University of Fort Hare

Together in Excellence

DEPARTMENT OF AGRICULTURE ECONOMICS AND EXTENSION

The Impact of new agricultural technology adoption on food security in South Africa: the case study of irrigation in the rural areas of Nongoma in Kwa-Zulu Natal Province of South Africa

Submitted in fulfilment of the requirements for the degree of

Masters in Agricultural Economics

M Agric (Agricultural Economics)

DEPARTMENT OF AGRICULTURE ECONOMICS AND EXTENSION

University of Fort Hare

Together in Excellence

NAME: BLOSE, M.R.

STUDENT # : 200909197

SUPERVISOR: Prof. A. OBI

Declaration

I hereby declare that all the contents of this document that I have submitted in fulfillment of the requirements of the Masters Degree in Agricultural- Economics at the University of Fort Hare, Faculty of Science and Agriculture are the product of my independent work. It has not been previously produced and submitted in any University by anyone else in the entire universe for a similar purpose. All the work that was written by other authors and used in the project is fully acknowledged.

Signature: ..... Date: .....

Name: Blose, M.R.

Acknowledgement

My first sincere gratitude goes to my supervisor Professor A. Obi without whom I would not have managed to come up with this document. Thank you very much for your wisdom and desire to see me succeed in this research. I gratefully acknowledge my supervisor for his guidance and advice during the course of this study. I really appreciate all the help you offered me, there was never a need for me to make an appointment to see you because you were always willing to assist me. I am thankful for his useful suggestions and comments which contributed to the success of this study.

My second gratitude goes to Dr. P. Ndou for guidance in analysis and writing.

My third gratitude goes to my family for the undivided support; they gave me during my study.

To GOD Almighty, your love, grace, blessings and wisdom did not go unnoticed. It is because of you that I am where I am today and it is also through your love that I had the wisdom needed to carry me through my research. You gave me strength to go on even when things did not seem so promising. May all the praise and glory be to you, the King of Kings forever and ever, AMEN.

Abstract

The Government of South Africa has been investing in the development of irrigation systems serving small-scale farmers for a long time with the expectation that these would lead to increased agricultural productivity that would translate to improved earnings for these farmers and lead to poverty reduction. Unfortunately, this does not seem to have happened and there are concerns about the current and prospective implications for the country meeting the Millennium Development Goals, particularly in respect to halving the number of people living in poverty. The main aim of this study was to assess the impact of the adoption of new technology on the socio-economic wellbeing of irrigating farmers of Maphophoma village in Nongoma Local Municipality of KwaZulu Natal (KZN) Province. The study employed a survey methodology to collect socio-economic data from farming households.

This study was carried out in Kwa-Zulu Natal Province. The KZN study area has both irrigating and non-irrigating farmers. The study assessed the socio-economic impact of irrigation on the farmer's livelihood. Currently the farmers are producing maize and vegetables with the common agricultural commodities between these two groups being maize, cabbage and potatoes. The farmers are producing at low levels of productivity. The government has engaged in a revitalization programme of the irrigation with the aim of upgrading the infrastructures and also providing the starter packs (seeds and fertilizers) to the farming communities. The primary data were obtained from the 120 households; 60 [illegible] randomly selected from farmers using irrigation and the other 60 from the non-irrigating farming households.

The key findings of the study show that the adoption of new technology has a positive relationship with the total yield of the farmers. Based on the findings of the study, an increase in the adoption of new technologies, by small-scale farmers, is recommended. If technology adoption is taken into consideration in small-scale farming it will reduce the extent of food insecurity, which results in poverty alleviation in rural areas. Relevant government structures need to work hand-in-hand with farmers in order to identify the real needs of these farmers. This will help to eliminate the promotion of unwanted technology or ideas by the farmers.

Key words: Agricultural technology, adoption, food security, irrigation.

Acronyms and Abbreviations

AIDS - Acquired Immune Deficiency Syndrome

BRU - Bio Resource Unit

ARDC - Agricultural and Rural Development Corporation

CMA - Catchment Management Agencies

DAFF - Department of agriculture forest and fisheries

FAO - Food and Agriculture Organization

GHS - General Household Survey

HA - Hectares

HIV - Human Immunodeficiency Virus

IMT- Irrigation Management Transfer

KZN - KwaZulu Natal

MDG - Millennium Development Goals

NGO - Non-Governmental Organizations

NWA - National Water Act

PIM - Participatory Irrigation Management

RDP-Reconstruction and Development Programme

RSA – Republic of South Africa

SA - South Africa

SIS - Smallholder Irrigation schemes

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1.Background

Using appropriate, research-based, agricultural technologies to promote food security is a major priority for many developing nations. Since farmers differ in their socioeconomic backgrounds, academic levels, learning needs and problems, these technologies must be communicated to them using proven extension education principles and appropriate teaching methods.

Agricultural technology is the application of techniques to control the growth and harvesting of animal and vegetable products (Gopal & Srivatava 2000). According to Kislev (1981) the intensification of fertiliser usage, (which is biochemical technology) and the use of tractors, (which is mechanical), are the two imp[illegible] categories of agricultural technology. Agrochemicals or farm machines are types of technology that significantly increase production. The adoption of technology is observed as an increasing trend in many fields; as a result, agriculture cannot neglect the adoption of new technologies. It increases agricultural productivity in developing areas of South Africa (McLachlan & Kuzwayo 1997) as anywhere else in the world. This embraces the adoption of genetically modified crops, pests and insect resistant crops as well as organic farming. The adoption and use of modern technology is generally a potential vehicle for development in smallholder farm but the adoption rates remain low (Spielman, Kristin, Martha & Gezahegn 2007).

According to Barab & Duffy (2000) technology adoption plays a vital role determining the future of the agricultural industry. Agricultural technology enhances the development and determines the future of agriculture. Land that has been overused or misused through agricultural practices can be remediated through the use of technology (McLachlan & Kuzwayo 1997). A significant shift in agricultural practices has occurred over the past century, in response to new technologies. In particular, the method for synthesizing ammonium nitrate made the traditional practice of recycling nutrients with crop rotation and animal manure less necessary (Kislev1981). Household food security in rural areas can be ensured through subsistence farmers, who will be

assisted with basic technology for water management, water harvesting and the traditional practice of recycling nutrients with crop rotation and animal manure less necessary (Joemat-Pettersson, 2009). New technology can provide additional rural employment, but there are always countervailing pressures to reduce labour input and lower costs. Technology also contributes towards lowering food prices by providing new and easy measures of agricultural production (Maxwell 2001).

New agricultural technologies and practices, which are accepted by smallholding farmers within their operational capacity and render positive incentives, can contribute considerably to the alleviation of poverty (Pinstrup-Andersen &Pandya-Lorch 1997). Where new technologies have been adopted, concerns are often raised that these technologies have different impacts on the well-being of men and women (Barab & Duffy 2000). Agricultural technology has the goal of food production and the preservation of non-renewable resources. It also helps smallholder farmers to improve their yields so that they generate an income and decrease poverty. There are factors that constrain smallholder farmers from adopting the new technologies, some of these factors are the level of education and financial status of the smallholder farmers themselves.

The occurrence of erratic rainfall has created uncertainty for agricultural production and emphasized the need for irrigation in Africa. The traditional system of irrigation comprises of the use of either a rope or buckets to lift and distribute water from shallow open wells, or watering cans to lift water from streams. Although the low capital requirement of these traditional technologies makes them advantageous and affordable, their low delivery capacity and labor intensive nature make them highly unfavorable to African production conditions (Kamara, Danso, Mahu, Cafie & Drechsel 2004).

Improved water lifting technologies, with relatively high efficiencies such as motorized pumps, have been tried but have been found to be favorable primarily to large-scale farmers. For small-scale farmers, who usually irrigate relatively small plots of land and operate relatively small capital, such technologies are unaffordable (Hyman, Lawrence & Singh 1995; Brabben & Kay 2000).

At present, South Africa has an estimated 1.3 million hectares of land under irrigation for both commercial and subsistence agriculture (Fanadzo, Chiduza & Mnkeni 2010). Irrigation was introduced to South Africa soon after the arrival of European settlers, although it only really started developing from 1912 onwards. According to Bruwer & Van Heerden (1995) and (Van Averbeke, M'Marete, Igodon & Belete 1998) describe this evolution thoroughly; moreover, they stress the early gap that existed between white and black irrigation. In the former Bantustans or Native Areas, minor irrigation developments occurred before 1950. Most irrigation schemes were started after the publication of the report from the so-called Tomlinson Commission on the socio-economic development of the Bantustans. This report and the implementation of some of its recommendations had a major effect on settlements, land use patterns and irrigation development in black rural areas. Its effects are still evident today. Based on information collected at existing schemes, the Commission suggested that irrigated holdings of 1.3 to 1.7 ha were adequate to provide a family with a living that would satisfy them, and whereby the whole family would work on the holding (Bruwer & Van Heerden 1995).

According Denison & Manona (2007) South Africa has about 217 smallholder irrigation schemes covering some 50 000 ha and these schemes are mainly located in former homelands. The schemes are estimated to support approximately 32 000 families across the country. In a database of smallholder irrigation schemes compiled by Denison & Manona (2007) it is shown that about 57% of the smallholder schemes are found in Limpopo province located in the northern part of the country, 23% in the Eastern Cape and 11% in KwaZulu Natal. The remaining 9% is distributed across the other four provinces Mpumalanga, North West, Free State and Western Cape. Denison & Manona (2007) stated that the other two provinces, Gauteng and Northern Cape were excluded because it could not be established if there are any smallholder schemes. Denison & Manona (2007) noted that, in post-1994 South Africa, most of these schemes were supported financially by the government but there is a notion that these schemes have not performed to expectations.

In South Africa, smallholder irrigation schemes are of secondary importance in terms of land area and farmer participation. In 2010, smallholder irrigation schemes covered 47 667 ha, compared to the 1 675 822 ha of registered irrigation land in 2008, of which 1 399 221 ha was

irrigated annually (Van der Stoep, 2011). The total population of 34 158 plot-holders on smallholder irrigation schemes in 2010 was also relatively small compared to the 1.3 million Black homesteads that had the other forms of irrigation practiced by Black people, was that these schemes represented a substantial public investment (Van der Stoep, 2011).

According to Muzari, Gatsi & Muvhunzi (2012) there is a large gap between what the smallholder farmer gets and what is feasible with the available technology in sub-Saharan Africa (Muzari *et al* 2012). In looking at what has gone wrong, a fundamental issue of concern relates to the technologies and institutional arrangements that are being promoted by governments in the region to increase agricultural productivity (Muzari *et al* 2012). The use of agricultural technologies affects the rate of increase in agricultural output Increased agricultural productivity, technology adoption rates, and household food security and nutrition can be achieved through improved agricultural practices, expansion of rural financial markets, increased capital and equipment ownership by rural households, and development of research and extension linkages(Muzari *et al* 2012). Increased technology development and adoption can raise agricultural output, hence improve household food intake.

Based on the evidence presented by Muzari *et al* (2012) one of the strategies for poverty reduction through increased agricultural productivity is to promote the production of high yielding crop varieties. Significant increases in crop production in sub-Saharan Africa can be achieved from improved and open-pollinated varieties developed with a comprehensive breeding system (Muzari *et al* 2012). The breeding should incorporate multi-sage selection for important agronomic traits such as disease resistance, insect resistance, drought and stress tolerance, high yield, and high response to improved cultural practices (Muzari *et al* 2012).

1.2. Problem statement

South Africa has invested substantially in smallholder irrigation to benefit smallholder farmers in less developed areas. There are more than 200 small-scale irrigation schemes in South Africa irrigating approximately 50 000 hectares and providing an income to over 37 000 farmers (Van Averbeke & Mohamed 2006). However, there are good reasons to believe that the production

performance at the smallholder level is sub-optimal with farmers probably more engaged in the production of low-valued food crops which do not even meet subsistence food requirements (Van Averbeke & Mohamed 2006).

There are various constraints that delay the growth of smallholder farmers varying from systems constraints, allocative constraints to environmental-demographic constraints (Kirsten, Perret & De Lange 2002). Some of the systems constraints are lack of access to land, poor physical and institutional infrastructure (Kirsten *et al* 2002).

The majority of smallholder farmers have limited access to land and capital and have received inadequate research and extension support resulting in considerably low standards of living (NDA 2005). This is due to the unproductive and inefficient use of land in the absence of appropriate research and extension services. Agriculture is largely carried out under increasing pressure of scarce land resources managed under insecure customary land ownership and communal grazing. These insecure tenure systems such as communal land tenure system constrain the farmers from producing to their highest potential (Kaimbi 2003).

High transaction costs are one of the major factors constraining growth of smallholder agriculture in African countries and this is largely attributed to poor infrastructure. Transaction costs start from different sources; they include costs of information, negotiation, monitoring and enforcement of contracts (Makhura 2001). Many farmers receive low prices for their cash crops by selling them at their farm gate or local market. However, these same farmers could receive much higher prices by selling their goods in urban centers (Ashraf, Gine & Karlan, 2005).

According to Kirsten *et al* 2002 environmental-demographic constraints also form part of the main constraints of smallholder farmers. As the population continues to grow, increasing pressure on fragile lands and agricultural production, smallholder perform under limited demographic conditions would lead to falling agricultural productivity, major food crises and increased rural poverty. According to FAO (2008) the challenge in South Africa is predominantly around access to food and means to produce it. Most smallholder farmers are located in the rural areas, particularly in the former homelands where both physical and

institutional infrastructure limits their expansion (FAO 2008). Lack of access to proper infrastructure (roads) for example, limits the ability of farmers to transport inputs, produce and also access information.

Statistics South Africa presented by GHS (2009) reported that an estimated 20% of South African households have inadequate or severely inadequate food access. The GHS (2009) report indicates further that during 2008 food access problems were mostly serious in Free State where 33.5 % of the households have inadequate food access. They were followed by household in Kwazulu-Natal with 23%, Eastern Cape 21.4 % and Mpumalanga 21.5 %. Western Cape (14.5 %) and Limpopo (11, 9 %) had the least food security problems in 2008.

In terms of livelihood objectives, evidence shows that most smallholder farmers do not wish for their children to become farmers (Van Averbeke & Mohamed 2006). Instead, they try by all means to give their children a formal education so that they can enhance their chances of receiving formal wage employment. However, this should by no means be taken as a sign that these smallholder farmers do not value their plots. As a matter of fact, Van Averbeke & Mohamed (2006) hold the view that, for most black irrigators, their plots present an important livelihood asset that could be put to productive use in times of need.

The main problem of irrigation schemes is the low performance of smallholder irrigation schemes and the subsistence basis that prevents farmers from increasing their cash income, whereas cash costs are generally high, such as the costs of mechanization and farming inputs (Ntsonto 2005). The specific problems in this regard are the low productivity of land and water, and the low contribution of irrigated farming to people's livelihood.

The production of smallholder irrigated farmers is not as intensive as needed and often involves the production of low value food crops which do not even meet subsistence food requirements. The evidence presented by Backeberg, Bembridge & Bennie (1996) makes it clear that South Africa has invested substantially in smallholder irrigation to support smallholder farmers in less developed areas. According to Joemat-Petterson (2009) the South African government sees smallholder irrigation as a tool for improving rural livelihoods, food security and empowering and mainstreaming the previously disadvantaged farmers in the local, national and international

economy. As such the government has invested significant financial resources into the rehabilitation of smallholder schemes across the country and mobilized strong technical support for these schemes through various partnerships between non-governmental organizations and local governments in the different provinces (Joemat-Pettersson, 2009).

Although the government pumps a lot of money into capacity building and the empowerment of small-scale farmers, the results do not justify the investment due to the lack of skills and experience of small-scale farmers, particularly the black farmers.

The problems faced by small-scale farmers are the lack of funds and information; these problems can be attached by the introduction of the joint efforts of farmers in terms of cooperation in matters such as irrigation schemes by which the farmers can share the available resources and information.

In general, most irrigation schemes in Africa have performed poorly. There is certainly a large gap between the actual performance and the pr erformance of these schemes (Bembridge 1986).

According to Bembridge (1986) a number of the problems experienced in African irrigation schemes can also be attributed to the shortcomings of project planning. Political structures as well as the means of communication that would enable the needs and desires of local people to be met are usually expressed at national and project levels. Irrigation development projects are frequently imposed upon from above, resulting in often futile efforts to stampede traditional farmers and socio-economic patterns into a high technology farming system (Bembridge 1986).

Smallholder irrigation schemes present special management problems, especially where water is scarce and supply is often less than the demand (Albinson & Perry 2002). Water distribution in smallholder irrigation schemes has proved to be a challenge at scheme management level. Scheme management failures have frequently resulted in chaos involving illegal tempering with water conveyance structures and water shortages at different locations within the scheme thus affecting the irrigation performance (Albinson & Perry 2002).

The emergence or increasing demand of non-agricultural users, especially mines which put pressure on community users, and smallholder irrigation schemes in particular, has paved the way for water rights' transfers from communities to other sectors (Bembridge, 2000).

1.3. The Objectives of the Project

The main objective

The main objective of this study is to measure the aggregate impact of the adoption of new agricultural technology to the food security of rural households.

Specific Objectives

- To identify the factors that influencing the adoption of technology amongst small-scale farmers in rural areas.
- To assess the availability of resources, land, for the implementation of food security programs.
- To identify the challenges encountered by small scale farmers in the adoption of new agricultural technology for food security programs.

1.4. Research questions

The study had two main research questions, namely:

- What are the factors affecting the adoption of technology amongst the small-scale farmers in rural areas?
- What are the challenges that encountered by small scale farmers in the adoption of new agricultural technology?

1.5. Hypothesis

This study proposed the testing of the following hypothesis:

> There is no relationship between farmers" production levels and adoption of improved (irrigation) technology.

1.6. Justification

By pointing out the factors that influence the adoption of technology, this study will provide guidance to the adoption of technology administrators and researchers for enhancing the program's effectiveness. The added knowledge on which factors have the greatest influence on new technology adoption will help administrators make more informed decisions on how to promote technology adoption.

Another benefit from the research will be provision of an explanation of the current state of technologies used by farmers. Furthermore, since technology adoption involves a variety of practices that are specific to individual crops, measuring its adoption on various crops may provide a strong case for increasing investment in various new technology adoption research.

The study was also conducted to determine the contribution of the adoption of new agricultural technology, which in this case is irrigation, to the socio-economic conditions and livelihood of the community surrounding the project area. The study will be carried out in the Maphophoma area because the area has smallholder farmers. Structural agricultural changes have been made in the past, in an effort to promote increased production amongst smallholder farmers. Changes such as land reform and improved access to credit have to be appreciated, as they have benefited some former disadvantaged black farmers. However, these reforms have not been sufficient in terms of the transition to commercial agriculture.

1.7. Outline of the study

This thesis consists of 5 chapters which are organized as follows: Chapter 1 covers the background of the study, problem statement, objectives, research questions, hypothesis and justification. Chapter 2 covers the literature review, which includes an introduction to the area of study, food security, history of small irrigation schemes in SA, socio-economic characteristics of irrigation schemes, the farming system and marketing in general, as well as irrigation management transfer and revitalization, constraints of smallholder farmers, role of land reform, dry land farming and the possible factors affecting agricultural production. Chapter 3 presents the selection of the study area and also, presents the research methodology used in the study.

Chapter 4 presents the presentation of research findings. Chapter 5 concludes the study and provides recommendations based on the findings of the study.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

The main aim of this chapter is to assess the main role played by adoption of new agricultural technology by small scale farmers to food security. The study reviewed literature on role of agriculture in food security and the factors that influence the adoption of new agricultural technology by small scale farmers. Furthermore this chapter looked on the impact of adapting to new technology to food security. Also review the small irrigation in South Africa and also the small irrigation and its development in SA. The management, renewal and rehabilitation of small irrigation schemes reviewed in this chapter. The role of land reform in the developing small scale farmers and the role of agriculture in food security also reviewed in this chapter.

2.2 Technology Adoption

Different authors define the term technology in a variety of ways. Rogers (1995) defines technology as the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome. A more meaningful definition may be that a technology is a set of new ideas. In this study, technology refers to modern irrigation.

The diffusion model of Hayami & Ruttan (1985), argues that technology transfer is necessary for improving the agricultural production of developing farmers. According to the diffusion model, increasing the farmer's production can be achieved through technology transferring from the most advanced farmers to the most backward farmers.

Irrigated agriculture, in South Africa, has a history that goes as far back as the 19th century (Bundy 1988). However, since its introduction in the country, so much has changed as the industry has developed in a number of ways, some of which are the result of various support systems from various sources, such as the government.

All the available evidence indicates that irrigation was an innovation that was introduced after colonization. The first era of smallholder irrigation development occurred during the 19th century

and can be referred to as the peasant and mission diversion scheme era, because it was associated with mission activity and the emergence of African peasantry (Van Averbeke & Mohamed 2006). Situated within the broad history of irrigation development in South Africa, the peasant and mission diversion scheme era coincided with the early part of the individual diversion scheme era identified by (Van Averbeke & Mohamed2006). Smallholder irrigation developments were also private and the technology used was similar (river water used).

Irrigated agriculture can be defined as agriculture in which the supply of water is increased by artificial means, involving the use of water control technology, including drainage to dispose of excess water. The analysis of information from Asia reveals that the yields per area, for most crops, have increased as a result of irrigation (Hazel & Haggblade 1990).

2.2.1 Measuring Adoption

The study by Mullen, Norton & Reaves (1997) suggest that adoption is usually a matter of degree; this is not to state that the measurement of adoption is simple. The rate of adoption is usually measured by the length of time required for a certain percentage of members of a system to adopt an innovation. Depending on the technology being investigated, various parameters may be employed to measure adoption. Measurements also depend on whether they are qualitative or quantitative (Nkonya, Schroeder & Norman 1997).

2.2.2. Determinants of Adoption

According to McNamara, Wetzsteina & Douce (1991) different studies are aimed at establishing factors underlying adoption of various technologies. Study such as Bt Cotton Adoption: A Double-hurdle Approach for North Indian Farmers: www.agbioforum.org/v15 n3 a05-mal.htm and Factors that Affecting the Adoptionof Roundup Ready Soybeans Technology in the U.S. by Mensah,E.C. : www.jepson.gonzaga.edu/jeb bp/volumes/v1 papers/mensah.pdf

Several factors have been found to affect adoption. These include government policies, technological change, market forces, environmental concerns, demographic factors, institutional factors and delivery mechanism. They include Market forces: availability of labor, technology resource requirements, farm size, level of expected benefits, and level of effort required to implement the technology; Social factors: Age of potential adopter, social status of farmers,

education level and gender-related aspects, household size, and farming experience; Management factors: membership to organizations, the capacity to borrow, and concerns about environmental degradation and human health of farmers; Institutional/technology delivery mechanisms: information access, extension services (McNamara *et al* 1991).

2.2.2.1 Economic Factors

The economic factor is the most important determinant of technology adoption. The farm size may determine the cost of adoption of new agricultural technology. The bigger the farm the more capital required to invest on a new technology adoption. The changes that that cost more are adopted slowly where as the changes that cost less are more quickly adopted.

(i) Farm Size

Much empirical adoption literature focuses on farm size as the first and probably the most important determinant. According to Abara & Singh (1993) the effect of farm size has been variously found to be positive. Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labor requirements, tenure arrangements and more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara & Singh 1993).

(ii) Cost of Technology

Caswell, Fuglie, CIngram, Jans & Kascak (2001) note that decision of adoption is often an investment presents a shift in farmers' investment options. Therefore adoptions can be expected to be dependent on cost of a technology and on whether farmers possess the required resources. Technologies that are capital intensive are only affordable by richer farmers.

Changes that cost little are adopted more quickly than those requiring large expenditures; hence both extent and rate of adoption may be dependent on the cost of a technology (Caswell *et al.* 2001).

(iii) Level of Expected benefits

Programs that produce significant gains can motivate people to participate more fully in them. In fact, people do not participate unless they believe it is in their best interest to do so. Farmers

must see an advantage or expect to obtain greater utility in adopting of technology. In addition, farmers must perceive that there is a problem that warrants an alternative action to be taken. Without a significant difference in outcomes between two options, and in the returns from alternative and conventional practices, it is less likely that farmers, especially small-scale farmers will adopt the new practice (Abara &Singh 1993).

A higher percentage of total household income coming from the farm through increased yield tends to correlate positively with adoption of new technologies (McNamara *et al* 1991 and Fernandez-Cornejo 1996).

(iv) Off-farm hours

The availability of time is an important factor affecting technology adoption. It can influence adoption in either a negative or positive manner. Practices that heavily draw on farmer's leisure time may inhibit adoption (Mugisa-Mutetikka, Opio, Ugen, Tukamuhabwa, Kayiwa, Niringiye & Kikoba 2000). However, practices that leave time for other sources of income accumulation may promote adoption. In such cases, as well as in general, income from off-farm labor may provide financial resources required to adopt the new technology.

2.2.2.2 Social Factors

The level of education might play a vital role in adoption of new agricultural technology. The educated people stand a better chance to understand the changes in technology. Also the age night play a vital role to adoption of new agricultural technology. The younger the adopter the better chances to adapt to changes. Most of the old people strongly believe to indigenous knowledge and its takes them time to adapt to new changes. Gender also might play a vital role in accepting changes since most women's in rural areas depended to their husbands.

(i) Age of Adopter

Age is another factor thought to affect adoption. Age is said to be a primary latent characteristic in adoption decisions. However there is contention on the direction of the effect of age on adoption (Adesiina & Baidu-Forson 1995). The effect is thought to stem from accumulated

knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. In addition, since adoption pay-offs occur over a long period of time, while costs occur in the earlier phases, age (time) of the farmer can have a profound effect on technology adoption. However age has also been found to be either negatively correlated with adoption or in farmers' adoption decisions (Baidu-Forso 1999).

(ii) Education

The effects of education on adoption in most cases relate it to years of formal schooling (Tjornhom, 1995 and Feder & Slade 1984). Generally education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Waller., Hoy, Henderson, Stinner & Welty 1998).

(iii) Gender Concerns

Gender issues in agricultural production and technology adoption have been investigated for a long time. Most show mixed evidence regarding the different roles men and women play in technology adoption (Doss & Morris 2001). Since adoption of a practice is guided by the utility expected from it, the effort put into adopting it is reflective of this anticipated utility. It might then be expected that the relative roles women and men play in both effort and adoption are similar, hence suggesting that males and females adopt practices equally.

2.2.2.3 Institutional Factors

Belonging to a rural social group enhance the social trust, allowing to ideas and information. Access to extension services is might increase the adoption after increasing awareness about the new technology (Caswell,Fuglie, CIngram,James & Kescak 2001). In rural communities the sense of belonging is vital and may gain participating in social community activities. The social groups might be good sources of lobbing and advocating for the changes (Caswell *et al* 2001).

(i) Information

Gaining of information about a new technology demystifies it and makes it more available to farmers. Information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell *et al.* 2001). Exposure to information about new technologies as such significantly affects farmers' choices about it. Feder & Slade (1984) indicate that provided a technology is profitable, increased information induces its adoption.

(ii) Extension Contacts

Good extension programs and contacts with producers are a key aspect in technology dissemination and adoption. IFPRI (1995) stated that a new technology is only as good as the mechanism of its dissemination to farmers. Yaron, Dinar & Voet (1992) states that the influence of extension can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies.

2.3. Factors affecting agricultural productivity

There are various factors that can affect agricultural productivity either directly or indirectly. Agricultural output and input affect the growth of the productivity directly. However factors such as decreasing number of farmers, land reform and others can affect growth of productivity of the sector indirectly (Kirsten & Vink 2003).

2.3.1 Agricultural output

According to Wiebe Soule & Schimmelpfennig (2001) agricultural output grew at an average of 2.9% per year in South Africa in the 1980`s whilst between 1960 and 1996 the growth slowed to 1.4%. This was due to policy changes around the 1980`s which led to the removal of existing controls over the movement of labour, microeconomic deregulation which led to a significant increase in various activities in informal economy, the decline in the state spending in agriculture and lack of support on producer price of maize (Kirsten & Vink 2003).

In the twenty-first century the shift in the structure of the agricultural sector and agricultural production led to a further slowdown of agricultural production by 0.19% (Liebenberg *et al*, 2010). The slowdown of overall agricultural output is due to a drag in the overall field crops output which is outpaced by the growth in the horticultural sector, which is as a result of composition of market share (Liebenberg & Pardey 2010). According to Wiebe *et al.* (1998) growth of horticultural output (fruits and vegetables) outpaced that of field crops and animal output by almost 0.5% since 1911.

2.3.2. Agricultural input

Agricultural inputs in general varied in terms of growth. There was a structural change in farmland use since 1910. Farmland grew by 91.8 million hectares in 1960, declining in 1996 to 82.2 million hectares and between 2000 and 2007 it has constantly remained within the range of 83.7 million hectares (Conradie Piesse & Thirtle 2009). Black farmers' share of area farmed in 1918 and 1991 was 15% and in 2000 it doubled to 30%. The reason the share of black farmland area was small compared to that of commercial farmland was due to discriminatory policies in particular Land Act of 1913 which confined land ownership by black farmers to native reserves comprising 15% of the total agricultural land area in the country. The twenty-first century saw a declining number of farmers and a steady growth of average farm size. In 1910 farm numbers and average farm size were estimated at 76,622 and 1,006 hectares respectively whilst in 2007 these were 44,575 and 1,400 respectively.

On the other hand intermediate inputs have increased since 1947/48; there share of total costs in 1947/48 was around 30% compared to 50% in 2006/2007. That being the case capital costs has increased within the same period whilst labour costs have reduced from 36% in 1947/48 to 15.1% in 2006/07. Land costs saw fluctuation over this period. In 1947/48 these were 6.6% and it grew to 15.55% and later declined to 3.0% of the total costs. The reason for this change was the introduction of tractors in the mid 70`s compared to the use of oxen in the 40`s. In the twenty-first century the drastic decline in the area planted was due to increasing costs of operation which therefore led to a reduction in the number of farmers and then land planted (Liebenberg & Pardey 2010).

2.4. Food security

Food security refers to the availability of food and one's access to it. A household is considered food secure when its occupants do not live in hunger or fear of starvation. Approximately 852 million people worldwide are chronically hungry due to extreme poverty, while up to 2 billion people lack food security intermittently due to varying degrees of poverty (FAO 2003).

According to FAO (2003) food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Food security for a household means access by all members at all times to enough food for an active, healthy life. Food security includes, as a minimum, the ready availability of nutritionally adequate and safe foods, and an assured ability to acquire acceptable foods in socially acceptable ways (FAO 2003).

The socio-economic setting plays an important role in food security or insecurity. National food self-sufficiency should not be used as an alternative for household food security or as an index of national welfare. While South Africa produces sufficient food, this in no way ensures food security at the individual household level (Mgijima 1999). This is because ensuring access to food at the household level depends not only on secure food supplies, but also on stable demand or purchasing power. If families are unable to grow or purchase enough food, and social welfare nets are absent or ineffective, there may be hunger. This is the case in many South African societies; it is estimated that 39% of the South African population is vulnerable to food insecurity (Mgijima 1999).

2.4.1. Food security status in South Africa

South Africa is largely deemed a food secure nation which produces enough staple foods or has the capacity to import food, if needed, in order to meet the basic nutritional requirements of its population (FAO 2008). DAFF (2011) supported the argument that South Africa seems to be food secure at the national level but the same cannot be said about households in rural areas. The national food self-sufficiency index (Figure2.1) clearly illustrates that South Africa is food self-sufficient or nearly self-sufficient in almost all major food products, with the ability to import due to shortages when necessary.

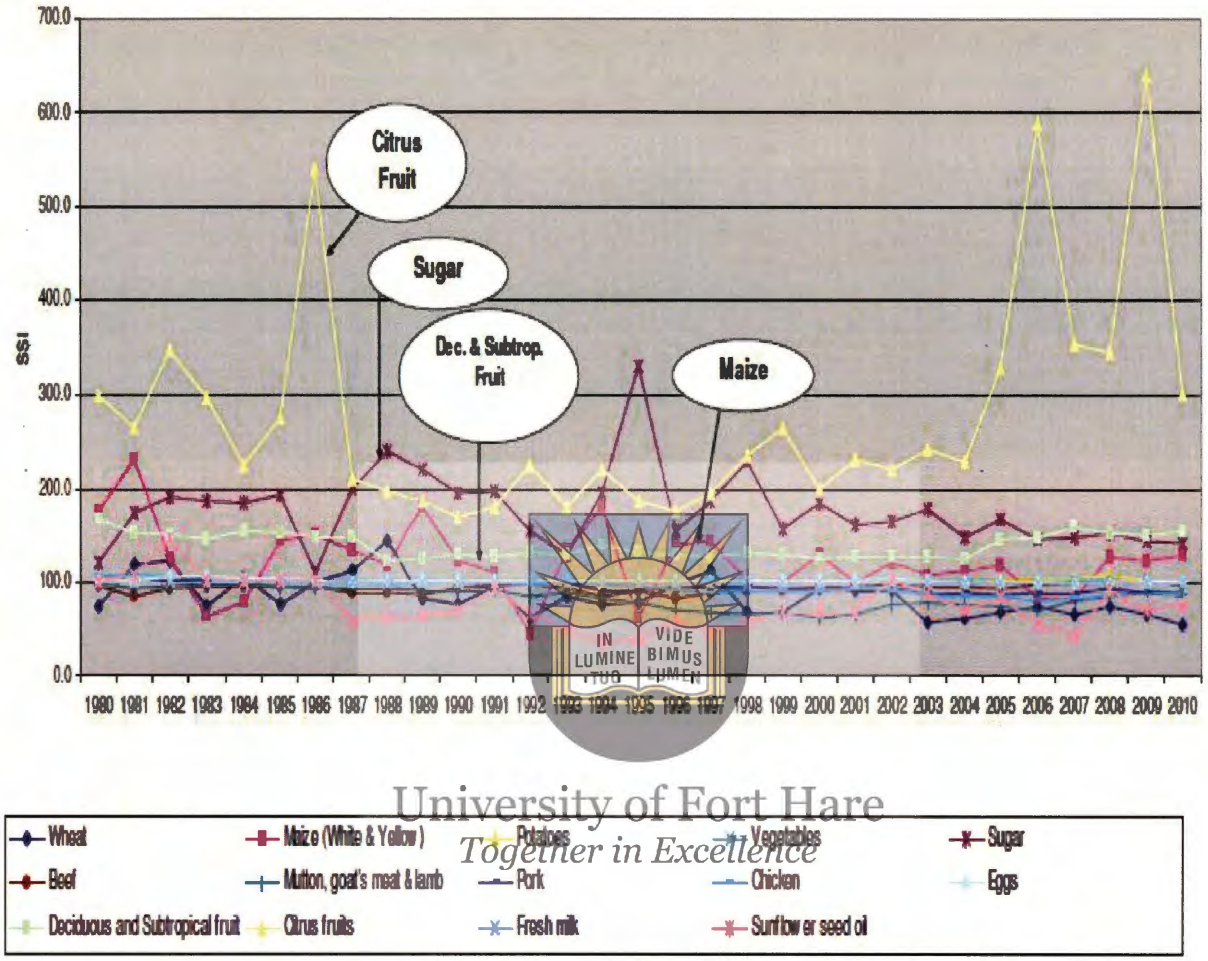


Figure 2. 1: National food self-sufficiency index

Source: Department of Agriculture, Forestry and Fisheries

The G H S (2009) reported that an estimated 20% of South African households have inadequate food access. The GHS (2009) also states that, in 2008, food access problems reached a high of 23% in KZN. According to FAO (2008) a high unemployment rate, inadequate social welfare systems and a high HIV/AIDS infection rate have all contributed to food insecurity in the country.

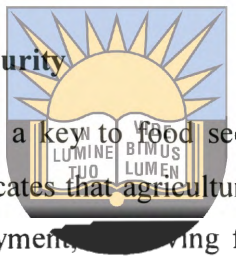
2.4.3. Household food security targets and measurement

The South African government has committed itself to halving poverty between 2004 and 2014. One of the critical components in meeting this objective is household food security. The link

between poverty, income and household food security is, however, not clear. While some households are poor, they might experience food security by means of their own food production.

DAFF (2011) indicate that food security is a broad concept and the meaning and the measurement thereof is not as obvious as it may seem. Food security is multidimensional in nature. Accurate measurement and policy targeting, therefore, remain a challenge due to the many dimensions involved.

2.4.4. The role of agriculture in food security



According to FAO (2004) agriculture is a key to food security in many parts of the world. Furthermore, the FAO (2004) report indicates that agriculture contributes to poverty alleviation by reducing food prices, creating employment, improving farm income and increasing wages. Making agriculture work must be a central component of policy approaches to the reduction of food insecurity and increasing economic growth. Increased investment in agriculture will help redress current inequalities. Empowering people to grow their own food for subsistence or income generation will provide nourishment and potential income to many people in the country.

FAO (2008) stated that agriculture is considered as one of the sectors that can play a significant role towards food security in the country. According to Aliber &Hart (2009) the Strategic Plan for South African Agriculture 2007 reveals further that there were approximately 240 000 black farmers in South Africa who provided livelihoods for more than a million family members as well as temporary employment to 500 000 people. It further confirmed that approximately 3 million small-scale farmers produce food primarily to meet their household consumption needs.

2.5. What influences the adoption of new technology by farmers?

A variety of factors appear to have been critical in determining the rate at which farmers have innovated new ideas and so been able to increase productivity for the benefit of growth and the pace of poverty reduction. Farmers will innovate to increase subsistence production, but as

innovation generally implies some type of investment in cash or labour the chances of farmers investing and innovating are greatly enhanced by the existence of secure markets. As the evidence shows, it is difficult to overestimate the importance of reliable output markets as an incentive to the adoption of new technology. Dorward , Kydd, Morrison & Urey (2004) argue that a key feature of many successful early Green Revolution environments was government's role in stabilizing output prices, a function which has been progressively dismantled in Africa where innovation has been limited.

2.5.1. Effective input supply systems, including credit

While there is danger in relying too heavily on technology on the shelf, effective input supply systems are essential, particularly when technological change or advance depends on purchased inputs. Inadequate formal seed supply systems have been shown to dampen, or even preclude the diffusion of new crop varieties (Tripp 2001). Increasing fertilizer use has long been plagued by difficulties in providing the right products in affordable pack sizes (Omamo & Mose 2001).

Establishing the systems to provide these inputs is however, one of the major challenges for many technologies, and not merely the conventional seed-and-chemical technologies. The delivery of tissue culture banana plantlets in Africa requires the development of a network of intermediary nurseries (Wambugu &Kiome 2001). Nurseries are also crucial for the spread of many agro forestry technologies, and efforts at encouraging farmer groups to take on this role have largely failed (Bohringer &Ayuk 2003). The delivery of veterinary technologies depends largely on the delivery role of the private sector (Leonard 1993). However, an operational system of input provision is often ineffective in the absence of effective credit systems. Previous experiences with state subsidies' credit provision have received much justified criticism (Adams & Vogel 1990). The new approaches are being considered, including linking input supply and output procurement (Dorward *et al.* 1998).

2.5.2. Supporting Infrastructure Particularly Irrigation

The presence of supporting infrastructure is fundamental to effective innovation in terms of new technology and was a major factor in Asia's successful Green Revolution. Roads are critical to supporting input and output marketing (Dorward *et al.* 2004), but the expansion of irrigation probably constituted the most important element of supportive investment. The expansion of

irrigation in developing countries has been greatest where increasing agricultural output through land expansion has been difficult; gains are therefore made by intensification. By 2030, it is projected that about 80% of future production gains will be made from growth which is, in part, dependent on irrigation with a much smaller proportion taking place through land expansion (De Haen,Stamoulis, Shetty & Pingali 2003).

2.5.3. Institutions that Support Food Security

Institutions that support household food security are sector-specific, such as agriculture, health or nutrition, and cross-sector institutions such as community development, women's affairs or economic development and planning ministries (Von Braun 1997). They may focus on the development of policies and regulations, service provision or research, and may present civil society, the public and private sectors, and the international community, including multi-laterals, foundations and other donors. Some institutions affect household food security through factor markets and, through them, households (Von Braun 1997). For instance, decisions made by the Planning Ministry will affect the pricing policies of factors of production and, through these; households will have variable access to those factors that they can convert into agricultural production, income or asset accumulation. Other institutions will affect household food security in a direct fashion, e.g., NGOs provide direct health services as a means to improve individuals' utilization of nutrients. Intra-household variables such as decision-making patterns and cultural beliefs and norms also influence the allocation of resources and individual food security (Collins & Roberts 1998).

2.5.4. Impact of the Adoption of New Technology in Food Security

The adoption of technology requires adequate incentives for producers. Investments in labour or cash will not be made unless adequate returns are guaranteed. One of the most important supporting factors in this regard is the adequacy of markets for outputs and inputs.

The technological advances of the Green Revolution, complemented by a massive increase in irrigation, provided a route out of poverty through: directly increasing producer incomes and wages; lowering the price of food; and generating new livelihood opportunities as success in agriculture provided the basis for economic diversification. Asian industrialization was in essence agriculturally led (Timmer 1988).

Advances in crop management technology have also occurred but these are often less visible and tend to be under-reported in comparison to the spread of new varieties; these have also made significant contributions to increased agricultural productivity (Franzel, Phiri & Kwesiga 2002).

Agricultural technology has been a primary factor contributing to increases in farm productivity in developing countries over the past half-century. Although there is still widespread food insecurity, the current situation would have been unimaginable without technological development (Mgijima 1999).

New technology can provide additional rural employment, but there are always countervailing pressures to reduce labour input and lower its costs (Mgijima 1999). According to Mgijima (1999) food prices are demonstrably lower because of technology, but the distribution of benefits between consumers and producers depends on the nature of the local economy and trade patterns. The adoption of technology requires adequate incentives for producers. Investments in labour or cash will not be made unless adequate [illegible] are guaranteed.

2.5.4.1. Role of Extension on Technology Adoption

According to DAFF (2011) Agricultural extension officers are intermediaries between research and farmers. They operate as facilitators and communicators, helping farmers in their decision-making and ensuring that appropriate knowledge is implemented to obtain the best results.

Agricultural extension officers need to communicate to matters regarding agricultural information to farmers. The extends to communicating information relevant to natural resources, animals, crops, how best to utilize the farmland, how to construct proper irrigation schemes, economic use and storage of water, how to combat animal disease, and save on the cost of farming equipment and procedures (DAFF 2011). They need to ensure that farmers understand this information and use it on their farms in order to obtain the best production. Agricultural extension officers often propagate new farming methods. This always takes place in conjunction with the farmers, who make the final decision. According to DAFF (2011) they also research food, fibre and animal products in conjunction with agricultural scientists. They assist cattle farmers, and guide and assist veterinary surgeons in the treatment of different animal diseases. Each agricultural extension officer is linked to one of the agricultural development

centers throughout the country; these centers render agricultural services to farmers (DAFF 2011).

Agricultural extension officers encourage farmers to adopt new, improved methods of farming, using a variety of methods to reach farmers i.e. organizing study groups for farmers, farmer days, demonstrations, lectures and literature, as well as informing the media. The best method is through personal contact with farmers on their farms (DAFF 2011).

It sometimes happens that an agricultural extension officer must re-plan a farm in conjunction with the farmer. All the resources on the farm are then thoroughly investigated. Sometimes it is necessary for agricultural extension officers to develop recovery programmes for eroded soil, protect cultivated land against erosion and develop a new pasture system (DAFF 2011).

They propagate farming and development programmes which aim to reach marginalized farmers or those who have little access to information and extension services. They do this in collaboration with farming communities, thus helping them to help themselves so as to become more self-reliant and independent (DAFF 2011).

2.5.4.2. Technology adoption lifecycle

Technology adoption is the most common phenomenon driving the evolution of industries along the industry lifecycle. After expanding new uses of resources they end with exhausting the efficiency of those processes, producing gains that are first easier and larger over time then exhaustingly more difficult, as the technology matures (Bohlen, Beal, & George 1957).

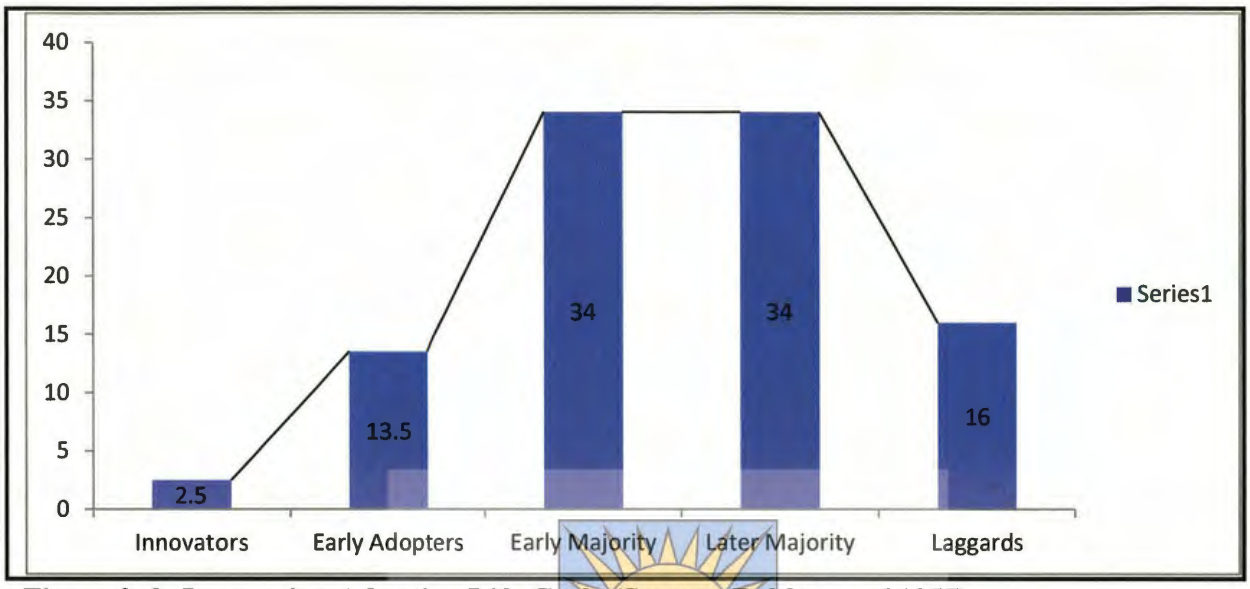


Figure 2. 2: Innovation Adoption Life Cycle (Source: Bohlen *et al.*1957)

Figure 2. 3: Summaries the individual stages of adopting the new technology changes.

Figure 2.4 summaries the group new technology adoption stages influenced by problem solving groups.

Figure 2. 4: Individual adoption stages (Source: Bohlen et al. 1957)

2.6. Smallholder Irrigation in South Africa

According to Van Averbeke & Mohamed (2006) the smallholder irrigation, can be defined as multi-farmer irrigation projects larger than 5ha, which were either established in the former homelands or in resource-poor areas of the black community. These smallholder irrigation

schemes consist of a number of smallholder irrigators who come together to form a multi-farmer project. De Lange (1994) categorized smallholder irrigators that make up the smallholder irrigation schemes in South Africa into four categories: (a) farmers on irrigation schemes; (b) independent irrigation farmers; (c) community gardeners; and (d) home gardeners. One of the common features of these smallholder irrigation schemes is that most of them are found in the deep rural areas where poverty levels are very high, with only a few located closer to towns.

Van Averbeke & Mohamed (2006) classified these eras as the smallholder canal scheme era which ended around 1960, the independent homeland era which lasted from 1970 to 1990 and the IMT and revitalization era which is still continuing. The most recent era in South African smallholder irrigation development can be referred to as the irrigation management transfer and revitalization era. This era more or less commenced in 1990, when political change in the country became inevitable. Development during this era was guided by the ideals of democracy and a better life for all. Politically, eradicating poverty and improving the quality of life of black people in rural areas and informal urban settlements became the primary aim. Initially, this aim was pursued through the RDP. Irrigation development, during the early 1990s, focused primarily on food security at the community or group level, favouring the establishment of small schemes. The data provided by Gibb (2004) indicates that at least 62 new irrigation schemes were established during this era.

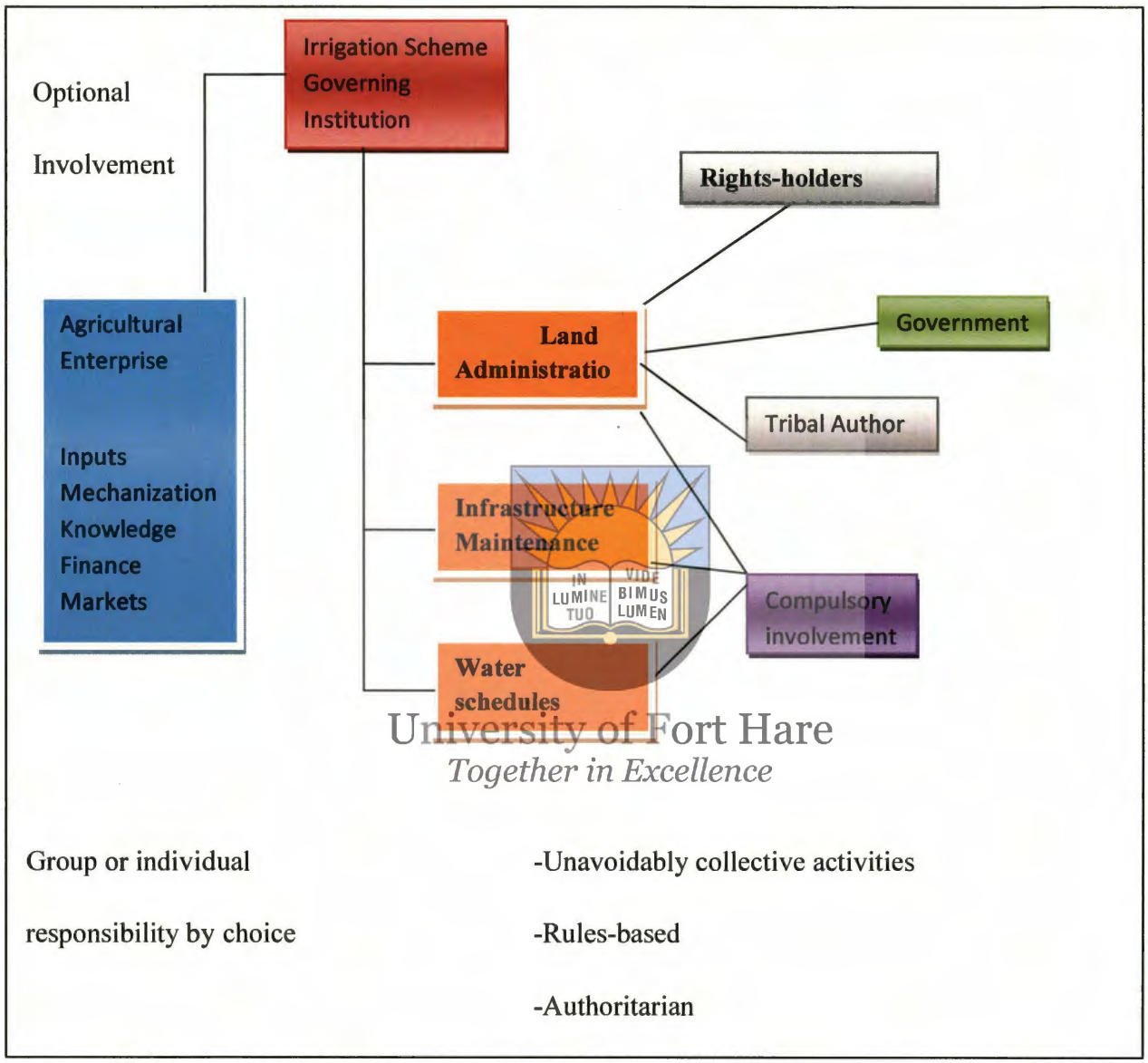


Figure 2.5: Irrigation scheme institutional structure

2.7. Smallholder Irrigation

Smallholder irrigation involves the change of water from one area into a relatively small area for the purpose of supplementing available water for crops (FAO 2001). The techniques of diverting the water include the use of gravity through canals or pipes and lifting water through the use of pumps for application in the fields through various irrigation systems, with the objective of increasing crop production (FAO 2001). The terms smallholder, small-scale, subsistence,

communal and emergent farmers have been freely used to mean the same thing although they have different meanings. According to Cornish (1998) farmers who practice both commercial and subsistence farming in order to derive a livelihood and the family is the principal source of labour.

According to Cornish (1998) the smallholder farm may also involve a small section in which high value crops are grown for commercial purposes, and the smallholder farmer usually earns a living from an irrigated area usually less than 5 ha. However, this may vary from one country to another. Smallholder irrigation also includes small individual farms and groups in which the farmers have taken on the responsibility of managing the distribution of water amongst members of their group (FAO 2001). According to Denison & Manona (2007), in South Africa, the smallholder farm is located in former homelands with the majority of the small farms being owned by historically disadvantaged races and groups.

2.8. Smallholder Irrigation Development

Over the past five decades, the trend in irrigation across the world has been a shift from the large scale towards the smallholder. Bembridge (2000) stated that demographic shifts, scarcity of land and water resources for irrigation, the need for food security starting from the family level, technology as well as poorly maintained large scale infrastructure, which does not cater for individual farmers' needs, have favored the development of the smallholder irrigation subsector.

Joemat-Pettersson (2009) states that smallholder irrigation has become the main source of income for the most rural population and, therefore, there exists a need to improve resource use in this subsector. The optimal use of these critical resources in irrigation will not only help produce enough food for everyone, but will also ensure sustainability.

2.9. Management of Smallholder Irrigation Schemes

SIS presents special management problems, especially where water is scarce (Albinson & Perry 2002). Water distribution in smallholder irrigation schemes has proved to be a challenge at scheme management level. Scheme management failures have frequently resulted in chaos involving illegal tampering with water conveyance structures and water shortages at different locations within the scheme, as these affect irrigation performance (Albinson & Perry 2002).

According to Albinson & Perry (2002) since the 1950s, governments across the globe managed smallholder irrigation schemes through parastatals and other agencies and farmers were usually relegated to simple farm workers despite the fact that they were supposed to pay for the services rendered by the agencies. In South Africa, government agencies such as the ARDC in the Northern Province managed smallholder schemes.

2.10. Renewal and Rehabilitation of Smallholder Irrigation Schemes

Irrigation renewal can be defined as a process of technical, managerial and institutional upgrading, including rehabilitation, of irrigation schemes with the aim of enhancing resource utilization and improving water delivery to the schemes (Bembridge 2000). The process is not limited to the upgrading of infrastructure, but it does include fundamental transformations to resource management techniques. In dealing with revitalization, an interrelated concept which is referred to as modernization is often encountered.

Despite the effort to enhance resource utilization, several problems are reported to be affecting the general performance of smallholder schemes. Small & Svendsen (1992) state that dysfunctional infrastructure, the lack of input and technology, severe financial constraints and inadequate managerial skills amongst the farmers, as well as their socio-economic settings, are the major causes of poor performance in the smallholder irrigation subsector. Bembridge (2000)

added that inefficient water management strategies and the lack of farmer participation in scheme management, as well as the lack of markets are amongst the constraints of this approach. In South Africa, all these problems have been reported to compromise optimal scheme performance (Bembridge 2000).

2.11. Socio-economic Characteristics of Irrigation Schemes

The agricultural economics literature has made clear links between the socio-economic characteristics of farmers and their performance in the farming business. For this reason, the present review examines the relationships that have been documented on the basis of research conducted in similar environments.

Small & Svendsen (1992) argue that smallholder irrigation is important in many developing countries in terms of agricultural food production, incomes for rural people and public investment for rural development. The performance evaluations have been carried out the world over, on individual smallholder schemes at the national level for specific types such as those publicly-operated and transferred to user associations or cross-system comparison of schemes, all with the aim of enhancing the efficiency of resource utilization.

2.11.1. Livelihoods

Bembridge (2000) state that the proportion of plot holder homesteads living below the poverty line on smallholder irrigation schemes ranged between 50% and 75%; this statistic questions the impact of small-scale irrigation on livelihoods and poverty. The common trend of most agricultural economists regarding agriculture as a tool for alleviating poverty has led to the perception that most rural households should engage in farming to improve their livelihoods. Monde 2003) states that, in the South African context, agriculture in most rural households is the main rural livelihood activity to secure an income and household food security.

Backeberg (1996) developed a comprehensive policy proposal which to assist the development of the smallholder irrigation sector. This proposal recognized that smallholder irrigation and associated livelihoods are directly affected by three policy domains, namely: irrigation policy, agricultural policy and rural development policy.

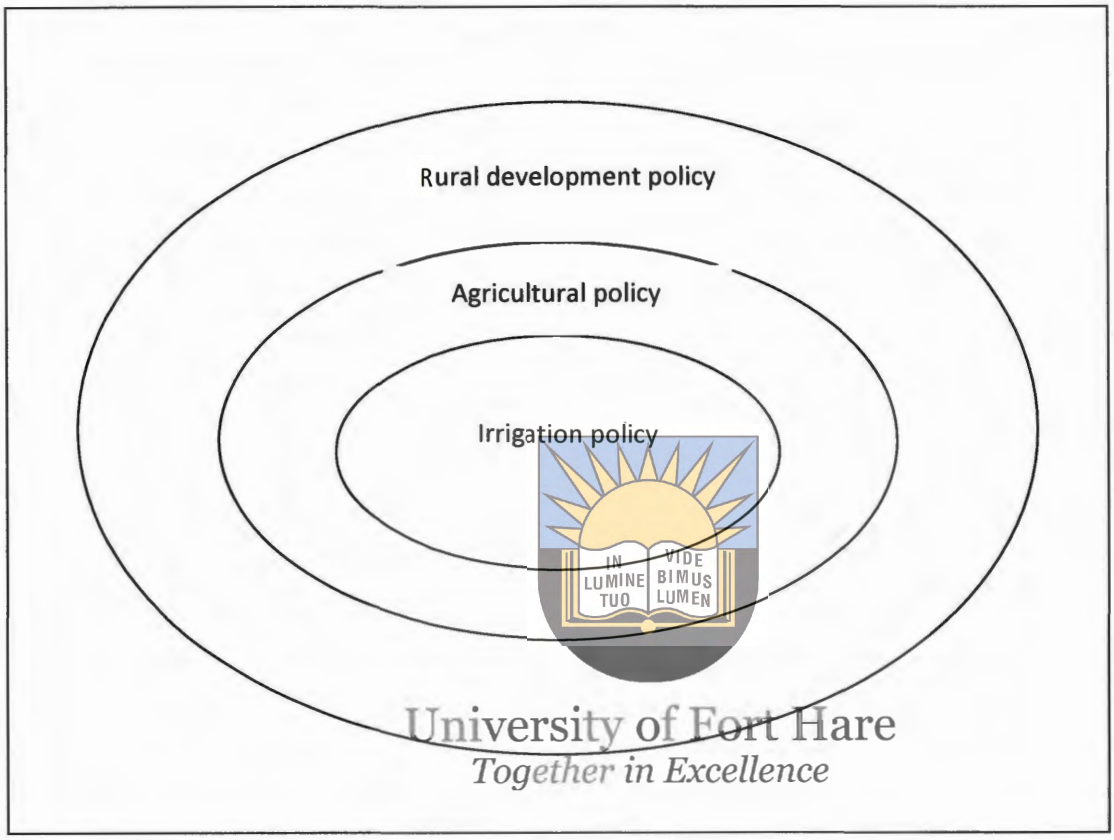


Figure 2. 6: Policy domains that directly affect the smallholder irrigation sector and associated livelihoods. (Source: Mohamed, S.S. 2006)

2.11.2. The Farming System and Marketing in General

According to Makhura & Mokoena (2003), in the absence of an effective marketing system for their products and inputs, farmers have neither the opportunity nor the incentive to become productive.

As most of the farmers do not have their own means of transport, they rely on contractors, taxis or neighbors and some expensive hired transport because of their relatively small quantities of produce. These means that they are sometimes inaccessible themselves because of the poor roads network in most rural areas (Makhura & Mokoena 2003).

There is a lack of market information and the dissemination of such information, both of which are critical for the survival of small farmers in the increasingly competitive marketing environment.

Constraints related to market access are not unique to smallholder irrigation as market access is a challenge faced by all farming activities (Makhura & Mokoena 2003). There is general agreement that smallholders stand to benefit from cooperation in relation to markets, the creation of economies of scale being the primary reason. Generally, smallholders favour collaboration in relation to input markets, because they do not compete with each other in this market and because collaboration brings about more convenient or cheaper access to inputs. Collaboration amongst smallholders, in relation to produce markets is less favoured, particularly when smallholders produce for local markets. This is because they compete with each other on these markets (Makhura & Mokoena 2003).

Makhura & Mokoena (2003) identify three types of markets which offer tangible benefits to smallholders. The first consists of markets for bulk commodities which offer comprehensive farmer support programmes, in South Africa, the prime example of this type of bulk commodity market is sugar cane. The second type of market in which smallholder collaboration is advantageous is production contracts and the third type is the produce markets of distant urban centers.

Farming systems in South Africa have been developed under primarily arid and semi-arid climatic conditions in which droughts are common. The adoption of agricultural practices by farmers maximizes precipitation utilization, ensures production as well as economic and social sustainability (Bennie & Hensley 2001).

2.11.3. Schematic presentation of farming system in general

On the basis of the linkages that have been established in the foregoing, it is possible to present a schematic that shows the flows and interactions within the farming systems similar to the one studied in this research. This information is presented in Figure 2.7.

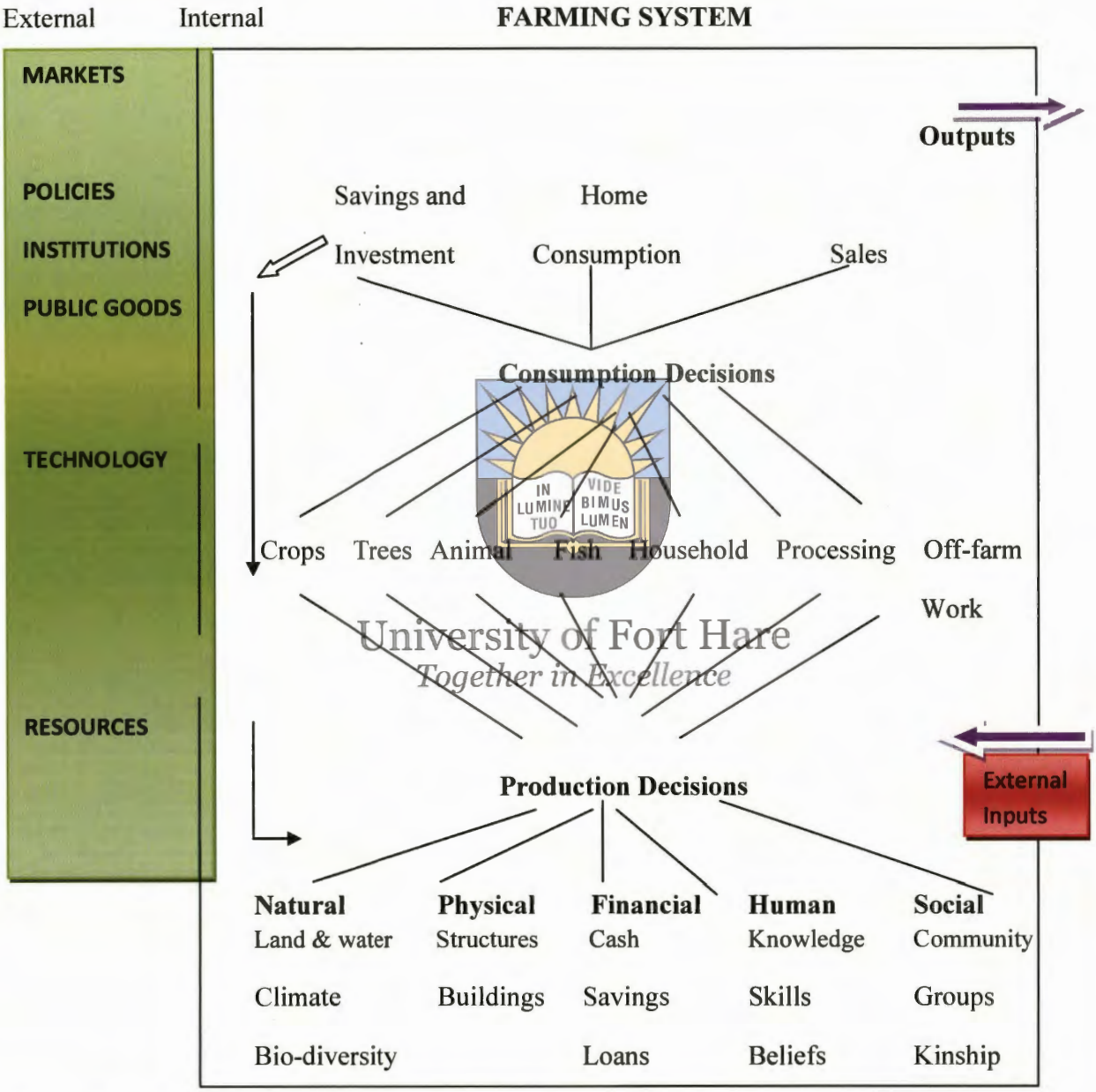


Figure 2. 7: Schematic Presentation of Farming System

2.12. The irrigation management transfer (IMT) and revitalization era

The current era in South African smallholder irrigation development can be referred to as the irrigation management transfer and revitalization era. This era commenced in about 1990, when political change in the country became certain. Development during this era was guided by the ideals of democracy and the pursuit of a better life for all. Politically, eradicating poverty and

improving the quality of life of black people in rural areas and informal urban settlements became a primary aim. Initially, this aim was pursued through the RDP. Irrigation development during the early 1990s focused, primarily, on food security at the community level, favouring the establishment of small schemes. The data provided by Gibb (2004) indicates that at least 62 new irrigation schemes were established during this era, adding about 2400ha to the total smallholder irrigation scheme area. These projects typically used mechanical pumps and sprinkler technology to extract and apply irrigation water. During the period of political change, from 1990 to 1994, the Independent Development Trust played a vital role in funding these types of projects (Van Averbeke and Mohamed, 2006).

2.13. Water as a Scarce Resource in South Africa

About two-thirds of South Africa is arid or semi-arid. Rivers in the country are few and relatively small in comparison to major rive[illegible]frican continent, and are largely shared internationally; approximately 65 percent of the land area of South Africa falls in internationally shared river basins Hirji Johnson, Maro & Matiza (2002). Annual rainfall across the country averages around 450mm per annum, which is barely half of the global average (RSA 2002). The magnitude and distribution of rainfall subjects large parts of the country to extremes of periodic droughts and floods; this emphasizes the need for efficient management of water resources as a national priority. This is reflected in the comprehensive water policy the NWA.

According to RSA (1998), the NWA pledges that the process of water management should create a fresh window of opportunity for previously disadvantaged individuals to improve their socio-economic situations while contributing to national economic development. It sets out ways in which this could be achieved through a legally binding framework within which water resources in the country will be protected for the benefit of all.

The Department of Water Affairs and Forestry is largely responsible for the implementation of strong vertical and horizontal cooperative governance between government departments, which is envisaged for crystallizing the process that will eventually be taken over by the CMAs. The realization of the challenge of ensuring equitable access to water by all stakeholders, particularly the poor, in a situation of growing water scarcity, will largely depend on the dedicated efforts to

increase the productivity of agricultural water use by smallholders, a move that is already recognized nationwide (RSA 2000).

2.14. Constraints of Smallholder Farmers and how they have been addressed in South Africa.

There are different constraints that restrain the growth of smallholder farmers; these vary from systems constraints to locative constraints to environmental-demographic constraints. Some of the systems constraints are the lack of access to land as well as poor physical and institutional infrastructure.

NDA (2005) stated that the land is debatably the most important asset in primarily agrarian rural societies, especially in the rural areas of South Africa, but is lacking in both ownership and size. There are restrictive administrative and social [illegible]es, such as land tenure, that should be improved. Most smallholder farmers have limited access to land and capital and have received inadequate or inappropriate research and extension support, resulting in chronically low standards of living (NDA 2005).

Agriculture is carried out amidst the increasing pressure of scarce land resources managed under systems of insecure customary land ownership and communal grazing land. These insecure tenure systems such as the communal land tenure system constrain the farmers from producing to their highest potential (Kariuki 2003). In South Africa, tenure reform is a component of a national land reform programme which also embraces the restitution of land, to people dispossessed by racially discriminatory laws or practices, and land redistribution to the poor (Adams, Sibanda & Turner 1999).

According to Machethe (2005) the South African government in partnership with NGOs has intervened with initiatives to improve the quality and quantity of infrastructure in the rural areas through programmes such as the Community Based Public Works Programme, Consolidated Municipal Infrastructure Programme, Poverty Relief and Infrastructure Investment Programme.

Ashraf, Gine & Karlan (2005) state that many farmers receive low prices for their cash crops by selling them at their farm gate or local market. However, these same farmers could receive much higher prices by selling their goods in urban centres. The difficulties which smallholder irrigation scheme farmers face in finding reliable markets for perishables is one source of transaction costs, due to the low bargaining power of a farmer whose product is spoiling. Smallholder farmers have little marketing knowledge and selling skills as well as little recognition of opportunities for product diversification or the links between market research and product development.

Environmental demographic constraints also form part of the main constraints of smallholder irrigation scheme farmers. As the population continues to grow, increasing pressure is placed on fragile lands and agricultural production; smallholder behavior under limited demographic conditions, would lead to a decline in agricultural productivity, major food crises and increased rural poverty. Resource-constrained farmers are forced to adopt practices that amount to ecological damage.

2.15. Role of Land Reform in Developing Small Scale Irrigation Schemes

One of the broad paths of agricultural development is the land reform process. The primary aim of land reform is to address inequality in the allocation of land between race groups. The poverty component prioritises those who lost their land as a result of racially discriminatory legislation. In South Africa this refers to those who lost land after the Native Land Act in 1913 and the Group Areas Act were issued (Gwanya 2003). Restitution, therefore, ensures that where feasible, the original inhabitants get their land back and where not feasible, the State provides compensation.

In South Africa, land is held under a number of tenure dispensations and, in most cases, they have insecure tenure. The South African government has, since 1995, when the Settlement/Land Acquisition Grant programme was launched, made efforts to improve access to land for productive purposes. The rationale of the programme was that if black people were provided with financial assistance, they would be able to purchase land on a willing-buyer willing-seller basis, thus allowing market forces to play their role and minimize the role of the government. The role of the government is to make land acquisition grants available and encourage people to

club together and form associations with a number of households in order to buy land together. It is also important that the role of the government fulfilled is in conjunction with that of other stakeholders, like some NGOs who take a lobbying role in the land reform process (Camac & Gordon 2005).

The redistribution component therefore rectifies the skewed distribution of land ownership between large farmers and smallholder farmers (Sibanda 2001). This ensures that smallholder farmers have access to land for residential and productive purposes so as to improve their livelihoods. Machethe (2005) suggests that the Settlement/Land Acquisition Grant programme did not live up to expectations and a new programme that of Land Redistribution for Agricultural Development was introduced. However, the major criticism of the land reform programme is that little attention has been given to the provision of farmer support services to land reform beneficiaries. It is therefore fruitless to embark on a land reform programme without ensuring access to farmer support services.

Most smallholder farmers are located in the rural areas, particularly in the former homelands, where both physical and institutional infrastructure limits their expansion. The lack of access to proper roads, for example, limits the ability of a farmer to transport inputs, produce and to access information. Delgado (1999) suggests that infrastructure is normally poor, markets for agricultural inputs and outputs are often missing and unreliable for smallholder farmers. This means that the acquisition of agricultural resources becomes difficult and the supply of market services also becomes limited. The lack of assets, information and access to services hinders smallholder participation in potentially profitable markets.

2.15.1. Land reform strategy used in South Africa

South Africa adopted the land reform in the form of LRAD. In South Africa, land reform is divided into three pillars, which are: (i) land redistribution. (ii) land restitution and (iii) land tenure reform.

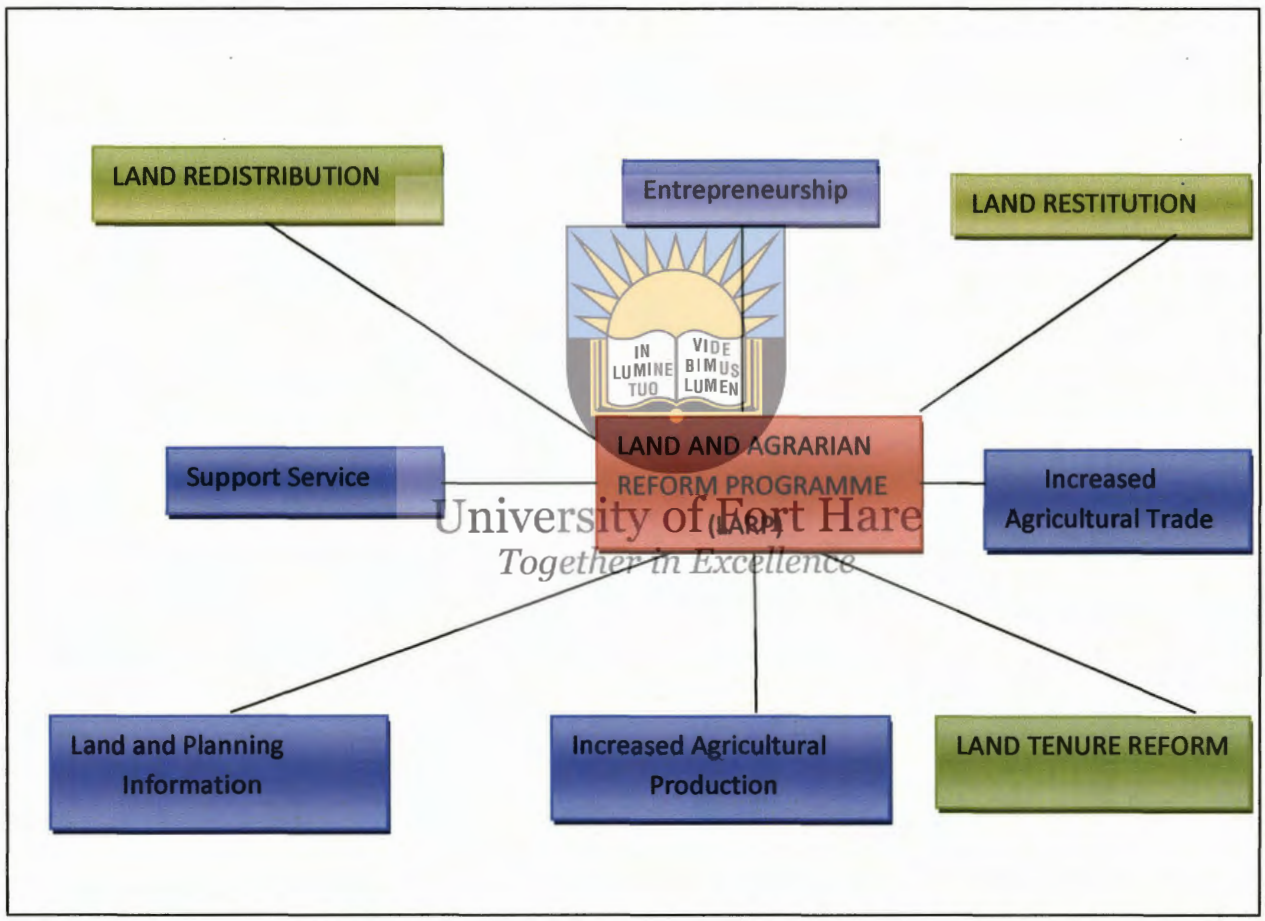


Figure 2. 8 : Land reform strategy Source: Ministry of Rural Development and Land Reform 2009

2.15.2. Land redistribution programme

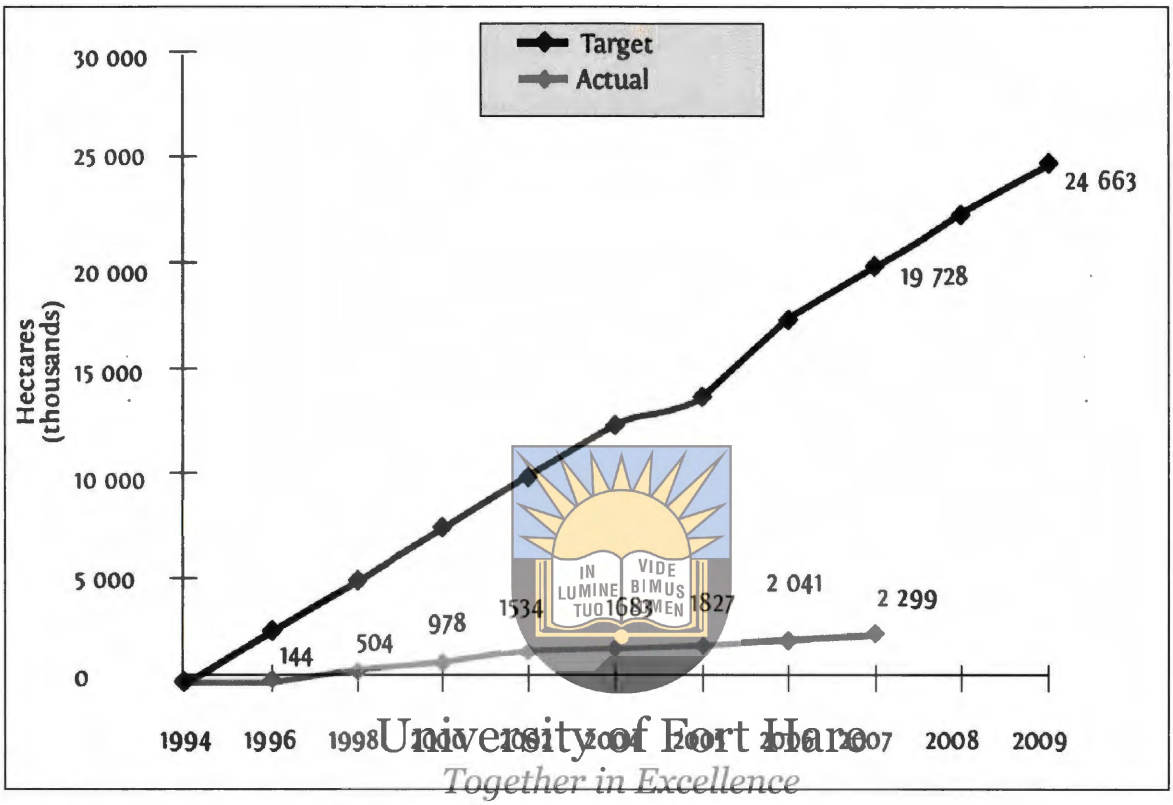


Figure 2. 9: Land redistribution progress for 2006/7

Source: DLA 2006/2007

The White Paper on South African Land Policy by DLA (1997) states that the purpose of this programme is to provide the poor with land for residential and productive purposes in order to improve their livelihoods. It also states that the programme is designed to assist other groups, such as the urban and rural poor, labour tenants, farm workers, the landless poor, and would-be farmers. While land transactions are voluntary, and are based upon a 'willing seller' and a 'willing buyer'. According to the DLA (1997) the White Paper states that expropriation will be used as an instrument of last resort where urgent land needs cannot be met through voluntary market transactions.

In 2001, a new sub-programme called the LRAD was introduced. The government envisaged that LRAD would help to achieve a number of key objectives of the land reform programme, for

example, contributing to the redistribution of 30 percent of the country's agricultural land by 2015; decongesting over-crowded former homeland areas; expanding opportunities for women and young people who stay in rural areas; and improving the nutrition and incomes of the rural poor who want to farm on any scale (DLA 1997).

2.15.3. The land restitution programme

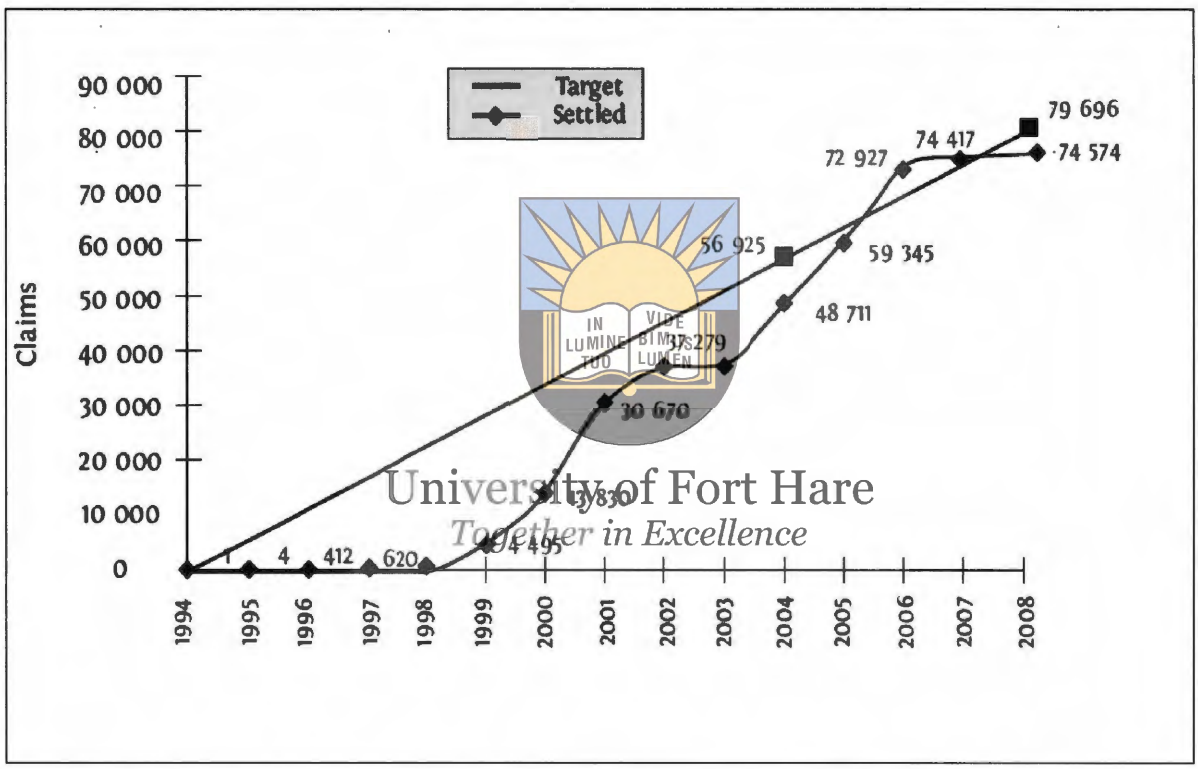


Figure 2. 10: Land restitution progress for 2006/2007 (Source: DLA 2006/2007)

This programme aims to restore land to those people who were displaced as a consequence of the Natives Land Act of 1913, the Native Trust and Land Act of 1936 and others. Those black households who owned land outside of the reserves were initially exempted from the provisions under the 1913 Act, however, from the 1950s until the 1980s these households or 'black spots' were subjected to forced removals (DLA1997). The programme only considers those people that can prove that they were forcibly removed after 19th June 1913. According to the DLA (1997) and Adams (2000) the Land Claims Court and Commission that was established under the Restitution of Land Rights Act 22 of 1994 is the body responsible for adjudicating these claims.

In the mid-1990s the government restructured the programme following criticisms about the pace of progress (DLA 1997 and Adams 2000). This led to a dramatic increase in the programme's speed of delivery.

2.15.4. The Land Tenure Reform Programme

The government's White Paper on Land Policy (1997) explains that until the early 1990s it was government policy that black people should not own land. The form that land rights took in the homelands and townships was permit based or held in trust. In most cases, the land was registered as the property either of the government or of the South African Development Trust. According to the DLA (1997) in many areas of the country, the administration of the land was confused and chaotic and, while households may have occupied land for many years, they had no legal right to that land.

2.16. Dry Land Farming

According to Bennie & Hensley (2001) the efficiency of precipitation use proved to be a valuable parameter for comparing the level of precipitation utilization of different production or management practices for dry land crop production. Increasing the length of the fallow period before planting increased the amount of pre-plant stored water in the soil, thereby reducing the risk of drought damage to crops; this also resulted in better yields (Bennie & Hensley 2001).

Dry land agriculture has its distinct importance in the sphere of agricultural production. About 70% of the total cultivated area in the country is dry land or rain-fed contributing about 42% of the total production of food grains. Dry land areas suffer due to frequent weather aberration resulting in crop failure and widespread unemployment. Since the cultivation in dry land areas involved high risks of crop failure, the farmers in such a situation, were unable to make high investments in their land for improvement.

2.16.1. The problems of dry farming

According to FAO (1996) the dry-farmer should, at the outset, know with comparative accuracy the annual rainfall over the area in which he intends to cultivate. He must also have a good acquaintance with the nature of the soil, not only as regards its plant-food content, but as to its power to receive and retain water from rain and snow. In fact, knowledge of the soil is indispensable in successful dry-farming. Only through such knowledge of the rainfall and the soil is the farmer able to adapt the principles outlined in this volume to his special needs.

Since, under dry-farm conditions, water is the limiting factor of production, the primary problem of dry-farming is the effective storage in the soil of the natural precipitation (FAO 1996). Only the water, safely stored in the soil within reach of the roots, can be used in crop production. Of equal importance is the problem of keeping the water in the soil until it is needed by plants. During the growing season, water may be lost from the soil by downward drainage or by evaporation from the surface (FAO 1996). It is necessary, therefore, to determine the conditions under which the natural precipitation stored in the soil moves downward and by what means surface evaporation may be prevented or regulated. The soil-water which is of real use to plants is that taken up by the roots and finally evaporated from the leaves. A large part of the water stored in the soil is thus used (FAO 1996). The methods whereby this direct draft of plants on the soil-moisture may be regulated are, naturally, of the utmost importance to the dry-farmer, and they constitute another vital problem of the science of dry-farming (FAO 1996).

FAO (1994) also state that the relation of crops to the prevailing conditions of arid lands offers another group of important dry-farm problems. Some plants use much less water than others. Some attain maturity quickly and, in that way, become desirable for dry-farming. Still other crops, grown under humid conditions, may easily be adapted to dry-farming conditions if the correct methods are employed and may in a few seasons be made valuable dry-farm crops (FAO 1994).

The individual characteristics of each crop should be known as they relate to low rainfall and arid soils. After a crop has been chosen, skill and knowledge are needed in the proper seeding, tillage, and harvesting of the crop. Failures frequently result from the deficiencies in adapting crop treatment to arid conditions (FAO 1994).

2.17. Irrigation and food security

The demand for irrigation water can be regarded as a derivative of the demand for food. The contribution of surface and groundwater irrigation development to today's aggregate food supply is sometimes overlooked as evaluations of policies and projects focus on identifying problems rather than benefits. FAO (1994) state that, despite the problem focus of the irrigation literature, the generally accepted estimates of the contribution of irrigation to global food production are in the range of 25 to 50 percent - a share that is set to rise as the new expensive biotechnology inputs come on board. Evidence presented by the FAO (1994) shows that modern biotechnology inputs will be productive but costly and, therefore, create a need for good soil moisture regimes to support optimum crop growth and reduce the risk of failure.

2.18. Possible Factors Affecting Agricultural Production

Part of the central research question is to determine the factors affecting agricultural production more broadly. Accordingly, the review covered aspects of the agricultural, economic, social and cultural environment which play a role in determining whether or not agricultural production is going on at an optimal rate.

2.18.1. Access to arable land

The level of farming undertaken relies on the amount of access to land (Matshe 2009). This means that in order for any farming activity (agricultural production process) to take place, amount of land and access to land is required. According to Altmann (2009) access to land is often considered a determinant of people's involvement in agriculture or farming. When a rural household has access to arable land it means that household can produce food for his or her family. But it is not always the case that when there is available land to undertake production, a household will make use of that available land in order to plough crops or keep livestock. Sometimes arable land can be available, but if other agricultural inputs like seeds and fertilizer are not available, agricultural production cannot take place. If one rural household does not have access to arable land, the head of that household will not produce food for him/herself or for the rest of the family. If a household has access to land, whether it is a field or home gardening, that

will be an advantage to him or her as compared to other rural households who do not have access to a piece of land. Musotsi *et al.*(2008) mention that in Kenya home gardening has been identified as a means of providing year round access to food for rural households. There can be much land available for food production, but if people lack the knowledge and skills to develop and maintain food gardens and fields that would improve the nutrition and health of their families, that would be a problem since they cannot produce without the requisite skills and know-how (SASSIX 2009). The access and amount of land a household has is associated with the amount of own household produce obtained in a harvesting season.

2.18.2. Productive inputs and resources

When there are no productive inputs to use, there will be no agricultural production process taking place. Rural households which used to produce food for themselves will find it difficult, in the absence of agricultural productive inputs, to produce food for themselves (Gilimani 2005). In the former homelands, access to agricultural support services is a major factor constraining the growth of agriculture. Without adequate access to farming support services, improvement in rural agriculture can hardly be achieved. According to Gilimani (2005) the scarce resources for rural households are the cash needed to purchase inputs and limited seasonal labour.

A household may produce food when it has the human and material resources to do so, such a household will have direct access to food. According to FAO (1997) the ability of households to produce food in adequate amounts and sufficient variety depends, to a large extent, on their access to resources such as sufficient and fertile land, labour, tools, seeds, draught power, credit and other essential agricultural services. The level of farming undertaken by a rural household depends and relies on access to and amount of water, seeds, fertilizer and agricultural equipment or resources that are available (Matshe 2009). The productivity of subsistence production is greatly increased by the use of improved inputs such as seeds and fertilizers. Improved access to agricultural inputs and appropriate farmer support through extension services would have a positive and significant impact on improved yields for food crop production by rural households (Baiphethi & Jacobs 2009).

Rural households with limited access to resources or with access to poor quality resources have fewer options and they often fail to access or acquire enough food for their families through their own production (Monde 2003). Those who own multiple resources are able to exercise a large variety of livelihood options and are often in a better situation in terms of accessing or acquiring food through farming. The lack of ownership and access to resources leads to rural households not participating in farming which will lead to them not producing food for themselves. The lack of access to resources other than land also deems agriculture a less viable livelihood option in rural areas (Monde 2003).

Agriculture appears to be a viable livelihood option when sufficient amounts of the factors of production such as land, labour and capital are owned and accessible. When there is limited access to any of these resources, it appears to encourage rural people to seek non-farm activities aiming at earning money so as to satisfy their other needs, including the need for food (Monde 2003). Rural households of South Africa are the worst affected by poverty because of their inability to attain sufficient resources (Kgaphe[illegible]shoff 2002). According to Baiphethi & Jacobs (2009) in former homeland areas of South Africa, there is evidence that agricultural resources are being underutilized. This means that in some cases in rural areas agricultural resources are there but rural people do not efficiently utilize them.

2.18.3. Time

Matshe (2009) state that time is a very important factor in the production process of food. If, for example, in a household everyone is employed, that means that no one will be responsible for agricultural production; all of their time will be dedicated to work, not farming. When there are adults in a household that are not employed, that means that there will be people available and responsible to undertake the agricultural production process and produce their own food (Matshe 2009). According to Matshe (2009) farming requires a very high time input from family members and hired labour in order for the agricultural production process to take place. People who are employed and do not have time to produce food for themselves will only acquire food through economic access (market) as they will have cash (money) since they will be working and receiving an income.

2.18.4. Knowledge, education and extension services

Rural households can produce food when they have knowledge to grow crops and raise animals (livestock) that provide beneficial nutritional outcomes and sustain household livelihoods on a continuous basis in a family. Nompozolo (2000) recommends that extension officers be trained in indigenous knowledge relevant to the farming communities they serve. If extension officers can be trained on agricultural production activities which occur in places where they are working, the households in those communities will benefit significantly from food production techniques for the products they are producing, if extension officers visit them in their communities. Nompozolo (2000) suggested that a reasonable amount of information is necessary to back up one's own food production in rural areas and for good performance in agricultural productivity.

Knowledge played a crucial role in decision making in terms of when and what to produce in order for a household to acquire food for its family. If someone does not have the requisite knowledge of how to produce food for his/her family, the family will most likely depend on cash in order for it to acquire food (Nompozolo 2000). Households in rural areas rely and use indigenous knowledge for farming. Knowledge is one of the most powerful tools that an individual can possess. For example, if one can be given knowledge by elders or by extension services or from a farming school, that individual will not have a problem when the planting season comes, especially if agricultural inputs will be available (Nompozolo 2000). Extension officers do not visit rural households on a regular basis and they are unable to fulfill their intended role of providing households with advice and encouragement in farming (Gilimani 2005). Most of the extension services in rural areas are focused on cash crops rather than food and subsistence crops, which are the primary concerns of rural households, in addition to the production of their own food production; it is also considered the key to food security (FAO 1994).

Education is the knowledge or skill obtained or developed by a learning process. There is knowledge that can only be passed down to people through the education system. Young people in rural areas need role models to motivate them and must be given a usable education and skills in order for them to understand and know farming activities better. Motivation is one of the tools

that can be used to boost the self confidence of and provoke a positive attitude amongst rural people, especially the youth who will be involved in farming in order to produce their own food.

2.18.5. Income

Changes in income alter the quantity of foods consumed by a household (Jacobs 2009). The amount of money a household has determines the quantity of food a household should have. Individuals have sufficient access to food when they have adequate incomes or other resources to purchase food (Ziervogel, Nyong, Osman, Conde, Cortes & Downing 2006). For a household, having a good income will allow them to purchase agricultural inputs so that the household can grow or produce its own crop and keep livestock with the purpose of getting food for the family. When a household has a good financial status, that household can even hire people for the agricultural production process.

Access to income can affect the probability of a rural household becoming successful in its own food production. The probability of success in one's own food production should be directly related to access to other sources of income. According to Aliber & Hart (2009) those rural households which have access to other sources of income made better use of all existing factors of production, while households which have access to little alternative income under-utilized some of their factors of production due to inadequate operating capital. Given the low levels of household income, those households will not have enough resources to engage in high input agricultural or own food production (Aliber & Hart 2009). In most cases, own food production, by households, becomes relatively less important as the total income rises.

2.18.6. Household size

Normally, the larger the family size, the more likely the household is to produce more as the household has more household members to participate in its own food production. This would only work if all family members are old persons who wish to produce own food or are able to perform the farm work; otherwise, this will not work if the household size consists of a majority of young children who cannot participate in household own food production or who cannot be used as family labourers or workers.

When the household size is composed of a few family members, it can participate in its own food production and produce food but not at the same rate as the household composed of many family members who are active when it comes to participating in farming or their own food production. The size of the household can sometimes be large, but if those household members do not have knowledge on how to produce food for themselves, then they will experience a problem when it comes to producing their own food. This means that the size of the household can determine the extent to which the rural household can produce its own food and the quantities they consume from their own food production.

2.18.7. Gender of the household head

According the FAO (1994) own food production is a major activity of rural women and their responsibilities and labour inputs often exceed those of men, in most areas in Africa. In most cases, the household heads in rural areas are women and they are the ones who participate most often in their own food production processes. The reason why most rural households are headed by women is that men leave rural areas to urban areas in search of better job opportunities so that they can earn a greater income in comparison to that which he would earn should he be involved in rural activities (FAO 1994). The number of female-headed households is increasing significantly in rural areas, in many developing countries, as rural men migrate due to the lack of employment and other income-generating opportunities in rural areas. In most cases, men only involve themselves in own food production for the family in the planting period and during harvesting time (FAO 1994). In the planting season, they prepare the land so that it can be easy to plough and they assist during the harvesting period by taking the produce from the fields to the household. According to FAO (1994) Men are largely responsible for the clearing and preparation of home gardens, fields, ploughing and participating to a greater or lesser degree in other agricultural tasks along with women. Women in rural areas are involved in their own food production process throughout. FAO (1994) stated that women in Africa play a major part in sowing, weeding, the application of fertilizers and pesticides, harvesting and the processing of food.

According to Lemke, Bellows & Heumann (2009), rural households led by women are found to be households which participate in their own food production to a far greater extent than other households. A case study of South African farms shows that female-headed households,

especially in rural areas, although having less access to earned income, take better care of the well-being of household members by making sure that they participate in their own food production process (Lemke et al. 2009). Women are crucial in the translation of the products of a vibrant agricultural sector into food and nutritional security for their households. In rural areas, the availability and use of time by women is also a key factor in home food production.

2.19. Chapter Summary

In the study agricultural technology was inter-changeable with irrigation. The adoption of irrigation by small-scale farmers may improve the food security of the rural households. Also the availability and access to the resources such as land may help the small scale farmers to produce more food for the rural communities. Small-scale farmers and farming community (rural households) of South Africa have the potential to contribute to growth in rural areas, reduce poverty and income disparity, and hence contribute to economic growth. People in rural areas are engaged in different activities as their livelihood strategies. Rural areas used to be places where surplus of food crop products was transferred to urban markets, but recent studies that to be no longer the case, as rural areas in nowadays purchases most of their food products from urban markets. The most employed food procurement strategies in rural areas are through obtaining food from markets and other portion from own food production. Rural households grow different food crop products in their home backyard gardens and in their fields, those ones still using them to grow crops.

CHAPTER 3

SELECTION OF STUDY AREA AND RESEARCH METHODOLOGY

3.1. Introduction

This chapter will present the information of the study area which is under the Zululand district municipality. The study takes place in the Maphophoma area which is at Nongoma. Nongoma is a rural area which is dominated by traditional leadership. Methodology adopted for the study is presented in this chapter. Methodology refers to the techniques or methods used to collect all the relevant data needed for the study. This chapter begins with a detailed description of the study area in terms of its biophysical and socio-economic characteristics. Following the site description, is a section that offers a detailed explanation of the methods used to collect, analyze and interpret the data. The framework of analysis as well as its application in this study is also explained in this chapter.

3.2. Selection of the Study Area

This study will be conducted at Maphophoma location, which is one of the rural villages of Nongoma in the KZN Province of South Africa. Maphophoma is one of the areas located at Nongoma Local Municipality in the KZN. The study area falls under the Matheni Tribal Council.

3.3. Description of the Study Area

The description of the study area is important because it familiarizes one with the area in which the study was carried out. Maphophoma normally receives about 837mm of rain per year, with most of its rainfall occurring during summer. Maphophoma can be referred to as a semi-arid place as it receives about 837mm rainfall per year. The climate has been recognized as suitable for crop production.

Maphophoma is under the Zululand district municipality. Zululand is one of the 11 district municipalities of the KZN province. The majority of its people speak isiZulu. The ZD is situated in the north-eastern part of the KZN. Zululand has an area of 15,307 km^2 and is primarily a rural

district with a population of 915 137 people living in 866 isolated rural settlements and six urban areas, which are 872 settlements in total.

Maphophoma is located in the Nongoma district of KwaZulu-Natal, within Zululand District Municipality (DC26). According to Tribal Authority Boundaries, it falls under the Matheni Tribal Authority. The geographic positioning co-ordinates define the locality of the Maphophoma area as S 28° 02'07" E 31°40 '12". The map showing the study area is presented in figure

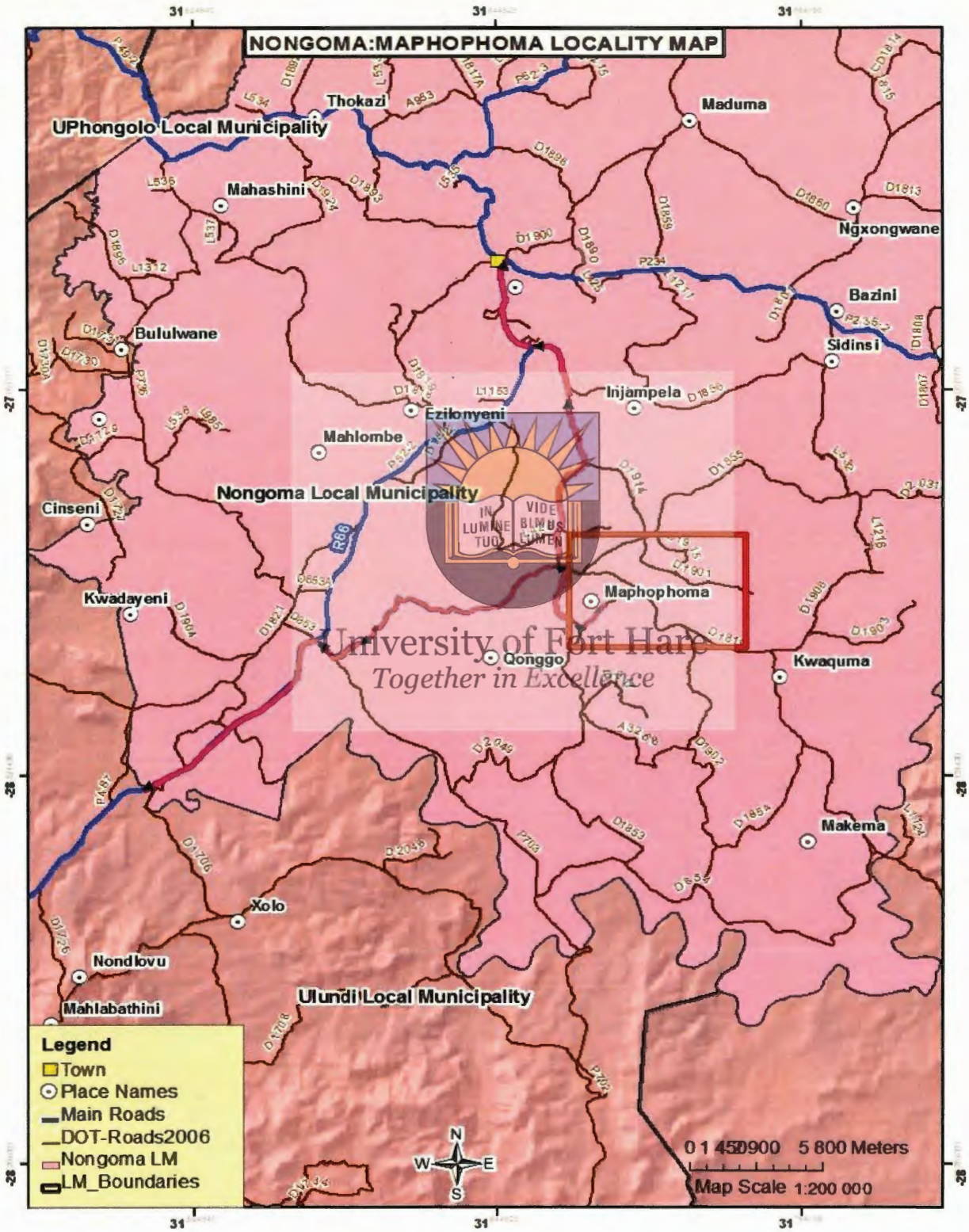


Figure 3. 1: The map of the study area (Maphophoma)

3.4. Climatic factors of Maphophoma

The area has an annual mean rainfall of 727mm and has occasional frost. Despite these climatic limitations, a wide range of crops can be successfully produced here. The annual rainfall of the study area is presented in Table 3.1.

Table 3. 1: Annual rainfall (mm) for the study area

	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Median		126	106	91	46	32	14	10	20	41	87	115	125
Mean	837	125	112	103	47	26	16	18	24	52	95	108	111

Source BRU 2012

The high annual rainfall is in between January to March with the average ranging from 103 to 125mm, from April to October is drops and it's picked up from November. From November to January is above 100 mm.

The annual temperature of the study area is presented in Table 3.2

Table 3. 2: Annual temperature (°C) for the study area

	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	19.3	23.0	22.7	22.1	19.8	17.4	14.7	15.0	16.5	18.3	19.3	20.5	22.2
Max	13.2	17.3	17.3	16.4	14.1	11.0	7.9	8.0	9.7	12.2	13.4	15.1	16.5
Min	25.4	28.4	28.2	27.5	25.6	23.9	21.8	22.0	23.2	24.8	25.3	26.2	28.2

Source BRU 2012

The high maximum temperature of the study area is at January with a value of 17.3 °C.

Table 3. 3: The evaporation of the study area

Evaporation	Ann	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
APan (mm)	1830	201	171	163	132	114	94	105	137	156	176	175	206

Source BRU 2012

According to BRU, KwaZulu-Natal is South Africa's best watered province; it has a larger area of high quality agricultural land than any other province, and it is the national leader in several agricultural products. Despite the fact that KwaZulu-Natal covers such a small portion of South Africa's land area, a significant percentage of the country's small-scale farmers are based here. Agriculture in KwaZulu-Natal is extremely diverse and relates to the patterns of its topography. Most of the world's agricultural activities can be practiced in the region. Due to its good, reliable rainfall and fertile soils, the agricultural sector has become very productive, and is known for its specialist capabilities in several types of farming. The Province has a total of 6.5 million hectares of land for farming purposes, 82% of which is suitable for extensive livestock production and 18% is arable land.

3.5. Sampling Method

For the purposes of this study, the unit of analysis was the farming household. The farming household was taken as a unit that consisted of all people residing in a single homestead, sharing resources and activities whether they were related or not. However, to determine impacts on livelihoods and incomes, household members residing elsewhere but get a share from the incomes of the rural households were considered in the analysis. This is because dependence on farm income represents another form of expenditure to the farming household.

The study focused on rural households of Maphophona Location trying to find out about the impact of technology adoption to food security, focusing on own food production as the place is capable of producing it own food crops. Interval sampling method which is a type of probability sampling, was a most suitable method which was used, as it tries to cover the whole target population by selecting few respondents to cover the entire village or population.

Sampling is the process of selecting units from a population of interest, so that by studying the sample, the results obtained from the sample may be generalized to the population from which the sample had been chosen (Leedy & Ormrod 2004). This means that the characteristics

obtained from the sample should reflect approximately the same characteristics as the population. Possible sampling methods are classified into probability and non-probability sampling. Probability sampling occurs when the probability of including each element of the population can be determined and when the population list is available whereas non-probability sampling refers to cases in which the probability of including each element of the population in a sample is unknown (Bless, Higson-Smith & Kagee 2006). When a complete population list is available, probability sampling is preferable but when it is not available non-probability sampling is more suitable.

3.6. Methods of Data Collection

The sample was drawn from the population list of 950 farmers obtain from the local Extension officer, the list involved all the farming activities in the area. The total ratio of irrigating and non irrigating farmers is 6.3 %. The ratio of total sample is 12.6%.

The study consists of a sample size of 120 respondents, 60 farmers from non-irrigating farms and 60 from irrigating farms. The data was collected from individuals or respondents through interviews using interviewer-administered questionnaires. The questionnaires were interviewer-administered to alleviate the problem of misunderstandings of words or questions, on the part of the respondents. The respondents presented with a series of questions that they responded directly to the questionnaire form itself, with the aid of an interviewer. This questionnaire method of data collection is much quicker than formal interviews. The interviewer reads questions to respondents and records their answers.

The advantage of this data collection method is that the interviewer will be in a position which allows him/her to probe for further information from the respondents. These questionnaires could also ensure that all the questions had been considered and that the respondents did not omit difficult questions. By having the questionnaires administered by the interviewer, it meant that information could also be obtained from respondents who could neither read nor write (Levy & Lemeshow 1991).

The questionnaire will consist of both open- and closed-ended questions. Open-ended questions allow respondents to express their views freely - but they will be minimized for easy data analysis - as well as to focus on issues related to the research. Most of the questions will be

structured as closed-ended questions for the benefit of obtaining information from respondents without consuming much of their time, and for the easy coding of responses.

3.7. Data Analysis and Interpretation

The study used graphs, tables (including cross-tables) and descriptive statistics (mean, frequency, standard deviation and percentages) to analyze data. Descriptive statistics used in the analyses of personal and household information while graphs and tables used to analyze other relevant information. This study also makes use of the multiple regression analysis to analyze the data and explain the relationship between several independent variables and a dependent variable. Data will be entered and analyzed using Excel in Microsoft office and the statistical computer software program SPSS, version 19.

3.7.1. Descriptive statistic

Descriptive statistic used to analyze the demographic information, such as the age, gender or level of education of each respondent. Under descriptive statistics the frequency was used. Descriptive statistics was used in the analyses of personal and household information while graphs and tables were used to analyze other relevant information.

3.7.2. Explore and M-Estimator

The study adopts Explore and M-Estimator, to compare the results between the irrigators and non irrigators farmers. The study looked on the mean total value of non irrigating farmers and the mean total income of irrigating farmers. Also the mean total expenditure of non irrigating farmers and the mean total expenditure of irrigating farmers. The result distributes the impact of adopting new agricultural technology.

The study looked on the Skewness of income for non irrigating and irrigating farmer when the Skewness is greater than 0 that means that distribution is skewed. The kurtosis value of the income of non irrigation farmers is less than 3, and also of the irrigating farmers which is less than 3, that means the distribution is flatter than normal.

The main reason of using both Explore and M-Estimator is to distinguished between irrigating and non-irrigating farmers.

Skewness: indicator used in distribution analysis as a sign of asymmetry and deviation from a normal distribution.

Interpretation:

- Skewness > 0 - Right skewed distribution - most values are concentrated on left of the mean, with extreme values to the right.
- Skewness < 0 - Left skewed distribution - most values are concentrated on the right of the mean, with extreme values to the left.
- Skewness = 0 - mean = median, the distribution is symmetrical around the mean.

Kurtosis - indicator used in distribution analysis as a sign of flattening or "peakedness" of a distribution.

Interpretation:

- Kurtosis > 3 - Leptokurtic distribution, sharper than a normal distribution, with values concentrated around the mean and thicker tails. This means high probability for extreme values.
- Kurtosis < 3 - Platykurtic distribution, flatter than a normal distribution with a wider peak. The probability for extreme values is less than for a normal distribution, and the values are wider spread around the mean.
- Kurtosis = 3 - Mesokurtic distribution - normal distribution for example.

The Explore procedure produces summary statistics and graphical displays, either for all of your cases or separately for groups of cases. There are many reasons for using the Explore procedure data screening, outlier identification, description, assumption checking, and characterizing differences among subpopulations (groups of cases).

M-estimators are solutions, θ, which minimize

$$\sum_{i=1}^{n} \rho(x_i, \theta).$$

This minimization can always be done directly. Often it is simpler to differentiate with respect to θ and solve for the root of the derivative. When this differentiation is possible, the M-estimator is said to be of **ψ-type**. Otherwise, the M-estimator is said to be of **ρ-type**.

In most practical cases, the M-estimators are of ψ-type.

In statistics, M-estimators are a broad class of estimators, which are obtained as the minima of sums of functions of the data. Least-squares estimators and many maximum-likelihood estimators are M-estimators. The definition of M-estimators was motivated by robust statistics, which contributed new types of M-estimators. The statistical procedure of evaluating an M-estimator on a data set is called M-estimation.

More generally, an M-estimator may be defined to be a zero of an estimating function. This estimating function is often the derivative of another statistical function: For example, a maximum-likelihood estimate is often defined to be a zero of the derivative of the likelihood function with respect to the parameter: thus, a maximum-likelihood estimator is often a critical point of the score function. In many applications, such M-estimators can be thought of as estimating characteristics of the population.

3.7.3. Linear regression model

This study also makes use of linear regression analysis in order to analyze the data and explain the relationship between several independent variables and a dependent variable. The study adopts the use of multiple regression analysis to predict a dependent variable based on more than one independent variable. The researcher chooses this model because it allows one to predict the impact of independent variables on a dependent variable. In order to explain the relationship between several independent variables and a dependent variable, the study used multiple regression model. Multiple regression analysis refers to a group of techniques which allow for measurement of the degree of relationship between a dependent variable and independent variables. The multiple regression allows the simultaneous testing and modeling of multiple

independent variables. In this study, the multiple regression model used access to resources of income, age of the household head, total size of the household, level of education, total size of land owned by the household and the farming expenditures as independent variables.

3.8. Testing using Multiple Regression Model or Analysis

The literature revealed that multiple regression analysis can be used to predict a dependent variable based on more than one independent variable. The researcher chooses this model because it allows one to predict the impact of independent variables on a dependent variable. In order to explain the relationship between several independent variables and a dependent variable, the study will use the multiple regression model. Multiple regression analysis refers to a group of techniques which allow for the measurement of the degree of relationship between a dependent variable and independent variables. Multiple regression allows the simultaneous testing and modeling of multiple independent variables.

The multi linear regression model formula:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \square\ldots\ldots\ldots\ldots\ldots_n X_n + U$$

Where:

Y = Dependent variable

X_1 -X_n= Independent variables

U = Error term

β_0 = the intercept and

β_1,-$\beta_n$are partial regression coefficients

Using the Statistical Package for Social Science (SPSS) Version 19 computer software, beta values ($\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, , \beta_6$ and β_7) will be obtained. These values will be used to measure how strong each independent variable (X_1, X_2, X_3, X_4, X_5,X_6 or X_7) influences the dependent variable (Y). Thus, the higher the beta value the greater the impact of the independent variable on the dependent variable.

Y = Dependent variable

Y = TOTYIELD

X = Explanatory variables

X_1 = IRRIGATION

X_2 = SOURCEIN

X_3 = AGHH

X_4 = TOTSH

X_5 = LVEDU

X_6 = LNDOW

X_7 = SPENT

U = Error term

Table 3. 4: Model variables applied in the analyses

Variables	Code	Unit	Type of Variable	Expected Sign +/-
Irrigation	IRRIGATION	Yes or no	Categorical	+
Source of income	SOURCEIN	Had or did not have	Continuous	-
Age household head	AGHH	Actual number	Continuous	+
Total size of household	TOTSH	Actual number	Continuous	-
Level of education	LVEDU	Attend formal schooling or not	Categorical	+
Land owned	LNDOW	Actual size in hectors	Continuous	+
Farm expenditure	SPENT	Had or did not have	Continuous	+
Farm income	TOTALIN	Had or did not have	Continuous	-

Since the study focused on the impact of new agricultural technology adoption on food security, irrigation is a mare independent variables others such as source of income, age of the household head, total size of household, land owned and expenditures are controlled variables.

Irrigation: in the study irrigation used inter-changeably with technology, if the farmers adopt irrigation that might have positive result to the yield.

Source of income: household income looks to the total income of the house hold including non-farm income such as salaries and social grants.

Age of household head: Age is an important that determines the indigenous experience of the household agricultural practices. The middle age household head has more access to the new technology that the old age household head. The older the farmers are more chances to have more farming resources than a younger farmer. Age is another factor thought to affect adoption. Age is said to be a primary latent characteristic in adoption decision.

Size of household: This is the actual number of people living together; the more the household members might increase the dependence. The increase in dependence might result on less money invested in farming. The higher the number of household size might result on more available labour for farm work.

Level of education: These means the highest level of education level of household head. Education is an important attribute to the adoption of new technology. The effects of education on adoption in most cases relate it to years of formal schooling (Tjornhom, 1995).

Land owned: Much empirical adoption literature focuses on farm size as the first and probably the most important determinant. According to Abara and Singh (1993) the effect of farm size has been variously found to be positive. The total land owned by the household for agricultural practices measured in hectors. Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labor requirements, tenure arrangements and more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara and Singh, 1993).

Expenditure: The farming is a business the more the investment the more the returns.

Income: The household with high level of income from farm practices may supplement other household needs, such as financing children education.

3.9. Explore Procedure and M-Estimator

According to Muthukrishnan & Radha (2010) the class of M-estimator was introduced by P.J.Huber in 1964, to estimate a location parameter robustly, has since been applied successfully to a variety of estimation problems where stability of the estimates is a concern. More generally, an M-estimator may be defined to be a zero of an estimating function (Huber 2009). The estimating function is often the derived from another statistical function: For example, a maximum-likelihood estimate is often defined to be a zero of the derivative of the likelihood function with respect to the parameter: thus, a maximum-likelihood estimator is often a critical point of the score function (Huber 2009).

Based on the evidence presented by Muthukrishnan & Radh (2010) M-estimators are very popular Ψ-type M-Estimator which has Ψ functions that are non-decreasing near the origin, but decreasing toward 0 far from the origin. Their Ψ functions can be chosen to re descend smoothly to zero, so that they usually satisfy $\Psi(x) = 0$ for all x with $|X| > k$, where r is referred to as the minimum rejected point.

Huber (2009) stated that there are many reasons for using the Explore procedure data screening, outlier identification, description, assumption checking, and characterizing differences among subpopulations. Skewness: indicator used in distribution analysis as a sign of asymmetry and deviation from a normal distribution. Kurtosis - indicator used in distribution analysis as a sign of flattening (Huber (2009).

The literature revealed that Explore can be used to distinguish the differences among groups. For that reason the study adopts Explore to compare the different between irrigating and non-irrigating farmers in terms of total yield. The Explore was used as a tool to identify the role of technology adoption in food security. The study looked at the mean total income of non irrigating farmers and the mean total income of irrigating farmers. Also the mean total expenditure of non irrigating farmers and the mean total expenditure of irrigating farmers were compared. The result distributes the impact of adopting new agricultural technology. The study

examined the Skewness of income for non-irrigating and irrigating farmers. When the Skewness is greater than 0 that means that distribution is skewed. The kurtosis value less than 3 means that the distribution is flatter than normal.

The Explore procedure produces summary statistics and graphical displays, either for all of your cases or separately for groups of cases. There are many reasons for using the Explore procedure to incorporate such aspects as data screening, outlier identification, description, assumption checking, and characterizing differences among subpopulations (groups of cases). Data screening may show that you have unusual values, extreme values, gaps in the data, or other peculiarities. Exploring the data can help to determine whether the statistical techniques that you are considering for data analysis are appropriate. The exploration may indicate that you need to transform the data if the technique requires a normal distribution.

In statistics, M-estimators are a broad class of estimators, which are obtained as the minima of sums of functions of the data. Least-squ[illegible]imators and many maximum-likelihood estimators are M-estimators. The definition of M-estimators was motivated by robust statistics, which contributed new types of M-estimators. The statistical procedure of evaluating an M-estimator on a data set is called M-estimation.

More generally, an M-estimator may be defined to be a zero of an estimating function. This estimating function is often the derivative of another statistical function: For example, a maximum-likelihood estimate is often defined to be a zero of the derivative of the likelihood function with respect to the parameter: thus, a maximum-likelihood estimator is often a critical point of the score function. In many applications, such M-estimators can be thought of as estimating characteristics of the population.

The decision of using Explore and M-estimator was to compare the two different groups of small scale farmers, which is non-irrigating and irrigating farmers.

3.10 Chapter Summary

The main aim of this chapter was to present the study area and the research methodology. The framework of analyzing as well as its application in the study is also explained in this chapter.

The importance description of the study area was identified in this chapter. The selection of this study area was influenced by the lack of resources and a free access to the area. The study was conducted in the deep rural areas of KwaZulu Natal under Nongoma Local Municipality.

The sample of 120 respondents was selected randomly selected. The primary data was collected by interviews using interviewer-administered questionnaires. The will use graphs and tables to present the findings. The data was analyzed by using Excel and SPSS version 19. To analyzed data, the study employed the descriptive statistic, explore, m-estimator and linear regression model.

CHAPTER 4

PRESENTATION OF RESEARCH FINDINGS

4.1. Introduction

The main aim of this chapter is to presents the inferential analysis carried out on the data used for the study. As has been described in chapter three, the analysis involved the fitting of a multiple regression model in order to determine the factors influencing the adoption of new agricultural technology. Also explore and M-estimator used for comparing the two groups of farmers. A total of 120 respondents were interviewed. The questionnaire that was used to collect data was divided into seven sections, namely: demographics, land acquisition, main crops, and credit acquisition for agricultural purposes, economic impact and production system. The result of the study would address the availability of resources, for the implementation of food security programs. In this chapter also the challenges encountered by small scale farmers in the adoption of new agricultural technology for food security programs will be addressed.

Descriptive statistic was used to analyse the demographic information, such as the age. Under descriptive statistics the frequency was used. This study was also used linear regression analysis in order to analyze the data and explain the relationship between several independent variables and a dependent variable.

4.2. Demographic Characteristics

The demographic information helps to give the over view of the household. It gives a clear understanding about the livelihood of that household you are interviewing.

In this section, aspects such as the gender of the household head, active population within the household, size of the household, marital status of the household head, age of the household head, level of education and source of income are revealed ad discussed. These aspects are important because the main household activities are coordinated by the household head and the head's decisions are most likely to be influenced by such demographic aspects (Makhura 2003). Demographic characteristics are important determinants of livelihood activities and outcomes. Kirsten, Perret & De Lange (2002) stated that demographic conditions have an impact on rural areas and the rural population. As the population continues to grow, increasing pressure that is

placed on land, agricultural production, and the rural household's behavior under limited demographic conditions such as education would lead to a fall in agricultural productivity, food crises and increased rural poverty. In this regard, the general information obtained from respondents is also included in this section.

Table 4.1 summarizes the personal information of the household head and household information as a whole. Demographic variables summarized in Table 4.1 include the age of the household head, household size, number of active members per household, marital status of the head of the household and the source of income for the household.

Table 4. 1: Demographic Characteristics of the study area

Variables	No. of farmers	Minimum	Maximum	Mean	Std. Deviation
Active population	120	1	11	4.43	1.913
Size of household	120	2	14	6.17	2.314
Age of household head	120	42	92	57.66	10.560
Source of income	120	1	2	1.53	.501
Total	120				

Source: Field work

4.1.2. Gender distribution

Gender is the main issue in the land allocation in rural areas; women's are more deprived than men's in accessing land. Gender issues in agricultural production and technology adoption have been investigated for a long time. Most show mixed evidence regarding the different roles men and women play in technology adoption (Doss & Morris 2001).

It is expected that male headed households participate in own food production more than female headed households do. This expectation is based on Dlova &Fraser (2004) findings that males are physically stronger, therefore, are more capable of coping with the heavy manual demands of farming practices than women are.

Table 4. 2: Distribution of gender of the household head

Variables	No. of farmers	Percent	Valid Percent	Cumulative Percent
Male	70	58.3	58.3	58.3
Female	50	41.7	41.7	100.0
Total	120	100.0	100.0	

Source: Field work

Table 4.2 shows that data was collected from a total number of one hundred and twenty (120) respondents, of which 70 were males and 50, were females. Therefore, the distribution of females is 41.7% while that of males is 58.2%. In South Africa, the population ratio of women to men is higher; this means that there are larger portions of females reaching old age than men (Tati 2009). The distribution of gender was purposefully chosen based on the assumption that the female population is greater than that of males and it is largely they who participate in farming.

4.1.3. Age of household heads

Knowing the age of the household head might helps to estimate the experience of the household to agricultural practice. Age might also identify the exposure to the indigenous farming skills of the household head. The age might also help the interviewer to structure his/her questions in a way that the despondence understands.

Previous studies have proven that the age of household heads in rural populations or areas, is twisted towards the upper ages. Age has an impairing effect on physical abilities, which is an important factor in small-scale farming. The ages of the households ranged from 42 to 92 years. Table 4.3 and Figure 1 below present the age distribution of the household heads. This is also presented in Figure 4.1.

Table 4. 3 Distribution of the age of the household head

Variable	No of farmers	Minimum	Maximum	Mean	Std. Deviation
AGEHH	120	42	92	57.66	10.560
Total	120				

Source: Field work

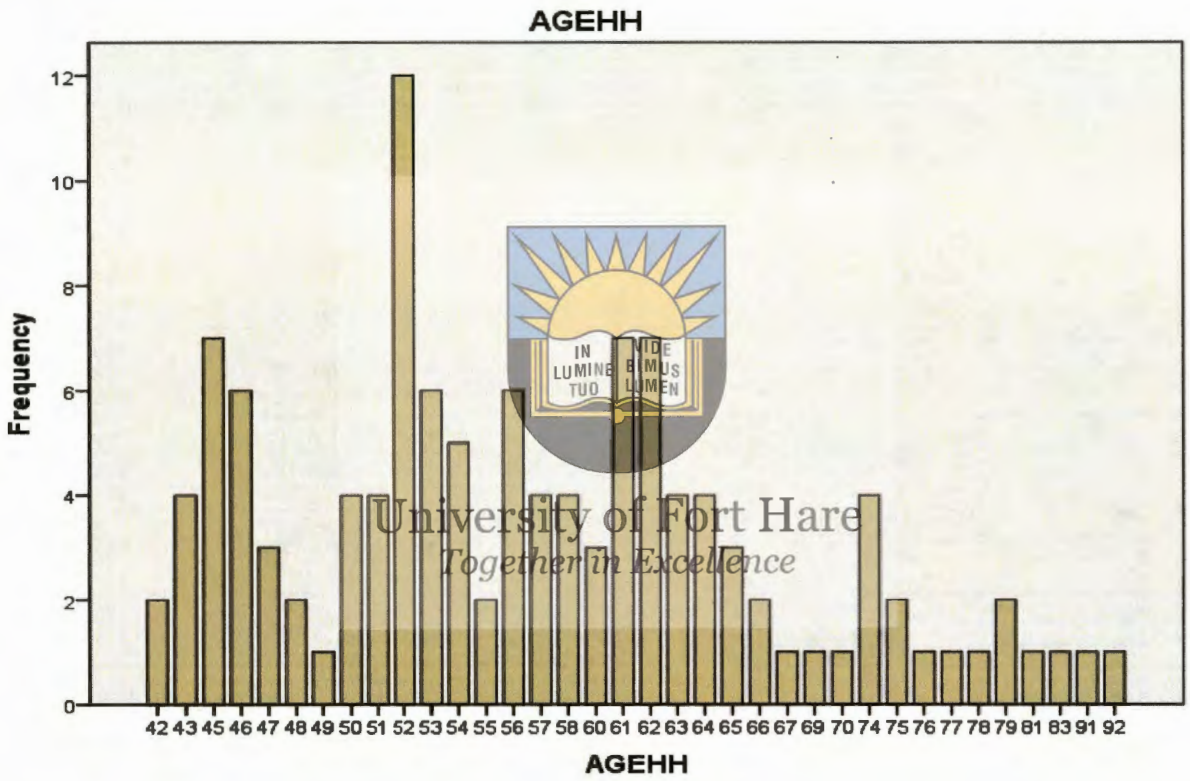


Figure 4. 1: Distribution of the age of household head

Source: From the field work.

4.1.4. Marital status of household heads

Marital status indicates the status of the head household of the interviewed. In the rural households the unmarried woman don't have access to the. Even the widow some time experience challenges in conation with the piece of land inherited from her husband.

In rural areas, especially older people (over 50 years), the household heads are or were married. Table 4.4 presents the marital status of the household members interviewed.

Table 4. 4 : Distribution of the Marital Status of the household head

Variables	No. of farmers	Percent	Valid Percent	Cumulative Percent
Married	60	50.0	50.0	50.0
Single	28	23.3	23.3	73.3
Divorced	4	3.3	3.3	76.7
Widow	28	23.3	23.3	100.0
Total	120	100.0	100.0	

Source: Field work

Table 4.4 shows that 23.3% of the respondents were not married (single). Married respondents were the majority as they constituted 50% of the respondent population. Only 3.3% of the respondents were divorced and 23.3% of the respondents were widowed. This is also presented in Figure 4.2.

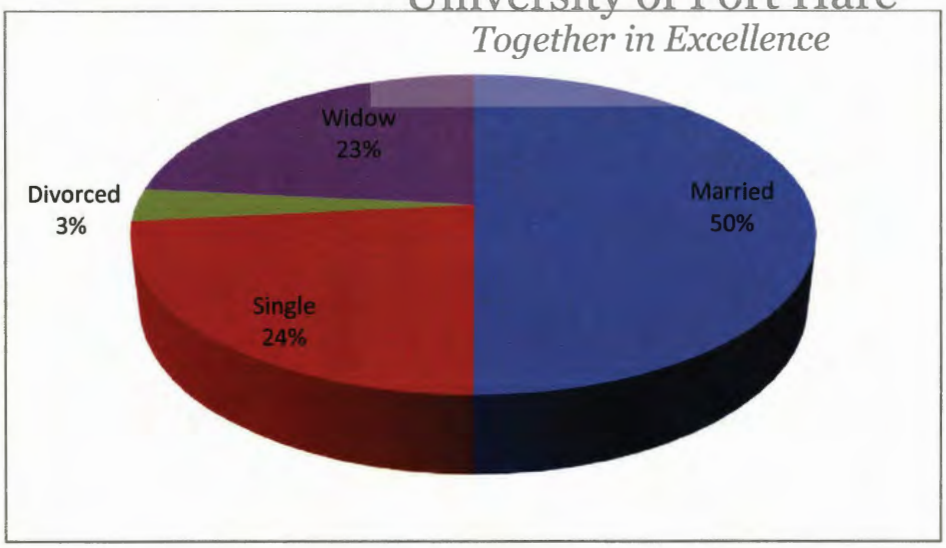


Figure 4. 2: Distribution of the marital status by the head of the household

Source: Field work

4.1.5. Education level of household head

By knowing the level of education of the interviewee helps the interviewer to understand the outcomes of the interview and the way of structuring questions education is the key to the adoption of technology.

Education is an important aspect of the socio-economic development of society (Koch 1991). According to Koch (1989), education influences decisions made on farms, such as decisions regarding the adoption of technology and good farming practice. This means that education plays a role in one's own food production. This study revealed that a high percentage of households have only a primary education level. Table 4.5 summarizes the distribution of level of education in the study sample.

Table 4. 5: Distribution of level of education by the head of household

Variable	No. of farmers	Percent	Valid Percent	Cumulative Percent
Non Educated	16	13.3	13.3	13.3
Primary Education	43	35.8	35.8	49.2
High School	51	42.5	42.5	91.7
Tertiary	10	8.3	8.3	100.0
Total	120	100.0	100.0	

Source: Field work

The level of education ranges from those who never attended school to those who have completed a tertiary qualification (Figure 4.3).

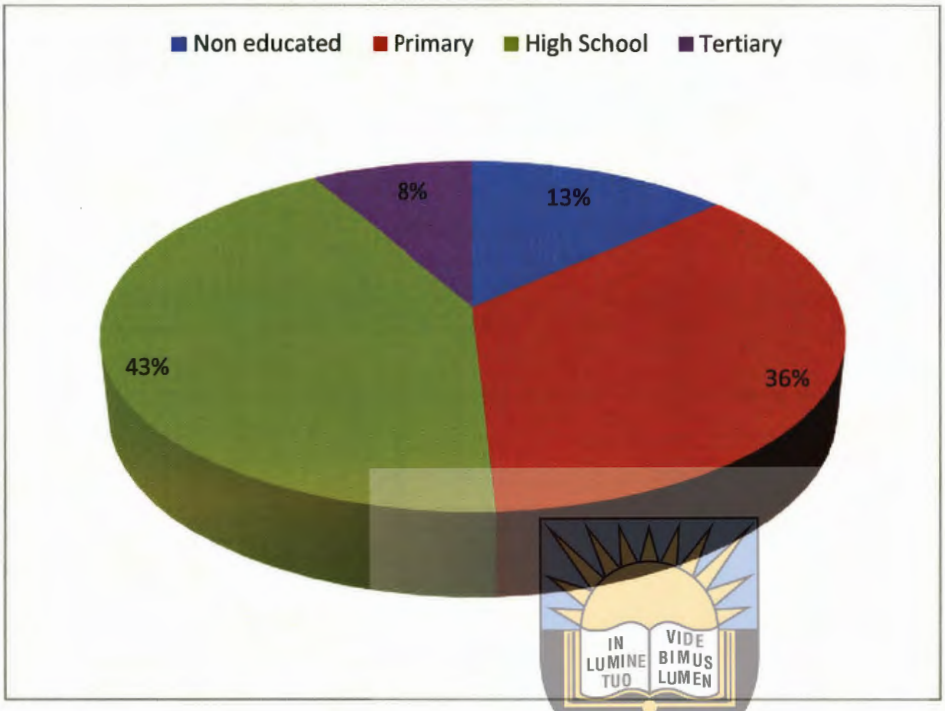


Figure 4. 3: Distribution of the level of education of the despondence (Source: From the field work)

4.1.6. Household size

The importance of knowing the size of the household might highlight the available labour for farm activities. The size of the household may highlight the amount of food required by that household.

Household size refers to the number of people living together in a household. Household sizes impact upon one's own food production, income and expenditure profile and thus influences livelihood activities. In contrast, household size determines the availability of labour in the own food production process. Table 4.6 summarizes the household size distribution.

Table 4. 6: Distribution of the actual size of the household

Variable	No. of farmers	Minimum	Maximum	Mean	Std. Deviation
SIZEH	120	2	14	6.17	2.314
Total	120				

Source: Field work

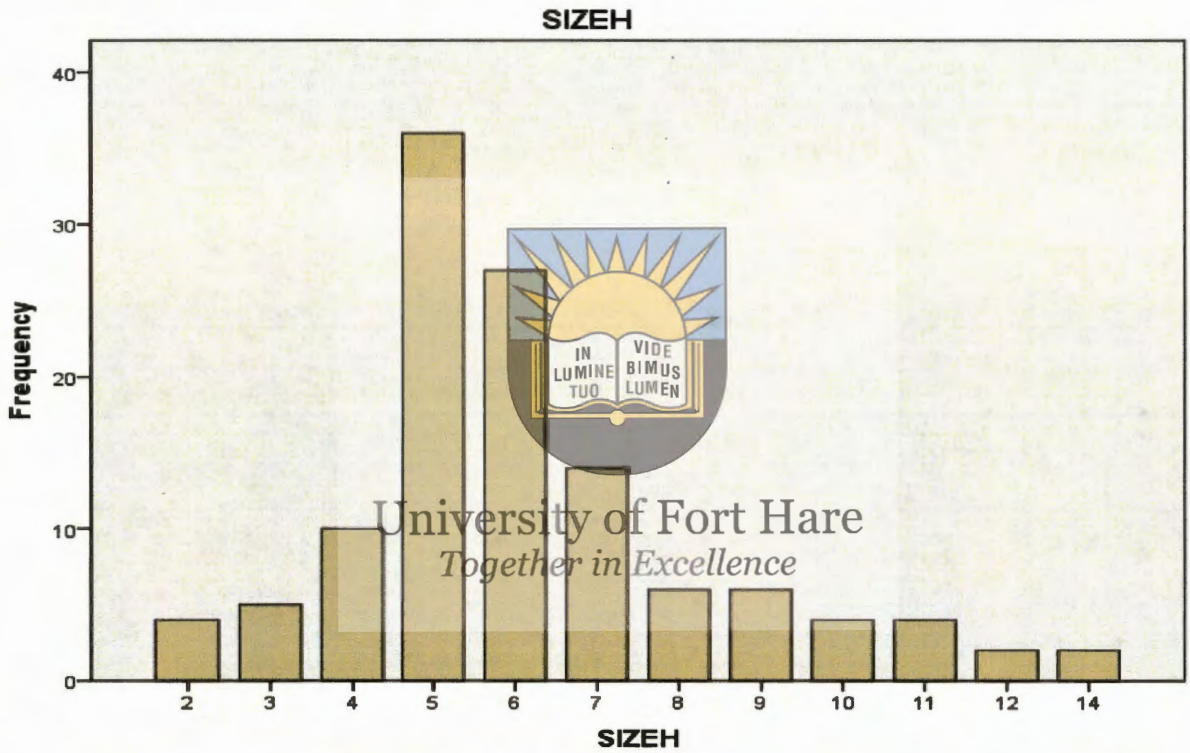


Figure 4. 4: Distribution of the total size of households
Source: From the field work.

4.1.7. Individuals bringing an income into households

In most cases in rural areas, the person bringing an income into a household is the household head. Most household heads get the money from social grants and, in this instance, it is an old age pension as most household heads are above 60 years and they receive grants from government. The source of income of household heads is presented in Table 4.7.

Table 4. 7: Distribution of source of income for household

Variable	No. of farmers	Percent	Valid Percent	Cumulative Percent
Employed	57	47.5	47.5	47.5
Grant	63	52.5	52.5	100.0
Total	120	100.0	100.0	

Source: Field work

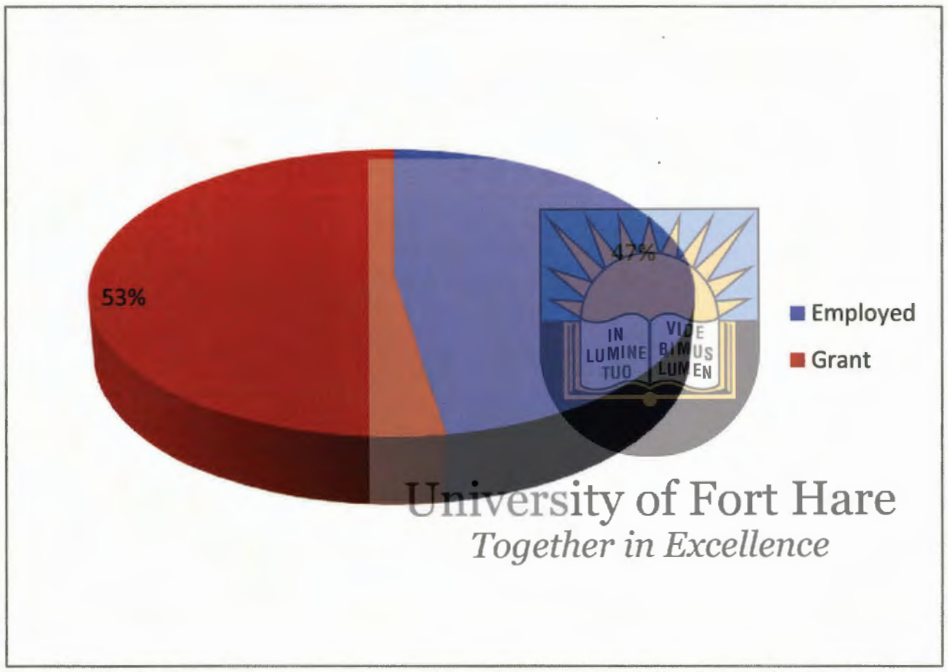


Figure 4. 5: Distribution of sources of income of the household

Source: From field work.

Figure 4.5 which present the source of income for households shows that most households depend on social grants as a source of income, since 53% of the households studied in this project receive social grants and only 47% of the household's heads are working.

Table 4.8 present the distribution of land owned by each household. Land owned by household is presented in actual number of hectors. Knowing the actual land used by household for food production might give and more reasonable estimation of total yield produced by household. The land owned by each household ranges from 0.5 hectors to 11 hectors.

Table 4. 8: Distribution of land owned by household

Variable	No. of farmers	Minimum	Maximum	Mean	Std. Deviation
LANDOWN	120	.5	11.0	2.243	2.1107
Total	120				

Source: Field work

4.2. Impact of Irrigation

The common crops produced in both study areas are maize, cabbage, potato and onion so the impact of irrigation was be assessed in regard to maize, cabbage, potato and onion. The common crops produced in both villages are maize, cabbage, potato and onion.

Table 4. 9: Distribution of farmers that produce maize

Irrigation	No. of farmers	Percent %
Non irrigating farmers	60	50
Irrigating farmers	60	50
Total	120	100

Source: Field work

Table 5.9 presents the maize production in both irrigating and non-irrigated farmers; the maize production in both farmers is 50% which is 100% in total. That shows that every interviewed household produced maize.

Table 4. 10 : Distribution of farmers that produce cabbage

Irrigation	No. of farmers	Percent %
Non irrigating farmers	36	45
Irrigating farmers	44	55
Total	80	100

Source: Field work

Table 4.10 presents the cabbage production. In irrigation farming households, 44 households produce cabbage while 16 households do not produce cabbage. In non-irrigation farming households, 36 households produce cabbage while 24 do not produce cabbage. The households that produce cabbage in both irrigating and non-irrigating households are 80, which indicate that 96% of the households produce cabbage.

Table 4. 11: Distribution of the farmers that produce potatoes

Irrigation	No. of farmers	Percent %
Non irrigation farmers	45	50.6
Irrigating farmers	44	49.4
Total	89	100

Source: Field work

Table 4.11 presents the potato production in [illegible]ion and non-irrigating farmers. Eighty-nine of the interviewed households (74.2%) produced potatoes while 31 households did not.

Table 4. 12: Distribution of the farmers that produce onions

Irrigation	No. of farmers	Percent %
Non irrigating farmers	58	49.2
Irrigating farmers	60	50.8
Total	118	100

Source: Field work

Table 4.12 presents the figures regarding onion production in both irrigating and non-irrigating farms. The production of onions amounts to 118 households in total. This constitutes 98.3 % of the interviewed farmers. Only 2 households do not produce onions, these constitute 1.7% of the total interviewed households. Onion is the second most produced crop in the Maphophoma area, after maize which is produced by 100% of the households studied here. Table 4.13 present the distribution of the household income.

Table 4.13: Distribution of total income of the household

Income Groups	Number Of Farmers	Percent %
0 – 2000	35	29.2
2000 – 4000	20	16.7
4000 – 6000	5	4.2
6000 – 10 000	12	10.0
10 000 +	48	40.0
Total	120	100.0

Source: Field work

Table 4.13 presents the total income earned from the production of both irrigating and non-irrigating farmers

Table 4.14, present the total expenditure for the household to farming practices.

Table 4. 14: Distribution of expenditure for farm activities by the household

Expenditure Class	Number Of Farmers	Percent %
0 – 200	9	7.5
200 – 500	20	16.7
500 – 1000	28	23.3
1000 – 4000	21	17.5
4000+	42	35.0
Total	120	100.0

Source: Field work

Table 5.14 summarizes the total expenditures for both irrigating and non-irrigating farmers.

4.3. Types of Food Crops Produced

In rural areas, different food crops are grown. The possible reason for households to grow different food crops could be that they want to have many food crop products to feed their families without using cash as they will be producing those crops for themselves; they might also want to purchase fewer food crop products from the markets. Food crop products which are produced by rural households differ from household to household. In general, over 13 types of

crops were grown in the area, most of which most are vegetables. Table 5.15 presents a list of the different food crops produced or grown by these households.

Table 4. 15: Distribution of the of crops grown

Crop	No of farmers	Percentage (%)
Maize	120	100
Beans	76	63.3
Onion	118	98.3
Cabbage	80	66.7
Butternut	27	22.5
Spinach	55	45.8
Green paper	6	5.0
Tomato	30	25.0
Sweet potato	12	10.0
Potato	89	74.2
Beetroot	10	8.3
Carrot	27	22.5
Pumpkin	31	25.8

Source: Field work

Table 4.15 present the various crops produced in the study area. The most produce crop is maize which is produced by all interviewed respondents. The green paper is only produced by 5% of the respondents.

4.4. Comparing of non-irrigating and irrigating farmers

Table 4.16, distributes the results of the Explore for total income and total expenditure.

Table 4. 16: Summary of comparing of non-irrigating and irrigation farmers

Descriptive Statistics		Total Income in Rands		Total Expenditures in Rands	
		Non Irrigation	Irrigation	Non Irrigation	Irrigation
Mean		2006.907	15247.067	531.5300	5137.6283
95% Confidence Interval for Mean	Lower Bound	1557.344	13239.161	446.1380	4436.0445
	Upper Bound	2456.	254.973	616.9220	5839.2121
5% Trimmed Mean		1850.822	14582.389	511.3296	4936.5574
Median		1870.000	13220.000	524.2500	4492.9500
Variance		3028588.26 9	60415147.3 18	109268.09 4	7375953.510
Std. Deviation		1740.2840	7772.7181	330.55725	2715.87067
Minimum		.0	5200.0	.00	659.60
Maximum		7500.0	43110.0	1500.00	13574.90
Range		7500.0	37910.0	1500.00	12915.30
Interquartile Range		2585.0	5508.8	359.63	2487.63
Skewness		1.083	1.594	.903	1.291
Kurtosis		1.749	2.579	1.189	2.637

The mean total value of non irrigating farmers of 2006.907 is less than the mean total income of irrigating farmers. Also the mean total expenditure of non irrigating farmers of 531.5300 is less than the mean total expenditure of irrigating farmers which is 5137.6283. This result distributes the impact of adopting new agricultural technology.

In Table 4.16, the Skewness of income for non irrigating farmers is 1.083 which is greater than 0, it's a skewed distribution and the skewness value of income of irrigating farmers is 1.594 which is greater than 0.

The kurtosis value of the income of non irrigation farmers is 1.749 which is less than 3, and also of the irrigating farmers which is 2.579 which is less than 3, that means the distribution is flatter than normal.

Table 4.17, present the distribution for Huber's M-Estimator[a] statistic for the total income and expenditure for non-irrigating and irrigating farmers.

Table 4. 17: Distribution of the total income and expenditure by the M-Estimators

	IRRIGATION		Bootstrap[b]				
						95% Confidence Interval	
			Statistic	Bias	Std. Error	Lower	Upper
TOTALIN	0	Huber's M-Estimator[a]	1822.108	33.241	240.054	1420.561	2345.950
		Tukey's Biweight[c]	1760.847	11.613	220.519	1372.441	2214.781
		Hampel's M-Estimator[d]	1826.822	5.044	210.173	1464.626	2248.743
		Andrews' Wave[e]	1759.472	10.671	220.793	1360.504	2211.896
	1	Huber's M-Estimator[a]	13441.702	53.539	642.494	12330.784	14822.196
		Tukey's Biweight[c]	12483.389	116.838	591.238	11582.613	13825.869
		Hampel's M-Estimator[d]	12922.787	117.887	699.706	11865.166	14592.619
		Andrews' Wave[e]	12459.319	129.083	591.371	11562.212	13829.761
SPENT	0	Huber's M-Estimator[a]	500.8806	-.5626	38.2864	424.4892	577.0494
		Tukey's Biweight[c]	471.6507	4.4081	40.2252	400.4084	563.3271
		Hampel's M-Estimator[d]	489.5693	3.0242	39.9976	414.6673	574.2524
		Andrews' Wave[e]	470.7388	4.7437	40.2488	399.9427	563.1020
	1	Huber's M-Estimator[a]	4728.0624	18.6924	243.0451	4299.0949	5252.8586
		Tukey's Biweight[c]	4663.2903	-15.4683	222.4874	4245.9478	5103.6095
		Hampel's M-Estimator[d]	4665.1356	15.4118	246.6130	4228.9216	5211.0589
		Andrews' Wave[e]	4672.4025	-20.8808	223.4434	4245.0225	5109.2354

0 = non-irrigating and 1 = irrigating farmers

The results confirming the significance association in Table 4.18, where irrigation is highly significance. Huber's M-Estimator[a] statistic value of total income for the non-irrigating (1822.108) is less than that of the irrigating (13441.702) and also in the total expenditure the Huber's M-Estimator[a] statistic value for non irrigating (500.8806) is less than that of irrigating farmers (4728.0624).

In Table 4.17, Huber's M-Estimator[a] statistic value of total income for the non-irrigating farmers (1822.108) is less than that of the irrigating farmers (13441.702) and also in the total expenditure the Huber's M-Estimator[a] statistic value for non irrigating farmers (500.8806) is less than that of irrigating farmers (4728.0624), confirming the significance association in Table 4.16, where irrigation is highly significance.

4.5. Linear Regression Model

Table 4.16 shows that seven (7) variables were associated with crop production in rural households. These are household source of income, irrigation, age of the household head, total size of the household, level of education of the household head, total land owned by the household and the total expenditure for production. The results of each factor's association with total yield are explained below:

Table 4. 18: Multiple regression results for the adoption of technology

Parameter	Coefficient (β_1,... β_7)	Standard Error	t - Statistic	Significance
(Constant)		503.035	-0.618	0.538
Irrigation	0.240	199.021	3.034	0.003**
Source of income	-0.016	135.735	-0.290	0.773
Age of household head	-0.010	6.819	-0.169	0.866
Total size of household	0.064	26.447	1.313	0.192
Level of education	0.095	85.457	1.692	0.093*
Land owned	0.641	33.537	11.452	0.000**
Expenditures	0.030	0.029	0.448	0.655

*** =5% significance; *=1% significance*

Table 4. 19: Model Summary Presenting R Square

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.892[a]	0.796	0.783	588.972

Table 4.19 present the R Square in a form of model summary.

In Table 4.16 the irrigation has high significance at and has positive relationship to the total yield production. The positive significance value of 0.003 shows that there is a sufficient evidence to support that the irrigation influences the total yield.

Source of income: Negative coefficient of -0.016 (β_1) for household source of income shows a negative relation between a household source of income and total yield production of the households. This means that household source of income does affect total yield production by rural households. A significant value of 0.773 shows that there is insufficient evidence to support that the household source of income influences a change away from total yield production by rural households, as 0.538 is greater than 0.05.

Irrigation: Positive coefficient of 0.240 (β_2) forvillage shows a positive relation between a village and total yield production of the households. This means that village does not affect total yield production by rural households. A significant value of 0.003 shows that there is sufficient evidence to support that the irrigation influences a change away from total yield production by rural households, as 0.003 is less than 0.05.

Age of household head: There is a negative relationship between total yield production and the age of the household head as it is indicated by negative β_3 coefficient of -0.010. This implies that the age of the household head does not matter, as they can participate in crop production. The negative relation between total yield and age of the household head is proved by that participate in crop production, any age headed households participated in production. The significant value of 0.866 as it is more than 0.05 is that it does not allow us to claim that the age of the household head has a negative relationship with production.

Household size: Positive coefficient of 0.064 (β_4) for household size shows a positive relation between a household size and total yield production of the households. This means that household size does affect total yield production by rural households. A significant value of 0.192 shows that there is insufficient evidence to support that the household size influences a change away from total yield production by rural households, as 0.192 is greater than 0.05.

Level of education: Regression coefficient of (β_5) 0.095 proves a positive relationship between total yield and the highest education level that the household head has. This implies that the higher the education level a person has the greater the total yield a person will produce. The possible reason for the positive relationship between education level and total yield can be that when a person is educated he/she will be able to make rational decisions and use resources efficiently that will result to more yield being produced. Indigenous knowledge of farming plays a very important role in rural areas as the majority of rural residents are not educated; however, as they are not educated they produce different food crop products themselves without any kind of help from extension officers. The significance level of 0.093 which is greater than 0.05 implies that we cannot claim that education level affects or influences the total yield produced by rural households, and a significance level of 0.093 also tells us that there is insufficient evidence to support that education level has influence to change the total yield production of rural households.

Land owned: Regression coefficient of (β_6) 0.641 proves a positive relationship between total yield and the total land owned by the household head. This means that the total land owned by the household does affect the total yield production of households. A significant value of 0.000 shows that there is sufficient evidence to support that the total land owned by the household influences a change away from total yield production by rural households, as 0.000 is less than 0.05.

Expenditure: Regression coefficient of (β_7) 0.030 proves a positive relationship between total yield and the total expenses the household used in production. This means that total expenditure used by the household does affect the total yield production of households. A significant value of 0.655 shows that there is insufficient evidence to support the notion that the total land owned by the household influences a change away from total yield production by rural households, as 0.655 is greater than 0.05.

The prior expectations that the development of irrigation schemes improves the yield production among farmers and that would positive influence the production yield, there was a positive and significant of 0.003 relationship. This suggests the need of adopting technology changes to farming. The study conducted by Joemat-Pettersson (2009) states that smallholder irrigation has become the main source of income for the most rural population and, therefore, there exists a need to improve resource use in this subsector. The optimal use of these critical resources in irrigation will not only help produce enough food for everyone, but will also ensure sustainability.

The belief that age is a primary underlying characteristic in adoption decisions, the study conducted by Adesiina & Baidu-Forson (1995), in this study there is a negative and significant relationship. The significant value of 0.866 which is more than 0.05 it does not allow us to claim that the age of the household head has a negative relationship with production. The result of the study agrees with the result of study conducted by Adesiina & Baidu-Forson (1995) stating that age is the primary underlying characteristic in adoption decisions.

The coefficient of (β_5) 0.095 of level of education proves a positive relationship between adoption decision and the highest education level that the household head has. This implies that the higher the education level a person has the greater the total yield a person will produce. The study conducted by Waller *et al* (1998) agrees with the result of this study, Waller et al (19980 states that generally education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices.

The study conducted by Machethe (2005) ensures that smallholder farmers have access to land for residential and productive purposes so as to improve their livelihoods. The result of this study shows a coefficient of (β_6) 0.641 proves a positive relationship between total yield and the total land owned by the household head. This means that the total land owned by the household does affect the total yield production of households. A significant value of 0.000 shows that there is sufficient evidence to support that the total land owned by the household influences a change away from total yield production by rural households.

The effort of government to make land acquisition grants available and encourage people to club together and form associations with a number of households in order to buy land together also goes concurrent with the result of the study (Camac & Gordon 2005).

The negative and significant of 0.773 shows the negative relationship between income and adoption of new technology. Study conducted by Jacobs (2009) changes in income alter the quantity of foods consumed by a household, the amount of money a household has determines the quantity of food a household should have. Also Ziervogel *et al* (2006) aggresses with the results of this study by saying individuals have sufficient access to food when they have adequate incomes or other resources to purchase food. Ziervogel *et al* (2006) also stated that when a household has a good financial status, that household can even hire people for the agricultural production process. Aliber & Hart (2009) stated that those rural households which have access to other sources of income made better use of all existing factors of production, while households which have access to little alternative income under-utilized some of their factors of production due to inadequate operating [illegible].

4.6. Chapter Summary

Multiple regression results for the adoption of technology, when the coefficient is negative shows a negative impact of that variable on a total yield, while the positive coefficient shows a positive relationship between the variable and total yield.

Whereas the significant of less than 0.05shows the influence of variable to the total yield while significance of greater than 0.05 indicates the insufficient evidence to influence the total yield. The findings show the impotent of adoption of new agricultural technology. In the study irrigation was used as an inter-changeably with technology.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter attempts to draw together the most important findings of this study and discuss the implications thereof for future research, which will be proffered as policy recommendations. The conclusion relates to the research problems stated at the beginning of this study; this is achieved by trying to provide answers to each of the research questions presented in Chapter 1.

Small-scale farmers and the farming community (rural households) of South Africa have the potential to contribute to growth in rural areas, reduce poverty and income disparities, and thus contribute to economic growth. People in rural areas are engaged in different activities as their livelihood strategies. Rural areas used to be p[illegible] which a surplus of food crop products was transferred to urban markets, but recent studies reveal that to no longer being the case, as residents of rural areas now purchase most of their food products from urban markets. The most employed food procurement strategies in rural areas are the acquisition of food from markets and from one's own food production. Rural households grow different food crop products in their backyard gardens and in their fields, those which are still using them to grow crops.

The main objective of this study was to identify the socio-economic impact of irrigation schemes in the livelihood of rural households. The focus of this study was the contribution of own food production to rural households; in addition to which the researcher looked at the possible factors affecting crop production of rural households.

5.2. Summaries

The aim of this section is to summaries all the chapters covered in this study, Chapter Two which is the literature review, Chapter Three which is the selection of the study area and research methodology and Chapter Four covers the study finding.

5.2.1. Literature Review Summary

The main objective of the study was to measure the aggregate impact of the adoption of new agricultural technology to the food security of rural households. The specific objectives were (i) To identify which factors that influences the adoption of technology amongst small-scale farmers in rural areas. (ii) To assess the availability of resources, such as land, for the implementation of food security programs. (iii) To identify the challenges encountered by small scale farmers in the adoption of new agricultural technology for food security programs. (iv) To describe farming systems in general and the project in particular. (v) To make recommendations in terms of policy, in this regard.

Literature reveals that rural households are reluctant to adapt to technology due to the lack of knowledge and skills. Technology input can positively or negatively affect the productivity growth by increasing the total yield or by reducing the total yield if it does not adopted correctly. In the study irrigation was used inter-changeably with technology. The importance of irrigation in agricultural production has been recognized for a long time and is being discussed within the broader framework of the role of improved technology in agricultural development. Challenges faced by small scale farmers it the access to resources such as land and capital to finance the adoption of technology. The adoption and the availability of resources may results to the food security of the rural households.

5.2.2. Selection of the Study Area and Research Methodology Summary

The selection of the study area was influence by the time convenience, lack of capital and also the easy access to the community. The total of 120 households was interviewed composed of 60 non-irrigating and other 60 of irrigating farmers. The purpose of selecting two groups of farmers was to compare the impact of irrigation to farming. The study was conducted in Maphophona location at Nongoma, which is the rural area of Kwa Zulu Natal.

The data was collected from individuals or respondents through interviews using interviewer-administered questionnaires. The questionnaires were interviewer-administered to alleviate the problem of misunderstandings of words or questions, on the part of the respondents. Descriptive statistic will be used to analyse the demographic information, such as the age, gender or level of

education of each respondent. The main reason of using both Explore and M-Estimator is to distinguished between irrigating and non-irrigating farmers.

This study was also made use of linear regression analysis in order to analyze the data and explain the relationship between several independent variables and a dependent variable.

5.2.3. Summary of the Study Findings

The study identifies that there is a positive relationship between the adoption of new technology and the small scale farmers. In the study the irrigation was used as an inter-changeable with new technology. The irrigation shows a highly significance and has a positive relationship with the total yield. The positive significance of irrigation also shows that there is sufficient evidence to support that the adoption of new agricultural technology influence the total yield of production. According to the study findings, common crops produced in both study areas are maize, cabbage, potato and onion. Maize is produced in all the areas where the study was covered.

5.3. Conclusion

The study was carried out at Maphophoma village, of Nongoma district, which is situated in the in KwaZulu-Natal Province of South Africa. An interval or systematic sampling technique was used to select a sample size of 120 rural households, 60 from irrigating and 60 from non-irrigating households.

To analyze the data, descriptive statistics were used together with multiple regression analysis. The main descriptive indicators that were employed or used were mean values, frequencies and percentages. The multiple regression model was used to test the influence or impact of possible factors affecting own food production. The multiple regression model was chosen because it can be used to predict the influence of independent variables on a dependent variable. The variables that were used in the study were defined and the dependent variable was own food production while the independent variables included household size, gender of the household head, educational level, household income, farming inputs and agricultural implementations.

The descriptive results provided information related to the personal information of the household head and household information (demographic information). The results show that the majority of the sampled rural households range from 42 to 92 years of age. The educational levels of

many household heads are generally low as only 8% have received some tertiary education. All the samples used in the study have an educational background. It can be inferred that most rural households depend on social grants as a source of income, since 52.5% of the study sample receives social grants. All the respondents have access to arable land and all of them are producing crops in those arable land. In rural areas the level of divorce is low since divorces were presented by 3% in the study sample. The total size of the households ranges from 2 to 14; this shows that the population growth is high in rural areas.

The results of the multiple regression analysis revealed that the total yield was influenced by independent variables, but not all independent variables have an influence on the total yield of rural households. The dependent variable is the total yield and independent variables are source of income, village, age of the household head, size of the household, level of education, land acquired, land owned and expenditures.

In the study irrigation was used inter-changeable with the new agricultural technology. The results presented that irrigation has a high significance and a positive coefficient. A significance value of irrigation shows that there is a sufficient evidence to support that irrigation positively influences the total yield production by the rural households. The results show a positive influence of adoption of new agricultural technology by small scale farmers.

5.4. Recommendations

Based on the findings of the study, an increase in the adoption of new technologies, by small-scale farmers, is recommended. If technology adoption is taken into consideration in small-scale farming it will reduce the rate of food insecurity, which results in poverty alleviation in rural areas. Government intervention is also recommended, with the provision of producer subsidies and the availability of a well trained committed extension officer.

The provision of trainings to the small-scale farmers, before any introduction of assistance from government, is necessary. The training will help the farmers to maintain and efficiently use the new ideas of production. Relevant governments structures need to work hand-in-hand with farmers in order to identify the real needs of these farmers are. This will help to illuminate the provision of unwanted technology or ideas by the farmers.

References

Abara, I. O. C. & Singh,S., 1993, "Ethics and Biases in Technology Adoption: The Small Farm Argument." *Technological Forecasting and Social Change*. 43:1993. 289-300.

Adams, D. & Vogel,R., 1990, 'Rural financial markets in developing countries'. In Eicher, C. and Staatz, J., (eds.) *Agricultural Development in the Third World*. Baltimore: Johns Hopkins University Press.

Adams, M., 2000, Breaking Ground: *Development Aid for Land Reform, Overseas Development Institute*, London (2000).

Adams, M., Sibanda, S. & Turner, S., 1999, *Land Tenure Reform And Rural Livelihoods in Southern Africa*. Natural Resource Perspectives. Viewed: 01/11/ 2011. From: www.odi.org.uk.nrp/ 39.html

Adesiina, A.A. & Baidu-Forson,J., 1995,Farmers' Perceptions and Adoption of New Agricultural Technology: Evidence From Analysis in Burkina Faso and Guinea, West Africa." *Journal of Agricultural Economics*. 13: (1995) 1-9.

Albinson, B., & Perry, C. J., 2002,*Fundamentals of Smallholder Irrigation: The Structured System Concept Research*. Report 58. IWMI Publications. Colombo, Sri Lanka

Aliber, M. & Hart, T.G.B., 2009,Should subsistence agriculture be supported as a strategy to address rural food insecurity? *Agrekon*, 48 (4) (2009): 434-458.

Altman, M., Hart, T.G.B., & Jacobs, P.T., 2009, Household food security status in South Africa. *Agrekon*, 48 (4) (2009): 345-361.

Ashraf, N., Gine, X. & Karlan, L., 2005, *Finding Missing Markets*: An agricultural Brokerage Intervention in Kenya.Viewd: 01/11/2011: From: www.povertyactionlab.com/project/projects.php.pid=17 Backeber,g G.R.,

Bembridge, T.J. & Bennie, A.T.P.,1996, *Policy proposal for irrigated agriculture.*

Backeberg G.R., Bembridge, T.J., Bennie A.T.P., Groenewald,J.A., Hammes, P.S., Pullen R.A. & Thompson, H., 1996, *Policy proposal for irrigated agriculture in South* Africa. WRC Report KV96/96. Water Research Commission, Rietfontein, Pretoria.

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

Backeberg, G.R., 2003, Water usage and irrigation policy. In: Nieuwoudt, L. and Groenewald, J. (eds.) *The challenge of change: Agriculture, land and the South African economy*. University of Natal Press, Pietermaritzburg.149-170.

Baiphethi, M.N. and Jacobs, P.T., 2009, The contribution of subsistence farming to food security in South Africa. *Agrekon* 48 (4): 1-24.

Barab, S. A., & Duffy, T. M., 2000, *From practice fields to communicates of practice*. Indiana University. W.W. Wright Education Building, Bloomington.

Bembridge, T.J., 1986, An Overview of Irrigation In Some Less Developed Countries of Africa. *Journal of Contemporary African Studies* 5 (1-2) : 99-118

Bembridge, T.J., 2000, *Guidelines for rehabilitation of small-scale farmer irrigation schemes in South Africa*. WRC report No 891/1/00. Water Research Commission, Pretoria. 163p.

Bennie, A.T.P. & Hensley, M., 2001, Maximizing precipitation utilization in dry land Agriculture in South Africa – *a review Journal of Hydrology* (Netherlands), (2001) 241 (1–2): 124–139

Bless, C., Higson-Smith, C. & Kagee, A., 2006, *Fundamentals of social research methods.* (4th edition). Juta& Company Ltd., Cape Town, South Africa.

Bohlen, J., Beal, M. & George, M., 1957, "*The Diffusion Process*", Special Report No. 18 (Agriculture Extension Service, Iowa State College) 1: 56–77. Viewed:15/10/2012 From:http://www.soc.iastate.edu/extension/presentations/publications/comm/Diffusion%20Process.pdf

Bohringer, A. & Ayuk, E., 2003, Farmer nurseries as a catalyst for developing sustainable land use systems in southern Africa. *Agricultural Systems* 77: 187-201.

Brabben, T. & Kay, M., 2000, *Treadle pumps – A viable option for Africa?;* GRID, Issue 16. IPTRID Network Magazine. International Program for Technology and Research in Irrigation and Drainage/Food and Agriculture Organization of the United Nations.

Bruwer, J.J. & Van Heerden, P.S., 1995, *Spotlights on irrigation development in the RSA: the past, present and future*. In: Proceedings of the Southern African Irrigation Symposium, Durban, 4-6 June 1991. WRC report num. TT 71/95, pp3-10.

Bundy, C., 1988,*The rise and fall of the South African peasantry*. 2nd Ed. David Philip, Cape Town

Camac, P. & Gordon, J., 2005, *Land Restitution and Redistribution: Providing Opportunities for Broad Based Rural Development*. South Africa Civil Society and governance. Case Study No 2. Viewed: 01 November 2011. From: http://www.ids.ac.uk/civsoc/final/southafrica/saf6.doc

Caswell, M., Fuglie,K., CIngram,C., Jans,S,. & Kascak,C.,2001, *Adoption of Agricultural production practices: Lessons learned from the US. Department of Agriculture area studies project.* Washington DC. US Department of Agriculture. Resource Economics Division, Economic Research service, Agriculture Economic Report No. 792.

Collins, K.J., & Roberts,D.F., 1998, *Capacity for Work in the Tropics*. Cambridge: Cambridge University Press.

Conradie, B., Piesse, J. & Thirtle, C., 2009, What is the appropriate level of aggregation for productivity indices? Comparing district, regional and national measures. *Agrekon,* Vol 48, No1, March 2009, p 9-21

De Haen, H., Stamoulis, K., Shetty, P. & Pingali, P., 2003, 'The World Food Economy in the Twenty-First Century: *Challenges for International Cooperation' Development Policy Review* 21(5- 6): 683-696.

Delange, M., 1994, *Small scale irrigation in South Africa.* WRC Report 578/1/94. Pretoria: Water Research Commission.

Delgado, C.L., 1999, Sources of Growth in Smallholder Agriculture in Sub-Saharan Africa: The Role of Vertical Integration of Smallholders with Processors and Marketers of high value-added items. *Agrekon* 38(special issue):165-186.

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

Denison, J. & Manona, S., 2007, Principles, Approaches and Guidelines for the Participatory. *Revitalisation of Smallholder Irrigation Schemes* Volumes 1 & 2. Water Research Commission Report No TT 309/07. Pretoria, South Africa

Department of Agriculture, Forestry & Fisheries., 2011, *Food Security by Directorate Economic Services Production Economics unit.* Viewed: 17/07/2012. From www.daff.gov.za:

Department of Land Affairs, 2007/2007, Annual Report.

Department of Land Affairs, 1997, *White Paper on South African Land Policy*, Department of Land Affairs, Pretoria.

Dlova, M.R., & Fraser, G.C.G., 2004, *Factors affecting the success of farmers in the Hertzog Agricultural Cooperative in the central Eastern Cape*. Fort Hare Papers 13, pp 21-33.

Dorward, A., Kydd,J. & Poulton ,C.,1998, *Smallholder Cash Crop Production under Market.*

Dorward, A., Kydd, J. Morrison & Urey,I., 2004, *A policy agenda for pro-poor agricultural.*

Doss, C.R and M.L Morris.,2001, "How Does Gender Affect the Adoption of Agricultural *Innovation*? The Case of Improved Maize Technologies in Ghana." *Journal of Agricultural Economics.* 25: (2001) 27-39.

Du Plessis, F.J., Van Averbeke, W. & Van Der Stoep, I., 2002, *Micro-irrigation for smallholders: guidelines for funders, planners, designers and support staff in South Africa*. WRC Report TT 164/01. Water Research Commission, Pretoria.

Fanadzo,M., Chiduza, C. and P. N. S. Mnken,P.N.S., 2010, *Overview of smallholder irrigation schemes in South Africa: Relationship between farmer crop management practices and performance*. Department of Agronomy, Faculty of Science and Agriculture, UFH,South Africa.

Feder, G. & Slade, R., 1984,"The acquisition of information and the adoption of new technology." *American Journal of Agricultural Economics*. American Agricultural Economics Association. 66:(1984)312-320.

Fernandez-Cornejo, J..1994, "The Microeconomic Impact of IPM Adoption: Theory and Application."*Agricultural and Resource Economic Review*. 25 (October 1996):149-160.
Food and Agriculture Organization, The State of Food and Agriculture.

Food and Agricultural Organization, 2008, *Socio-Economic & Livelihood Analysis in Investment Planning.* Viewed: 3/09/2012. From: www.fao.org/.../3-7-social%20analysis%20session_167en.pdf

Food and Agricultural Organization, 2004, *UBET – Unified Bioenergy Terminology.* Rome, FAO.Viewed: 20/08/2012 From: www. fao.org/docrep/007/j4504E/j4504e00.htm

Food and Agricultural Organization, 2003, *World Agriculture towards* 2015/2030: An FAO Perspective, London: Earthscan.

Food and Agricultural Organization, 2001,*Smallholder Irrigation Technology: Prospects for Sub-Saharan Africa.* IPTRID Secretariat Food and Agriculture Organization of the United Nations Paper Number 3 – March2001. Rome, Italy.

Food and Agricultural Organization,1996, *Agriculture and Food Security.* World Food Summit, November, 1996, Rome.

Food and Agricultural Organisation ., 1997, *Agriculture, food and nutrition for Africa: A resource book for teachers of agriculture*: Viewed: 24 October 2011From : http://www.fao.org/docrep/w0078e/ w0078e04.htm#P1642_90314

Franzel, S., Phiri,D. & Kwesiga,F., 2002, *Assessing the adoption potential of improved fallows in eastern Zambia.* InTrees on Farm: Assessing the Adoption Potential of Agroforestry Practices in Africa. Wallingford, UK: CAB International. Growth World Development 32: (2002) 73-89.

General Household Survey, 2009, Revised Version. Viewwd: 10/08/2012. From: http://www.statssa.gov.za/publications /P0318/P0318June2009.pdf

Gibb, A., 2004, *Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes*. Year 1 Progress Report, WRC Project No. K5//1463/4. Arcus Gibb, Berea, East London.

Gilimani, B.M., 2005, *The economic contribution of home production for home consumption in South African agriculture*. Viewed: 24 October 2011. From: http:// www.bioline.org.br/ request?nd08035

Gopal. L. & Srivastava, V.C., 2000, History of Agriculture in India: Agricultural technology.

Gwanya, T., 2003, *Commission on Restitution of land rights: Achievements and challenges.* Viewed:01/10/2011.From:http://land.pwv.gov.za/restitution/land%20Restitution%20IN%South %20%Africa%20_%2020- 05-03.doc

Harper, J. K., M. E. Rister, J. W. Mjelde, B. M. Drees, and Way,M.O.,1990, "Factors influencing the adoption of insect management technology." *American Journal of Agricultural Economics*. 72(4) (1990) :997-1005.

Hayami, Y & Ruttan, W.V. ,1985, *Agricultural development an international perspective.* The Johns Hopkins University Press.

Hazel, P. B. R. & Haggblade, S., 1990, *Rural-urban Growth Linkages in India; Background paper prepared for the 1991 Country Memorandum for India*, World Bank, Washington DC

Hirji, R., Johnson, P., Maro, P., & Matiza, C.T. (eds.), 2002, *Defining and Mainstreaming Environmental Sustainability in Water resources Management in Southern Africa.* SADC, IUCN,

Huber, P. J.,(2nd ed), 2009 *Robust Statistics*. Hoboken, NJ: John Wiley & Sons Inc. ISBN 978-0-470-12990-6.

Hyman, E., Lawrence, E. & Singh, J., 1995, *The ATI/USAID market gardeners project in Senegal*; Washington, D.C.: Appropriate Technology International.

International Food Policy Research Institute (IFPRI), 1998, Pest Management and Food Production: *Looking into the future,* Vol. 20, no. 52. Applying science to sub-Saharan Africa's food needs. Reported by Ellen Wilson. 2020 Vision. News and Views. February 1995 Viewed: 20/01/2013. From:http://www.ifpri.org/pubs/books/ufa/ufa_ch26.pdf

Jacobs, P., 2009, *Market development and smallholder farmers: A selective literature survey.* Viewed: 19/10/2011. From: http://www.hsrc.ac.za/Document-3219.phtml

Joemat-Pettersson, T., 2009, *Raising the Stakes*. The Financial mail Volume 202, number 11. The business Media Company. Rosebank, South Africa.

Kamara, A., Danso, G., Mahu, S. A., Cofie, O. & Drechsel, P.,2004, *Agricultural Water Investments and Poverty Impacts in West Africa:* A review of Treadle Pumps with a Focus on Ghana and Niger; 2004; an unpublished draft paper.

Kariuki, S., 2003. *Failing to learn from failed Programmes. South Africa's Communal Land Rights Bill.* Viewed: 01 November 2011.
From:www.univie.ac.at/ecco/stichproben/Nr7kariuki.pdf

Kgaphola, M. & Boshoff, E., 2002, Proposed for a conceptual frame of reference to study household food accessing strategies and utilization patterns. *Journal of Family Ecology and Consumer Science.* 30: (2002)65-74.

Kirsten, J. & Vink, N., 2003, *Policy Module South Africa.* Presented under the Roles of Agriculture Project in International Conference on the 20-22 October 2003 Rome, Italy. Agricultural and Development Economics Division, Food and Agriculture Organization of the United Nations Liebenberg,

Kirsten, J., Perret, S. & De Lange, A., 2002, *Rural development. Focusing on small-scale agriculture in Southern Africa*. University of Pretoria, Pretoria.

Kislev, Y., & Peterson, W., 1981, Induced Innovation and Farm Mechanization: *American Journal of Agricultural Economics* 63(3) (1981): 562-565.

Leedy, P. & Ormrod, J., 2004, *Practical Research: Planning and Design* (8th Edition). Prentice Hall, New York.

Lemke, S., Bellows, A.C. & Heumann, N., 2009, Gender and sustainable livelihood: case study of South African farm workers. *International Journal of Innovation and Sustainable Development,* 4 (2-3) (2009): 195-205.

Leonard, D.,1993, Structural reform of the veterinary profession in Africa and the New Institutional Economics. *Development and Change* 24:227-267.

Liebenberg, F. & Pardey, P.G., 2010, *South Africa Agricultural Production and Productivity Patterns. The Shifting Patterns of Agricultural Production and Productivity Worldwide*. The Midwest Agribusiness Trade Research and Information Center, Iowa State University, Ames, Iowa, 2010.

Machethe, C.L., 2005, *Agriculture and Poverty in South Africa: Can Agriculture Reduce Poverty?* Viewed: 01 November 2011. From: http://www.sarpn.org.za/ documents/d0001005/p1125-Agriculture- Poverty_Machethe_2004.pdf

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

Matshe, I., 2009, *Contributing of smallholder production to food security:* Evidence from Sub-Haran Africa.

Maxwell, S., 2001, Agricultural issues in food security. In: S. Devereux and S. Maxwell (eds), *Food Security in Sub-Saharan Africa*. London, UK: IT Publications.

Mclachan, M. & Kuzwayo, P., 1997, *Bold Choices: Making the South African. Nutrition Strategy*. Paper 128. 101-114. Pretorea.

McNamara, K. T., Wetzstein, M.E. & G.K. Douce, G.K.,1991, "Factors Affecting Peanut Producer Adoption of Integrated Pest Management." *Review of Agricultural Economics*. 13 (1991):129-139.

Mgijima, C., 1999, *Situational Analysis of Food Security and Nutrition in South Africa.* A Speech at the 3rd Session of the International Consultative Conference on Food Security and Nutrition as Human Rights, Randburg, South Africa

Ministry for Agriculture and Land affairs, 2001, Ministry for Agriculture and Land Affairs, *Land Redistribution for Agricultural Development,* Ministry for Agriculture and Land Affairs, Pretoria.

Mohamed, S.S., 2006, *Livelihoods of plot holders on a smallholder canal irrigation scheme.* D Tech. Agric. Thesis, Department of Crop Sciences, Tshwane University of Technology.

Monde, N., 2003, *Household food security in rural areas of central Eastern Cape.* PhD Thesis, Unpublished, University of Fort Hare.

Mugisa-Mutetikka, M., A.F. Opio., M.A. Ugen., P. Tukamuhabwa., B.S. Kayiwa, C. Niringiye & Kikoba,E.,2000, "*Logistic Regression Analysis of Adoption of New Bean Varieties in Uganda.*" Unpublished.

Mullen, J.D., G.W. Norton & Reaves,D.W., 1997, "An Economic Analysis of Environmental Benefits of Integrated Pest Management." *Journal of Agricultural and Applied Economics*. Southern Agricultural Economics Association. 29 (2):243-253

Musotsi, A.A., Sigot, A.J. & Onyango, M.O.A., 2008, *The role of home gardening in household food security in Butere division of Western Kenya*. African Journal Food, Agriculture, Nutrition and Development, 8 (4): 375-390. Available online:

Muthukrishnan.R & Radha.M., 2010, M-Estimators in Regression Models. *Journal of Mathematics Research* Vol. 2, No. 4; November 2010. Viewed: 31/03/2013. From: www.ccsenet.org/jmr

Muzari, W., Gatsi, W. & Muvhunzi, S., 2012, The Impacts of Technology Adoption on Smallholder Agricultural Productivity in Sub-Saharan Africa: A Review: *Journal of Sustainable Development*; Vol. 5, No. 8; 2012. Published by Canadian Center of Science and Education. Viewed: 31/03/2013. From www.ccsenet.org/jsd

National Department of Agriculture, 2005, *Agricultural Policy in South Africa.* Viewed: 10 August 2012. From: http://www.nda.agric.za/docs / policy98.html

National Department of Agriculture, 2002, *Integrated Food Security for South Africa*. Viewed: 01/11/2011. From: www.nda.agric.za /doc/cropsestimates/ food%20security%20strategy.pdf

Nkonya, E.,Schroeder, T. & Norman, D., 1997, "Factors Affecting Adoption of Improved Maize Seed and Fertilizer in Northern Tanzania." *Journal of Agricultural Economics*. 48 (1) :1-12

Nompozolo, S., 2000, *An analysis of the Characteristics and constraints of Smallholder Commercial farmers in the Transkei Region,* The Eastern Cape, South Africa. Unpublished M Agric (Agricultural Extension) Dissertation, University of Fort Hare, Alice.

Ntsonto, N.E., 2005, *Economic performance of the smallholder irrigation schemes: A case study in Zanyokwe, Eastern Cape, South Africa*. Unpublished thesis, University of Pretoria, Pretoria.

Omamo, S. & Mose,L., 2001, *Fertilizer trade under market liberalization*: Preliminary evidence from Kenya. Food Policy 26:1-10.

Pinstrup-Andersen, P., Pandya-Lorch, R. & Rosengrant, M., 1997, *The World Food Situation: Recent Developments, Emerging Issues, and Long-Term Prospects*. Washington DC, USA: International Food Policy Research Institute (IFPRI).

Rogers, E.M.,1983, *Diffusion of Innovations*. Republic of South Africa, 2002. New York: The Free Press.

Republic of South Africa,1998, *National Water Resources Strategy*. Department of Water Affairs and Forestry (DWAF), Pretoria.

Republic of South Africa, 2002, *National Water Resources Strategy: Proposed First Edition: Summary*. Department of Water Affairs and Forestry (DWAF), Pretoria. SARDC, World Bank: Maseru/Harare/ Washington.

Sibanda, S., 2001, *Land reform and poverty alleviation in South Africa.* Unpublished paper presented at the Conference on Land Reform and Poverty Alleviation in Southern Africa, convened by the Southern African Regional Poverty Network, Human Sciences Research Council, Pretoria, 4-5 June.

Small, L.E., and Svendsen, M., 1992, *A framework for assessing irrigation performance. Working Papers on Irrigation Performance*. International Food Policy Research Institute. Washington, DC, USA

South African Social Investment Exchange (SASSIX), 2009, *Training to set up household food gardens.*Viewed: 24 October 2012. From: http://www.sasix.co.za/projects/view/FS-FS-MAY-0004/

Spielman, J.D., Kristin ,D., Martha N. & Gezahegn, A., 2007, *Social Learning, Rural Services, and Smallholder Technology Adoption: Evidence from Ethiopia.* Working (IFPRI, Addis Ababa). World Development paper International Food and Policy Research Institute.

Tati, G., 2009, *Elderly headed households, markets and consumptions in urban South Africa.* Viewed: 03/11/2012. From: http://www.openmeeting2009.org/pdf_files/Pdf%20papers/gabriel%20tati.pdf

Timmer, C.P., 1988, The agricultural transformation. *Handbook of Development Economics,* Vol. 1. Amsterdam: North Holland

Tjornhom, J.D., 1995, "*Assessment of Policies and Socio-Economic Factors Affecting Pesticide Use in the Philippines.*" MS. thesis, Virginia Polytechnic Institute and State University.
114 Uganda Exports Promotion Board. Uganda Services Exporters Association. Viewed: 20/01/2013. From: http://www.ugandaexportsonline.com.

Tripp, R,. 2001, Seed Provision and Agricultural Development. Oxford, UK: James Currey. to address rural food insecurity? *Agrekon* Vol. 48:472-94.

Van Averbeke, W., M'Marete, C.K., Igodan, C.O. & Belete, A., 1998, *An investigation into food-plot production at irrigation schemes in central Eastern Cape.* WRC Report num. 719/1/98. Pretoria, SA.

Van Der Stoep, I., 2011, *Irrigation Water Measurement – From Voluntary Management to Pending Regulations.* Paper presented at the Water Research Commission 40-Year Celebration Conference. 31 August - 1 September 2011, Kempton Park, South Africa. URL: Viewed: 23/03/2013. From: www.wrc.org.za/Pages/KH_ConferenceProceedings

Van Averbeke,W.V. & Mohamed, S.S., 2006, *Centre for Organic and Smallholder Agriculture, Department of Crop Sciences*, Tshwane University of Technology, Pretoria, South Africa

Von Braun, J., 1997, "*The Links between Agricultural Growth, Environmental Degradation, and Nutrition and Health: Implications for Policy and Research.*" In Sustainability, Growth, and Poverty Alleviation: A Policy and Agro-ecological Perspective, edited by Vosti and Reardon. Baltimore: The Johns Hopkins University Press.

Waller, B.E., Hoy, C.W., Henderson.J.L., Stinner,B. & Welty,C.,1998, "Matching Innovations with Potential Users: A Case Study of Potato IPM practices." *Agriculture, Ecosystems and Environment.* 70(1998):203-215.

Wambugu, F. & Kiome,R., 2001, *The Benefits of Biotechnology for Small-Scale Banana Washington:* World Bank.

Wiebe, K.D., Soule, M.J., & Schimmelpfennig, D.E., 2001, *Agricultural Productivity for Sustainable Food Security in Sub-Saharan Africa.* FAO Corporate Document Repository, Economic and Social development Department.

Yaron, D., Dinar,A. & ,Voet, H., 1992, "Innovations on Family farms: The Nazareth Region in Israel." *American Journal of Agricultural Economics.* American Agricultural Economics Association:361- 370.

Ziervogel, G., Nyong, A., Osman, B., Conde, C., Cortes, S., & Downing, T., 2006, *Climate variability and change: Implications for household food security*. Viewed: 24/10/2012. From: http://www.aiaccproject.org/working_papers/Working%20Papers/ AIACC_WP_20_Ziervogel.pdf

APPENDIX 1: QUESTIONNAIRE

Questionnaire

University of Fort Hare

Faculty of Science and agriculture

Department of Agricultural Economics and Extension

The impact of new agricultural technology adoption on food security in South Africa: The case study of irrigation in the rural areas of Nongoma in Kwa-Zulu Natal

Name of the interviewer	
Name of respondent	
Location of the farm	
Date of the interview	
Questionnaire number	

A. Demographic Information

1. Please provide the following information about your household.

Demographic Variable	Response
Household head gender	
Household head age	
Number of people bellow 15 yrs	
Active population (15 – 64 yrs)	
Number of people above 64 yrs	
Number of males	
Number of females	
Total size of the household	

Household status

Single	1	Married	2	Divorce	3	Widow	4

House hold head

Male	Female	Child
1	2	3

2. What is the highest level of the head of household has completed?

No formal education	Primary school only	High school	Tertiary education	Other (specify)
1	2	3	4	5

B. Source of food for the household

1. What is the main household's food acquisition strategy?

Buy from markets	Own production	Both
1	2	3

2. Using the land, is the household producing enough for the family?

Yes	
No	

3. Do the household members have enough time for own production?

Yes	
No	

4. How many years has the family been involved in farming?

.....

5. Which of the following mostly affects your produce?

Pests	Diseases	droughts	frosts
1	2	3	4

C. Land acquisition

1. How did you acquire land?

Communal	Rent/ Lease	Privately owned	Bought	Inherited	Other (specify)
1	2	3	4	5	6

2. How much land do you own?

1 ha	2 ha	3 ha	Others (specify)
1	2	3	4

3. How many hectares of land are you cultivating at the moment?

1 ha	2 ha	3 ha	Others (specify)
1	2	3	4

4. If you are utilizing less than the available land what are the reasons?

Lack of capital	Poor topography	Fencing	Lack of labour	Theft of produce	Other (specify)

D. Main crops produced

1. List the main crops you grow in your plot and provide the following information for the cropping season

Name of crop	Season		Area (Ha)	Produced yield this yr (season)(kg/bags)	Produced yield last yr (season) (kg/bags)
	Winter	Summer			

E. Reproduction System

1. What type of production are you using?

Organic farming	Inorganic farming (eg fertilizer)

2. What is the source of seed/seedlings?

Department of Agric	
Buy it yourself	
Both	

3. What is the source of water for irrigation?

River	Dams	Boreholes	Harvested water	Other
1	2	3	4	5

F. Credit Acquisition for agric purpose

1. Do you need credit for farming?

Yes	
No	

2. If yes what do you need credit for?

Buy inputs	For fencing	Family support before harvest	Labour	Other (specify)

3. Where do you get the capital for farming?

.....

4. Have you ever applied for credit?

Yes	
No	

G. ECONOMIC IMPACT

1. How much money does your household earn from the following income sources on a monthly basis?

SOURSE OF INCOME	RESPONSE	OPTIONAL (MONTHLY INCOME (RANDS))
Wages and salaries	1	
Old age grant	2	
Disability grant	3	
Child grant	4	
Other	5	

2. Has your agricultural income improved during the past three years?

Yes	
No	

3. How would you rate the economic well-being of your household after you adopted irrigation?

It has improved	1

Stay the same	2
Worsened	3

4. What is the total income of production?

5. Please state other technology activities in your plots and how much money you spent on it, during the same cropping season (Production costs)

Items	Units	Quantity	Units Price (R)	Amount (R)
Fertilizer				
Pesticides				
Herbicides				
Irrigation				

H. General

1. State major production needs of the project

2. State your marketing needs

3. Do you have link with the Department of Agriculture?

Yes	No

4. Have you received assistance from the Department of Agriculture?

Yes	
No	

5. What are the challenges to production –input in your farm?

Lack of many to buy inputs	Lack of knowledge on how to procure right inputs	No challenges at all	Other
1	2	3	4

6. Does the family own the following items if yes please state the quantity of each item?

Assets	Yes	No	Quantity
Cattle			
Goats			
Chickens			
Donkeys			
Horses			
Sheep			
Pigs			

7. Farming assets owned

Assets	Quantity	Year bought	Price paid when bought	Value today
Land				
Tractor				
Oxen				
Hand hoe				

8. Does the family own the following items?

Items	Yes	No
TV		
Radio		
Cell phone		
Compute		

APPENDIX 2: CODE BOOK

Code Book

The impact of new agricultural technology adoption on food security in South Africa: The case study of irrigation in the rural areas of Nongoma in Kwa-Zulu Natal

A. Demographic Information

Gender of head of household
Gender HH: Male = 1
Female = 2

Age of head of household
AGEHH: Actual age

Active population of the household

ACTIVE PH: Actual number
Total size of a household

SIZEH: Actual size
Marital status of the household
MARST: Married = 1
Single = 2
Divorced = 3
Widow = 4

2. Level of education of the head of the household
LEVELEDU: Non educated = 1
Primary = 2
High school = 3
Tertiary = 4

B. Source of food for the household

1. What is the main household's food acquisition strategy?
FOODACQ: Buy from markets = 1
Own production = 2
Both = 3

2. Using the land, is the household producing enough for the family?

ENPROD: Yes = 1
No = 0

3.Do the household members have enough time for own production?

YRSFARM: Yes = 1
No = 0

4. How many years has the family been involved in farming?

YEARFRM: 0 – 5 = 1
6 – 15 = 2
15 + = 3

5. Which of the following mostly affects your produce?

AFFECTSPRD: Pest = 1
Disease = 2
Drought = 3
Frost = 4

C. Land Acquisition

1. How did you acquire land?

LANDAC: Communal = 1
Inherited = 2
Bought = 3
Rent = 4
Privately owned = 5
Other = 0

2. How much land do you own?

LANDOWN: actual number of hectares

3. How many hectares of land are you cultivating at the moment?

CULTVHA: Actual number of cultivated hectares

D. Main Crops produced

1. List of the main crops that are grown in your plot.

CROP: Actual number of crops

E. Reproduction System

1. What type of production are you using?

TYPEPRD: Organic = 1
Inorganic = 2

2. What is the source of seed/seedlings?

SEEDSOU: Agriculture = 1
Buy it = 2
Both = 3

3. What is the source of water for irrigation?

IRRIGATIO : Irrigation = 1
Non irrigation = 0

F. Credit Acquisition for agric purpose

1. Do you need credit for farming?

NDCRD: Yes = 1
No = 0

2. If yes what do you need credit for?

CREDITFOR: Buy inputs = 1
Other = 0

3. Where do you get the capital for farming?

CAPITAL: Family income = 3 points
Agric = 2 points
Lima = 4 points

4. Have you ever applied for credit?

CRDAPL: Yes = 1
No = 0

G. Economic impact

1. What is a source of income on a monthly basis?

SOURCEIN: Employed = 1

Grant = 2

2. Has your agricultural income improved during the past three years?

IMPRD: Yes = 1
No = 0

3. How would you rate the economic well-being of your household after you are involved in the scheme?

ECONM: Improved = 1
Other = 2

4. The total income of production

TOTALIN: Actual total income

5. How much money you spent on the farming inputs during the same cropping season

SPENT: Actual total expenditure

F. General

1. State major production needs of the project

NEEDS: Tractor = 1
Labour =2
Other = 3

2. State your marketing needs

MKTND: Transport =1
Marketing skills = 2
Network = 3
Other = 4

3. Do you have link with the Department of Agriculture?

AGRICLNK: Yes = 1
No = 0

4. Have you received assistance from the Department of Agriculture?

AGRICASS: Yes = 1
No = 0

5. What are the challenges to production –input in your farm?

CHLNG: Money to buy inputs = 1
Other = 2

6. Does the family have livestock?

Cattle: (LSUCT) Actual number of LSU
Goats: (LSUGT) Actual number of LSU
Chickens: (LSUCH) Actual number of LSU

7. Farming assets owned

FARMASST: 1 – 5 = 1
5+ = 2

8. Family assets owned
FAMILYASST: TV = 1
Radio = 2
Cell phone = 3
Computer = 4
TV + Radio + Cell phone = 5
TV + Radio = 6
TV + Cellphone = 8
TV + Radio + Cellphone [illegible]puter = 9