest	Rate (%)			
	Per (Code)			

A.27. Did you take enough loan (Y/N)?-----; if N, what is the reason?-----  
 -----

A.28. In the last 12 months, how much were the HH cash income from different sources?

Source	Amount (R)
Crop	
Wage	
Farm labor	
Casual labor	
Social grant	
Remittance	

A.29. In the last 12 months, on what did you spend your cash income?

Item	Amount (R)
Farm	
Food	
Drink	
Funeral	
Savings	
Entertainment	
Rituals	
Education	

A.30. Compare livestock with crop, which do you consider more important? -----  
 --- (L/C)

Why? -----

A.31. In the last 7 days, how many times did you eat each of the following food items?

Food item	No. of times
Maize product	
Light pap	
Rice	
Sweet potato	
Beans	
Potato	
Any Vegetables	
Poultry meat	
Beef	
Mutton	

Goat meat	
Pig meat	
Fish	
Milk	
Bread	

A.32. How do you rank food prices in the past 12 months?

A.33. In the past year, which months were you experiencing food shortages? <b>Food item</b>	<b>Months</b>
Maize product	
Light pap	
Rice	
Sweet potato	
Beans	
Potato	
Any Vegetables	
Bread	

A.34. If you did experience food shortages, what were the coping strategies? -----  
 ---- (Code)

Codes

1. Sell cattle's
2. Sell small stocks
3. Off-farm employment
4. Took credit



A.35. Are you satisfied with your achievements in life? ----- (Y/N); Explain-----

-----

A.37.1. Reason for trend -----

A.38 What year did you start producing the following crops? How many Ha did you start with? How many Ha do cultivate today? How many Ha did you cultivate 5 years ago? What is the trend in the area of each crop you cultivate; increasing (3), no change (2) or decreasing (1) in the last 10 years?

Crop	Yr started	Ha. started with	Ha. today	Ha. 5 yrs ago	Trend
Maize					
Beans					
Potato					
S. potato					
Butternut/Pumpkin					
Vegetables					

THANK YOU FOR YOUR TIME