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Risk preferences of smallholder irrigation farmers in the former Ciskei homelands of the Eastern Cape Province, South Africa

By

MATHLO ITUMELENG

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Department of Agricultural Economics and Extension

Faculty of Science and Agriculture

University of Fort Hare

Alice

Supervisor

Ajuruchukwu Obi

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DECLARATION

I, Itumeleng Modjadji Mathlo, declare that the thesis hereby submitted for the MSc degree in Agricultural Economics at University of Fort Hare is my own independent work and has not previously been submitted by me at any other academic institution. Where use has been made of the work of others, such work has been duly acknowledged in this text**.**

Signature

Date

DEDICATION

I dedicate this work to my loving parents Rebecca and Matome Mathlo, for the sacrifices they made towards my education. Thank you for the support that you gave me throughout my studies. Papa you taught me that impossible doesn't exist and indeed I've seen that. Thanks for always seeking the best in me. To my siblings, Elizabeth, Lehlogonolo, Tumiso, Tshegofatso and Lethabo thank you for believing in me and all the support you gave me, hope you will walk in my footsteps, trusting that I have paved a way for you all.

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ABSTRACT

Although several studies have investigated on commercial farmers' risk preferences, there is still lack of information on the risk attitudes and risk preferences of smallholder farmers in South Africa. Risks associated with the adoption of new agricultural technology need to be explored in order to address the transition from homestead food gardening to smallholder irrigated farming. This study seeks to understand risk perception of smallholder irrigation farmers by linking constraints to commercialisation, adoption of new agricultural technologies and risk preferences of smallholder farmers in the former Ciskei Homelands of the Eastern Cape.

A total of 101 respondents were surveyed, consisting of 38 smallholder farmers and 63 homestead food gardeners in the Eastern Cape. Questionnaires were used to record household activities, socio-economic and institutional data as well as household demographics through personal interviews. The probit results indicated that older farmers are less risk averse thus more willing to take risk. The risk analysis indicates that farmers who are employed elsewhere are more willing to take risk as income is playing a major role in risk preferences. The results also prove that factors such as tenure system and years in farming have a major influence on farmers' decision to take risk and adopt new agricultural technology.

According to the multi-logit model the major factors influencing technology adoption and risk taking are household size, water rate and type of irrigation system used by the farmers. This study provides useful practical insights for policy makers, farm advisers and researchers in the design of effective and efficient policies, programmes and projects which can affect the adoption of technology, increase smallholder farmers capacity to manage risk and drive growth in the food market.

Keywords: Risk preferences, agricultural technology adoption, probit, multinomial logit, irrigation, smallholder farmers

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CHAPTER 1

INTRODUCTION

1.1 Background

Agricultural production in low income developing countries is generally poorly diversified; focusing on rain fed staple crop production and raising livestock activities that are inherently risky. The significance of agriculture in the economies of developing countries has long been recognized. In Africa, the agricultural sector plays a significant role in terms of its contributions to the Gross Domestic Product (GDP), income and employment (Nkanleu, Gokowski and Kazianga, 2003). More than 80% of the population in some countries in Africa are dependent on small-scale farming as their primary source of livelihood. Agriculture contributes to industrial growth through endowment of cheap labour, capital for investment, foreign exchange earnings, and markets for manufactured consumer goods, enhanced rural incomes to support increasing numbers dependent on the industry, as well as food and raw material needs for the fast growth in urban populations (Kydd, Dorward, Morrison and Cadisch, 2001).

According to Van Rooyen (1997), agriculture contributes both directly and indirectly to economic growth. The direct contribution is reflected by the relative small proportion of GDP and employment. However, the indirect contribution through agriculture's linkages and multipliers is large. One of the most fundamental roles of agriculture is supplying food to the consumer at an affordable price. Agricultural production in South Africa has increased on average at a rate of 3.4% annually since the 1980's, while the population has increased at an average rate of 2.6% (FAO, 2010).

In South Africa the term smallholder irrigation is mostly used when referring to irrigated agriculture practiced by black people. South Africa has about 1.3 million ha under irrigation, of which 0.1 million ha is in the hands of smallholders (Backeberg, 2006). Smallholder irrigators have been categorized into the following four groups,

namely, (i) farmers on irrigation schemes; (ii) independent irrigation farmers; (iii) community gardeners; and (iv) home gardeners (De Lange, 1994; Crosby, et al., 2000; Du Plessis, Van Averbeke and Van der Stoep, 2002). Backeberg (2006) estimated the number of South African smallholder irrigators to range between 200 000 and 250 000, but majority of these were farming very small plots, mainly to provide food for home consumption. South African smallholder irrigation schemes are multi-farmer irrigation projects larger than 5 ha in size that were either established in the former homelands or in resource-poor areas by black people or agencies assisting their development.

Smallholders farmers in most developing countries are somewhat land constrained, poorly linked to markets, and are more vulnerable to risk than larger farmers in the same area. Therefore, the logical starting point for identifying priority policy interventions that target smallholder farmers in a certain area would be recognizing important differences within and across that areas small- farm sector.

Risk is an issue of critical importance to smallholder farmer's decision making and it complexes their livelihoods (Belaineh, 2000 and 2002, Belaineh and Drake, 2002). For the farmers the main issue raised by inconsistency of climate, price and other risk factors is how to respond and adapt systematically, contextually and enthusiastically to unfolding risks to reduce the possibility of losses and its downside consequences. Studies in experimental economics have tried to examine to what degree risk attitudes lead to impacts on economic performance. They find that the risk aversion has been inversely linked with economic outcome such as investment in physical, human capital and wage growth (Shwa, 1996).

However, most economic analysis assumes the preferences of individual farmers are taken as given and those preferences decide the farmer's selection. Based on this assumption, society's economic behavior is obtained by aggregating the choices in the society. This way leaves little room for investigating how the environment in which farmers make decisions affects those decisions (Postlewaite, 2011).

Other studies, however, suggest that individual experiences can have long term effects on preferences that can affect long term individuals' risk attitudes. In their

study Malmendier and Nagel (2011), find that personal traumatic experiences such as the combat experiences of veterans have long term effects on financial decisions. Particularly their findings show that having experienced psychological shocks decrease an individual's willingness to take financial risks.

Information acquisition and learning would influence inactivity to cope with various sources of risks (Noell and Odening, 1997). Risk information that is traditional early warming techniques and those channels from government sources, the way it is communicated, reliability of the information and the eventual learning assumes importance to pilot in a complex and uncertain world. Noell and Odening (1997) further suggest that information collection and processing is, among other things, a significant risk management behavior over time. Adesina and Quattara (2000) argue that unless policy makers improve the accessibility of information that allows farmers to progress their managerial capacity for making more risk- efficient cropping decisions, it is unlikely that farmers will be able to cope with persistent risks that affect their welfare and livelihoods. Partially as provision of information to farmers could enable them to make more informed decisions- whilst attributing communication of technical information to farmers' sources alone is arguable, as there are various informal source of wisdom and information with varying contents and magnitude in the rural context.

The risk environment of farmers markets is changing, among others due to increasing market liberation and industrialization of agriculture (Boehlje and Lins, 1998). These changes lead to new risks management instruments are being developed. Risk management strategies adopted by farm managers will be in accordance with their personal preferences for risk. In this context it would be useful for developers and sellers of such new risk strategies to have insight into these preferences of farmers (Beal, 1996).

Risk preferences play an important role in economics. Studies in experimental economics have tried to examine to what degree risk attitudes lead to impacts on economic performance. They find that the risk aversion has been inversely linked with economic outcome such as investment in physical, human capital and wage growth (Shwa, 1996). However, most economic analysis assumes the preferences of

individual farmers are taken as given and those preferences decide the farmer's selection. Based on this assumption, society's economic behavior is obtained by aggregating the choices in the society. This way leaves little room for investigating how the environment in which farmers make decisions affects those decisions (Postlewaite, 2011).

There are clear opportunities for commercialization of smallholder farming in Africa but the challenge lies in bringing markets to farmers – 'pulling' demand for goods that will encourage farmers to make investments, find innovative ways of overcoming spatial and technological constraints (Livingston, Schonberger and Delaney, 2002). Despite phenomenal success of the commercial sector in South Africa and significant progress in integrating smallholders since democratic reforms, food security concerns remain in South Africa. Recent global increases in food have further aggravated vulnerabilities and make it imperative to examine alternative food production questions in the country.

1.2 Problem statement

There are many obstacles to the growth of smallholder agriculture. One of the obstacles is the persistence to out dated production technologies because farmers do not adapt to technologies whose benefits are do not well demonstrated and they do not see any incentives to adoption to improved practices.

Smallholder farmers involved in agricultural production in developing countries come across a number of risks, including crop yield risks due to discrepancies in rainfall and fluctuating output prices. Farmers' decisions to decline welfare improving opportunities because of perceptions of risk have significant policy implications. While the existence of agricultural risk and its effects on developing countries is well known, there are few empirical estimations of the magnitude and nature of household risk aversion in this context. Moreover, there is petite information on the basic household factors behavior affecting risk behavior. With developing countries, there may be vital linkages between risk aversion on the part of the farm households and seemingly distinct elements such as household fertility, educational attainment, and gender dynamics. Working on these elements can expand outcomes for technology adoption (Yesuf and Bluffstone, 2007).

According to Eswaran and Kotwal (2002), for a given risk aversion, under-investment in risky production activities will be greater for households who are constrained in their consumption smoothing activities. Whilst it is the role of constraints that is ultimately of concern and of policy interest (Zimmerman and Carter, 2003), the dependence on measures of wealth to identify the impact of risk on many contexts is challenging as it is not fully possible to deal with the endogeneity issues entailed in identifying the fundamental relationship between a measure of wealth and production decisions. An unobserved preference for risk will affect not only current production choices, but also past production choices and thus the asset- wealth of a household, causing a household's ability to deal with the risk to be endogenous to production choices. Only if an innate measure of risk preferences is also included can endogeneity problem be solved.

From a social learning theory perspective, Tucker and Napier (2001), the increased emphasis on formal information sources will yield higher levels of perceived risk. (Although, interpersonal sources such as friends and neighbours, should also play a substantial role in risk perception by dispensing information from formal and other sources more widely throughout the agricultural community. Relatively, Tucker and Napier (2001) argue that informal sources may also have access to information about specific local issues that formal sources do not. Therefore, increased communication with and/or with-in various farmers' groups are likely to be associated with risk perceptions and selection of risk management tools. To add on, Belaineh and Drake (2002) and Belaineh (2002) claim that smallholder farmers in Eastern Ethiopia perceive risk subjectively, that is, at individual and group levels, and respond accordingly. Perception of risk is subjective in a sense that it is vulnerable to variations depending on the past contextual experiential learning, provision of and/or access to information, confidence in institutions and bases of information, farm and farmer's characteristics, interaction and status in the community and psychological mindset of the individual farmers and the groups.

Studies reveal that households' response towards risk is due to a number of factors when faced with new agricultural technologies. Some of these factors are relative to the nature of the transformation in agricultural production, whereas others are relative to farmers past experiences and characteristics. This indicates that farmers

are more sensitive to loss than gains. According to Yesuf and Bluffstone (2007) smallholders who stand to lose as well as gain more than their loss are significantly risk averse than those that face potential gains only. Therefore, there is a need for agricultural extension intervention involving losses and gains may face systematic resistance by farmers in low income and high risk environments. Once initial successes convince farmers that technology is viable, risk aversion declines. Therefore, smallholder farmers base their investment and production decisions, partially tend to be unwilling to adopt new agricultural technologies even when expected net returns are high. As such a better understanding of risk behavior is necessary for identifying appropriate farm- level strategies for adoption of new technology by small holder farmer (Yesuf and Bluffstone; 2007).

There is already some experiential evidence that hypothetical questions on risk correlate as expected with risk taking behavior (Knight, Weir and Woldehanna, 2003). These studies determine whether there is a correlation between risk preferences and behavior, but the focus is not to present an empirical model of risk-taking behavior under uncertainty. In particular, a household's ability to deal with risk is not controlled by a household's perception of risk in a given activity (Dercon, 1996). It focuses on risk preferences and risk perceptions to determine whether they influence individual behavior as a model of labour allocation under risk would, predict in particular recognizing that the ability of a household to deal with risk is crucially important in determining how preferences affect behavior.

South African studies where farm- level data sets were used to identify the importance of multiple risk sources include that of Hardman, Darroch, and Ortman (2002) and Stockil and Ortman (1997). In this studies it was found that factor analysis suggested that crop gross income, government policy, livestock gross income, credit access, government regulation and costs were described as risk sources. Stockil and Ortman analyzed the importance and dimensions of risk sources and the respondents, identified changes in the cost of farm inputs, government legislation, rand exchange rate and product prices as the most important sources of risk. Factor analysis of risk sources showed that various dimensions to risk exist including changes in government policy, enterprise gross income, credit access and cost changes.

Bullock, Ortman and Levin (1994) identified price, climate and yield variability as the most important sources of risk in vegetable production. The results also showed that government policies added to the level of uncertainty faced by vegetable farmers. However, a comparative analysis among large and small vegetable farmers portrayed differences in their perceptions of risk. Small farmers perceived changes in credit availability and changes in input costs to be more important risk sources than large farmers. In their studies Swanepoel and Ortman (1993) revealed that sources of and responses to risk in farm production, marketing and financing were considered to be variations in livestock production, rainfall and livestock prices, the threat of land reform, and changes in input costs.

Smallholder irrigation farmers are characterized by significant business risk and there is evidence that poor smallholder farmers are typically risk averse (Binswanger and Sillers, 1983). Although studies have investigated commercial farmers's risk preferences, there is lack of information on the risk attitudes of smallholder farmers in South Africa. This study seeks to understand risk perception of smallholder irrigation farmers by linking constraints to commercialisation, adoption of new agricultural technologies and risk preferences of smallholder farmers in the former Ciskei Homelands of the Eastern Cape.

1.3 Research objectives

The main objective of this research is to determine risk preference patterns and attitudes that influence the transition from homestead food gardening to irrigate farming of smallholder farming systems in the former Ciskei Homelands of the Eastern Cape. The study will more specifically:

- Understand farming systems by these farmers
- Analyse the adoption of new agricultural technology smallholder irrigation farmers
- Assess the risk perception of smallholder irrigation farmers

1.4 Research questions

This study is guided by the main research question: what influence does risk preference attitudes and patterns have on the transition of homestead food gardeners to smallholder irrigation farming? This question is further guided by the following sub questions:

- Which farming systems do smallholder farmers use?
- What are the constraints of homestead food gardeners to irrigated smallholder farming?
- How do smallholder farmers adopt to new agricultural technology?
- What are the perceptions of small irrigation farmers on risk?

1.5 Hypotheses

The hypotheses to be tested in this study are:

- Farmers use the same farming system
- Small holder farmers are late adopters of new agricultural technology
- Smallholder farmers are more risk averse

1.6 Justification of the study

Unemployment is high and tends to rise as households lose jobs in the urban centres. Farmers in these areas are not really part of commercial agriculture. This is one of the reasons that the contribution of smallholder agriculture to the gross domestic product (GDP) is still limited in South Africa. The majority of disadvantaged farmers are not part of mainstream agriculture and practices smallholder agriculture in the former homelands. This kind of smallholder farming is characterized by low production and poor productivity, poor access to land and poor access to inputs and credit. In order to generate enough income, farmers engage themselves in off- farm or non- farm income generating activities.

It is, however, possible for smallholder farming to survive economically when given a set of opportunities. Smallholder farmers are used to take rational decisions in order

to adapt to conditions they find themselves in. for example, given a set of resources, farmers will strive to optimize production. Another particular and critical set of opportunities involves opening access for smallholders to interact with other economic agents.

To some extend the process of agricultural transformation in South Africa involves moving households from smallholder production to producing for the market or commercializing. Commercializing has a number of benefits and advantages. In particular employment is promoted and income generated (Ngqangweni, 2000). The commercial environment provides a potential for increased production and thus for improving food security for the rural poor. Studies by Ngqangweni (2000); Delgado, Rosegrant, Steinfeld, Ehui and Courbois, (1999) have shown positive and strong multiplier effects of investing in agriculture. Therefore, agriculture has an important role to play in fostering rural development and poverty alleviation. It is through commercialization of smallholder agriculture that the previously disadvantaged groups can become a significant part of the economic base of rural economies. It is respected that efforts to promote structural change, such as land reform, improved access to credit and a number of markets have benefited some, although a small minority of black farmers. But the reforms have not been sufficient to improve the participation in commercial agriculture of the majority of smallholder and emerging farmers.

There is risk aversion of smallholders to commercialize. Therefore research is needed to identify policy options that will stimulate the transition of smallholder farmers to become commercial operators. This study aims to propose ways to alleviate constraints to commercialization by smallholder farmers. According to Binswanger (1982), poor smallholder farmers are risk averse and their production and economic environments are characterized by a high degree of uncertainty. Owing to their wealth smallholder farmers are also expected to be relatively vulnerable to risk and consequently, risk is expected to be an important determinant of their decisions. These general conclusions and observations have stimulated extensive research into the effects of risk on smallholder farmers' adaptation. The case of rural poor households whose capacity to bear risk is low, tend to exhibit a

risk averse behavior. Income or production shocks could thus have a drastic impact on the households.

An insight into the sources of risk has a clear implication as to how riskiness of adoption of technology may be reduced, thus increasing the likelihood that relatively more risk averse farmers will adopt to new agricultural technology. Knowledge of farmers, risk preferences could help in the design of technological and institutional practices tailored to their economic behavior in order to improve the likelihood that rural development programmes will succeed in improving household incomes. The findings of the study will guide on how the government and/or the private sector can develop policies that help farmers reduce and/or manage risk and tailor literacy and risk management education and strategies towards the various farmer groups in South Africa.

1.7 Chapter summary

Chapter 1 presents the introduction of the study which gives an overview of agriculture in developing countries. The chapter proceeds by introducing the concept of risk and its effect on small holder farmers. The problem statement is thoroughly explained. It also goes on to explain the objectives and research questions. The chapter is concluded by the justification of the study.

Chapter 2 is the review literature which covers a wide range of issues. It begins by defining smallholder farmers and how the term is used in the South African context. It further explains risks and its effects on agriculture and the types of risk thereof. It proceeds with the adoption of technology and the theories of technology adoption. It further it continues with the concept of technology adoption by addressing the factors that affect the adoption of technology. The concept of commercialisation is defined, the constraints to commercialise, and the role that risk play in commercialisation is also tackled. The chapter concludes by identifying the sources of risk and the risk management strategies thereof.

Chapter 3 provides the utility theory, thereby explaining the expected utility theory and measure of risk aversion is discussed and the justification presented for the use of the Arrow Pratt Absolute Risk Aversion to measure decision makers risk aversion. The Chapter concludes with the various methods for measuring risk attitudes for agricultural producers.

Chapter 4 presents the methodology, introducing the study area. Data collection methods and instruments are presented. The variables are specified in this section as is the background on the empirical data analysis models used in the study.

Chapter 5 provides the results and discussion

Chapter 6 is the summary, conclusion, recommendations and policy implications.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter introduces the concept of risk and its effect on agriculture. The chapter proceeds to review literature on the adoption of new agricultural technology by smallholder farmers thus reviewing the different theories and the factors affecting the agricultural technology adoption. It further presents the concept of commercialization and the constraints of smallholder farmers to commercialise. The chapter then links the role of risk with commercialisation by smallholder farmers. It continues by introducing the sources of risk and risk management strategies and the chapter concludes by reviewing literature on the South African studies on risk preferences.

2.2 Defining South Africa's smallholder farmers

In South Africa the term smallholder irrigation is mostly used when referring to irrigated agriculture practiced by black people (Backeberg, 2006). South Africa has about 1.3 million ha under irrigation, of which 0.1 million ha is in the hands of smallholders (Backeberg, 2006). Smallholder irrigators have been categorized into the following four groups, namely, (i) farmers on irrigation schemes; (ii) independent irrigation farmers; (iii) community gardeners; and (iv) home gardeners (De Lange, 1994; Crosby et al., 2000; Du Plessis *et al*., 2002). Backeberg (2006) estimated the number of South African smallholder irrigators to range between 200 000 and 250 000, but majority of these were farming very small plots, mainly to provide food for home consumption. South African smallholder irrigation schemes are multi-farmer irrigation projects larger than 5 ha in size that were either established in the former homelands or in resource-poor areas by black people or agencies assisting their development.

Ortmann and King (2010) describe them as farmers with limited access to factors of production, credit, information, markets and are often constrained by inadequate property rights and high transaction costs, and the household labour use is dominant

on the farms. Smallholders farmers in South Africa demand larger holdings and are relatively more market oriented in comparison to homestead food plots, and sometimes are referred to “emerging farmers”. These "emerging farmers" are associated with the land reform programme and are basically black smallholders who are expected to produce more for the market but are probably not doing so (Van Averbeke *et al*., 2011).

According to Aliber *et al*. (2009), geographically, smallholder farmers in South Africa are unevenly distributed. Aliber *et al*. (2009) understood a broad definition of agricultural smallholders in South Africa, including farmers who function independently, farm in groups, subsistence farmers, and the market orientated whose purpose is mainly commercial. Thus, there are two categories of smallholders that can be identified using this broader definition, those whose farming is mainly subsistence and the commercially oriented smallholders. In total, there are about 4 million smallholder individuals who participate in South Africa‘s agricultural sector and of the 4 million, about 92% are engaged in farming mainly for home consumption and only 8% of these farmers mainly produce for household income (Aliber et al., 2009). This statistics provided by Labour Force Survey (LFS) of Statistics South Africa categories smallholders in terms of their major purpose of farming (Aliber et al., 2009). Statistically this may be used as a proxy to differentiate between the subsistence smallholders and commercial smallholders.

The 92% of subsistence smallholders indicated that they purposely farm to ensure household food security vis-à-vis accumulation of wealth. Although subsistence-smallholders contribute less to the national agricultural market share and the national economic growth at large, their role in mitigating hunger cannot be ignored (Aliber et al., 2009). This can be best explained by the high public expenditure incurred by the government to establish irrigation schemes and provided food parcels to needy households during the 1930s and the early 2000s hunger experiences in South Africa. Therefore, efforts to enhance subsistence production, is necessary.

In 2007, during the Polokwane conference, the African National Congress (ANC) government called for land reform and agrarian change as one way of supporting subsistence food production, expanding the productivity of commercial-smallholders

and maintaining a vibrant and competitive agricultural sector (Aliber and Hall, 2009). Commercial-smallholder farming has been promoted through several government support programmes. These programmes include land reform policies, additional grant money for farm improvements and initial operational costs, and use of mentors or strategic partners, the purpose of whom is to ensure adequate farm and business management (Aliber and Maluleke, 2010).

The land redistribution and restitution programmes targeted the resourced-poor commercial-smallholders and this led to failure of numerous projects. According to Aliber and Maluleke (2010), of projects delivered between 2001 and 2006, 29% were not actively involved in agricultural production and were generally deserted, and another 22% were producing extremely low outputs that generated low income. Nevertheless, there are a few commercial-smallholders'projects that have been successfully integrated in the South African formal agricultural markets (Aliber, 2011). The identified successful farmers were grouped into associations or cooperatives, and shared input costs, group labour, and marketed their produce collectively. These groups realised high production and farm gross margins (Aliber, 2011). For increased number of successful commercial-smallholders, there is a need for government interventions to resurrect the large number of failed projects across the country (Aliber and Maluleke, 2010). In addition to land redistribution and restitution, the government of South Africa availed capital funding through its Comprehensive Agricultural Support Programme – CASP (Aliber and Hall, 2009). In this programme, land reform beneficiaries were entitled to 70% share while other agrarian reform beneficiaries were entitled to only 30% of the capital funding (Aliber and Hall, 2009). However, this support has not yielded much in terms of saving the declining agricultural productivity of smallholders (Aliber and Hart, 2009).

2.3 Risk and its effect on agriculture

Risk and uncertainty are perceived as characteristics of agricultural production. They could arise due to biophysical factors such as inconstant weather events, diseases or pest infections (Adesina and Brosen, 1987). Other factors such as changing economic environment, introduction of new technologies or crops, and uncertainties surrounding the public institutions and their policy implementation also combine with

these natural factors to create a surplus of yield, price and income risks for farmers (Anderson, Dillon, and Hardker, 1985; Mapp and Persaud, 1979). The risk situation is severe in majority of agriculture in sub- Saharan Africa. The low and high inconsistent rainfall and the absence of institutional innovations (e.g. disaster payments) too shift part of the risks from the private sector to public sector, makes risk management a critical part of farmers' decision making (Shapiro, Sanders, Reddy and Baker, 1993).

Risk is an issue that affects many aspects of people's livelihoods in developing countries. It is a persistent characteristic of life in developing countries, mainly in the rural areas (IFAD, 2008; World Bank, 2005). The economic stability of any rural area can be destroyed by crises caused by different types of natural disasters such as livestock diseases and climatic conditions. According to IFAD (2008b) almost 1.4 billion people live on less than US$1.25 a day, seventy percent of which reside in the rural areas and are dependent on agriculture and are also at risk from recurring natural disasters. Natural disasters have a negative impact on food security and overall social and economic development of poor rural households.

According to the World Bank's (2001) World Development Report, agriculture and agribusiness are the primary sources of income for most families and businesses in developing countries. Agriculture's dependence on weather, such as rainfall leads to production risk and affects the farmers' ability to repay debt, to meet land rents and to recover essential living costs for their families. The instability of farmers and producers leads into macroeconomic vulnerability (Guillaumont, Jeanneney and Brunn, 1999; Benson and Clay, 1998).

Many researchers have found that risks cause farmers to be less willing to undertake activities and investments that have higher expected outcomes, but carry with them risks of failure (Alderman, 2008 and Adebusuyi, 2004). Dercon (2002) states that the failure to cope with agricultural risk is not only reflected in household consumption but also affects nutrition, health and education and contributes to inefficient and unequal intra- households allocations. Traditional risk reducing strategies helps to cope with risky incomes (Morduch, 1999). Although the distinction between risk management and risk strategies may seem important from a theoretical point of

view, its importance is less from a practical point of view because farmers experience both fear and fate in their daily lives (Dercon, 2007).

2.4 Types of risks in agriculture

All agricultural enterprises, most especially in developing countries operate under a situation of risk or uncertainty (Meuwissen, Huirne and Hardaker, 2001). Five general types of risks are described by Hardaker et. al (2004). They are described as follows: production risk, price or market risk, financial risk, institutional risk and human risk.

- Production risk is referred to as the uncertainty of natural growth processes of crops and livestock. Weather, disease, pests, and other factors affect both the quantity and quality of commodities produced (Langeveld, Verhagen, Van Asseldonk and Metselaar, 2003).
- Price or market risk is the uncertainty about the prices producers will receive for commodities or the prices they must pay for inputs (inputs costs). The nature of price risks varies with each commodity.
- Financial risk results when the farmer borrows money and creates an obligation to repay debt. Rising interest rates, the prospect of loans being called by lenders and restricted credit availability are also aspects of financial risk.
- Institutional risk refers to uncertainties surrounding government actions. Tax laws, regulations for chemical use, rules for animal waste disposal, and the level of price or income support payments are examples of government decisions that can have a major impact on the farm business (Wolf, Just,Wu and Zimberman, 1998).
- Human risk refers to factors such as problems with human health or personal relationship that can affect the farm business. Accidents, illness, death, and divorce are examples of personal crises that can threaten a farm business (Hartman, Frankena, Oude, Nielen, metz and Huirne, 2004).

These risks can be interrelated and one event can cause several impacts on other realities. All the categories of risk have an effect on the income of the stakeholder. Risk perceptions can vary from one farmer to the other, from sector to sector, from

product to product depending on farmer's experiences and the degree of risk aversion.

2.5 Adoption of agricultural technology

2.5.1 Theories on adoption of technology

Adoption refers to the process where an individual passes through since they heard of innovation (technology) until it starts to be used on a continuous basis (Rogers, 1991). Technology is defined as any idea, object or practise that is perceived as new by the members of a social system. A product innovation is an end product for consumption while a process innovation is an input to a production process (Rogers, 1991). A distinction must be made between the individual adoption by a firm or farmer and the aggregate adoption. The level of adoption is the degree or intensity with which a new technology is used when the farmer has complete information about it. It can be measured as the amount of use of that technology or as the farmer use or not uses that technology (Zilberman, 1985). Adoption is the outcome of a dynamic decision making process that includes learning about the technology through the collection of information.

Technologies play an important role in economic development (Carteling, Di Benedetto, Doree, Halman and Song, 2011). In agriculture, among the most frequently advocated strategies for climate adaptation and economic development is technology research and development (Rosenberg, 1992). Technological change can lead to productivity growth by either expanding the total output or increasing application of the relatively cheap inputs and trimming down use of the more or less expensive inputs (Huffman and Evenson, 1993).

2.5.2 Factors affecting adoption of technology by smallholder farmers

The uptake of new technologies or farming practices has attracted considerable interest over the years. The majority of the studies tend to focus on the classics comparison between adopters and non- adopters (Dadi, Burton and Ozane, 2004)

with very few studies investigating the differences between early and late adoption of technologies in general and irrigation farming in particular.

2.5.3 Function of age in technology adoption

Age is a primary characteristic in adoption decisions. However, there is controversy on the direction of the effect of age adoption. Age was found to positively affect the adoption of sorghum in Burkina Faso (Adesina and Baidu- Forson, 1995). The effect is thought to result from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. Adoption pay- offs occur over a long time and, while costs occur at earlier stages, age of the farmer can have profound effect on technology adoption. A study conducted by Bembridge (1991) on maize technology transfer in a typical homeland maize- growing area in South Africa established that 30% of producers were sixty years of age.

Age has been found to be correlated with adoption or not significant in farmers' adoption decisions. Similar studies by Kirsten and Jerkins (2003) and Adesina and Baidu- Forson (1995) established that age was either significant or was negatively related to adoption. Older farmers, because of investing several years in a particular practice, may not want to jeopardise it by trying out a completely new method. Farmers' perception that technology development and subsequent benefits, require a lot of time to realise, can reduce their interest in the new technology because of their advanced age, and the possibility of not living to enjoy it (Caswell, Fuglie, Ingram, Jans and Kascak, 2001; Khanna 2001).

2.5.4 Function of gender in technology adoption

Effective application of agricultural technologies in production has strategic implications. The productivity of labour will be altered depending on accessibility of the technology between men and women. In many smallholder farms, technology is mostly at the disposal of men whereas women contribute seventy percent of agricultural production (Lubwana, 1999). According to Doss and Morris (2001) there

is no significant association between gender and technology adoption of improved maize technology among farmers in Ghana. Phiri, Franzel, Mafogonya, Jere and Katanga (2004) showed that the adoption of improved fallow practices among house- holds in Zambia is neutral. Where else, Essa and Nieuwuldt (2001) in South Africa indicate that male farmers tend to adopt hybrid seed maize and fertilizer. They also argued that constraints to adoption of technology by women include socially conditioned inequalities in the access, use and control of resources and credit. They also reported a positive association between adoption of maize and the presence of male decision makers among smallholder farmer support programs in South Africa.

2.5.5 Function of education and training in technology adoption

Generally education is thought to create a favourable mental attitude for the acceptance of new practices especially if information- intensive and management-intensive practices on adoption (Caswell, et al., 2001). Education is perceived to reduce the amount of complexity perceived in technology thereby increasing technology's adoption. According to studies conducted by Moser and Barrett (2003) education is an important determinant of production efficiency and technology diffusion. Formal education and training in agriculture improves farmers' ability to acquire accurate information, evaluate new production processes, use new agricultural practices and understand the benefits of adopting appropriate farm practices (Hollaway, Shankar and Rahman, 2002). Education can encourage new technology adoption by lowering learning costs or it may discourage adoption by profitable off- farm employment opportunities and new technologies may reduce the ability of farm operators to substitute their inputs away from cultivation.

Training is one of the most critical factors of the technology transfer processes. Stroebel (2004) stated that training to enhance technology transfer and adoption programmes at sheering steeds played an important role in training the small ruminant farmers in the correct use and adoption of medical technologies. There are many technologies available that do not require formal education level. In these cases training projects are essential to develop the desire for new technologies and its implementation by the farmers (Abdulai, Owusu and Bakang, 2011).

2.5.6 Function of income in technology adoption

Previous studies have shown the significance of income on technology adoption of improved agricultural technologies by smallholder farmers (Langyntuo and Mekuria, 2005). Access to cash which promotes adoption of risky technologies through the relaxation of liquidity constraints as well as boosts the household's risk bearing ability is hardly available to resource poor farmers for varied reasons (Langyintuo and lowenberg, 2006). Farm income may affect adoption negatively or positively depending on its contribution to household income and farm profitability. Farmers with more wealth and liquidity maybe better able to finance the adoption of new technologies and farming practices (Essa and Nieuwoudt, 2001).

Iqbal, Ireland and Rodrigo (2005) in Sri Lanka found that farmers who were likely to adopt to intercropping are those who rely principally on their own farm enterprise for their income. Non-agricultural incomes on the other hand can reduce risk associated with the trial of new technology. Lingyintuo and Mungoma (2008) showed that the relationship between wealth and technology adoption, using data from households in Zambia approved that within any given farming community, households on the upper part of the wealth scale are most likely to adopt new technologies because of their secure economic positions. On the other hand those on lower wealth scale that is smallholder farmers may be willing to adopt because of their greater desire for upward mobility in the economic group but are unable to invest in new opportunities and therefore lowest in terms of adoption of new techniques.

2.5.7 Function of risk considerations in technology adoption

Agriculture is a nature of risky activity, and farmers' risk attitudes are known to deeply influence their choices, especially when dealing with new technology (Bocque'ho and Jacquet, 2010). Risk averse farmers are reluctant to invest in innovations about which they have little first- hand experience. Farmers who are risk averse will seek reducing strategies and technologies to adopt in their farming systems. That is why smallholder farmers will implement technologies that do not necessarily yield maximum net returns (Bocque'ho and Jacquet, 2010). Smallholder

farmers who consider adopting new technologies tend to be pessimistic about possible yield gains until they have more information on the results of new technology (Sanders, Shapiro and Ramaswamy, 1996).

The adoption of new technologies is positively related to the degree of risk aversion (Kebede, 1992). Malawian maize growers' perception of the relative riskiness of new seed varieties influenced the probability of their adoption and intensity of cultivation. This study provided strong evidence that the primary economic character of the adoption decision and also highlighted the importance of risk in the decision process. Risk aversion tends to reduce adoption and to a greater extend as relative riskiness and scale is increased.

2.5.8 Function of land tenure in adoption

According to Cotula (2006) land rights are the backbone of land tenure. Land rights include ownership and a range of other land holding and use rights which coexist over the same plot of land (Hogson, 2004). These rights may be based on national legislation, customary law or the combination of both. These rights may be held by individuals, groups, or by the state. Land is arguably 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 structures 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). This is due to the unproductive and inefficient use of land in the absence of appropriate research and extension services.

There are various constraints that impede the growth of smallholder farmers varying from systems constraints, allocative constraints to environmental-demographic constraints (Kirsten, Perret and De Lange, and Undated). Some of the systems constraints are lack of access to land, poor physical and institutional infrastructure. The background of a smallholder farmer given above suggests that one of the main

constraints that smallholder farmers face is poor access to sufficient land. Agriculture is largely carried out under increasing pressure of scarce land resources managed under insecure customary land ownership and communal grazing land. These insecure tenure systems such as communal land tenure system constrain the farmers from producing to their highest potential (Kariuki, 2003). If farmers perceive their tenure as secure, they have an incentive to invest in land improvements and maintain existing improvements to increase productivity. However, policies such as the land reform process play a role in finding solutions for problems associated with limited access to land. 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).

Hazell and Lutz (1999) have demonstrated that the rights that farmers have over natural resources can be important in determining whether they take short- term or long- term perspective in managing resources. Farmers who feel that tenure is insecure, with or without formal rights are less likely to be interested in conserving resources or making investments that improve the long term productivity of resources. Therefore stronger land rights and presence of land title are often associated with an increased livelihood of adoption and investment in new agricultural technology.

According to Placeand Braselle, (2009), although there are strong theoretical reasons why more complete land rights are expected to enhance agricultural technology investment, empirically this link has been found to be weak. Some of the reasons are adequate incentives in African tenure systems, thin credit market, endogenous tenure, failures of tilting programs and empirical difficulties. Community rights over land discourage investment because the community fears negative externalities from investments made (Besley, 1995). Collective management inhibited the adoption of new crops and new techniques by requiring consensus (Pannell, Marshall, Barr, Curtis, Vanclay and Wilkinson, 2006). When land is owned by the state, existing tenure arrangements may not give security to the holder, and the state can block endogenous institutional change (Hagos and Holden, 2006).

Investment incentives may be sufficient even if endogenous tenure is insecure. If individuals are altruistic towards other members of the community, they may not be discouraged by the possibility that land will revert to the larger group. However, if output is shared, the rest of the community members should encourage investment by its individual members (Besly, 1995). In the case of tenancy contracts, the threat of eviction can be used to elicit greater efforts from the tenant (Banerjee and Ghatak, 2004). Investment in agriculture competes with investment in capital goods, which are recoverable in the event of eviction. Even given insecurity, returns in agriculture may still be higher (Hayes, Roth and Zepeda, 1997).

2.6 Adoption of Agricultural Production Technology in South Africa

In South Africa, a wide range of technologies have been innovated and transferred to farmers to boost productivity and production efficiency (Kodua-Agyekum, 2009; DAFF, 2010). Establishment of irrigation schemes, animal traction, improved seed, fertilizers and agro-chemical application are among the technologies developed to benefit farmers. Black smallholders and subsistence farmers have been among the targeted beneficiaries of these technologies (Kodua-Agyekum, 2009; Van Averbeke et al., 2011). To ensure high adoption rates, the government of South Africa incurred investment costs to establish the irrigation schemes and provided input subsidies through rural development programmes (Kodua-Agyekum, 2009; Van Averbeke et al., 2011). However, adoption rates of these technologies such as irrigation, fertilizer and agro-chemical application among smallholder farmers seem to be low mainly due to poor extension services, low participation of farmers in decision making, and lack of investment capital (Kodua-Agyekum, 2009, DAFF, 2010).

Large-scale farmers are more likely to adopt these technologies compared to smallholders because they have more investment capital to source for credible information about the new technologies and experiment on the new technologies (DAFF, 2010). Due to the relative increase in the cost of labour, large-scale farmers have resorted to adoption of labour-saving and intensive capital-using technologies (DAFF, 2010). Labour saving and intensive-capital-use technologies seem to be more productive and efficient though they may worsen the high unemployment and declining smallholder agriculture situation. Probably this may be due to high costs

associated with these new technologies and most rural-poor black farmers cannot afford adopting them (DAFF, 2010). For example, the use of long-lasting herbicides and more efficient mechanized agriculture which is costly, and has led to loss of employment among seasonal farm workers (DAFF, 2010). Low rates of adoption of new technologies especially on the small-scale irrigation schemes have led to low production efficiency, low productivity, low household incomes, unemployment, increased food insecurity and wide spread poverty levels among Eastern Cape's rural communities (Kodua-Agyekum, 2009).

2.7 Commercialisation of agricultural products by smallholder farmers

2.7.1 Defining commercialization

Agricultural commercialization refers to the process of increasing the proportion of agricultural production that is sold by farmers (Pradhan, Dewina and Minsten, 2010). Commercialization of agriculture as a characteristic of agricultural change is more than whether or not a cash crop is present to a certain extent in a production system. It can take many different forms by either occurring on the output side of production with increased marketed surplus or occur on the input side with increased use of purchased inputs. Commercialization is the outcome of a simultaneous decision-making behavior of farm house-holds in production and marketing (von Braun, Bouis and Kennedy, 1994). It involves a transition from subsistence-oriented to increasingly market-oriented patterns of production and input use. Separation of household decision of production and consumption begins at the moment commercialization commences. Household decision-making of production and consumption is non-separable in subsistence farming while it is separable in market-oriented farming (Gebre-Ab, 2006). In a situation where decisions are non-seperable, the objective of the household is to maximise utility and where it is completely separable, the objective is profit maximisation.

The objective of utility maximisation is dominant in the early phase of commercialisation whilst that of profit maximisation is dominates in the subsequent phase. Pingali and Rosegrant (1995) classified farming systems as smallholder,

semi- commercial and commercial based on market orientation. The main purpose of smallholder farming is to produce to maintain food household self sufficiency. The semi- commercial system is focused towards generation of marketable surplus and maintaining household food security. In commercial system, profit maximisation is the main motive of the entrepreneur. Production of cash crops in addition to staples or even exclusively is another form of commercialisation. Moreover, commercialisation also involves the widening of the household's market transactions relating to inputs and outputs.

At the farm household level commercialization is measured simply by the value of sales as a proportion of the total value of agricultural output. At the lower end, there would always be some amount of output that even a basically subsistence farmer would sale in the market so as to buy basic essential goods and services. For this reason the ratio of marketed output up to a certain minimum level cannot be taken as a measure of commercialization. If the cut-off level for a certain country is put at, say, 15 per cent, then it is the increase above this level that would be said to measure the extent of commercialization at the farm household level (Gebre-Ab, 2006).

2.7.2 Commercialisation of smallholder farmers

Commercialisation of smallholder farmers implies increased participation, or, rather an improved ability to participate in output markets. In the developing areas of South Africa, like in other developing countries, smallholder farmers find it difficult to participate in markets because of a range of constraints and barriers reducing the incentives for participation to markets and productive assets difficult (Pingali and Rosegrant,1995).

The usual path of commercialization of smallholder agriculture starts with growth in the marketable surplus of staples. This could continue until it becomes the dominant portion of the total output of the household, or, there could be a diversification of the marketed portion into staples and other food crops. Another route consists of combining production of staples for own consumption with production of cash crop

for the market. Both, these routes, or, any variant of them, are the processes that took place in Asia's economic development. A third, and an unusual path is the replacement of subsistence production by cash crop production; a direct switch over from subsistence to market production**.**

According to Gebreselassi and Sharp (2008) Countries like Ethiopia are likely to follow a two-track approach in the commercialization of smallholder agriculture, covering the usual and an unusual route. In the food crop surplus producing areas of the country, households would follow the normal pattern of progressively increasing the portion of marketed surplus in the total output, while in the food deficit areas households would shift towards producing for the market and relying on cash income to procure food crops from the market. These are respectively designated track one and track two hereafter.

The increase in the ratio of marketed output though simple as an indicator of commercialization, carries with it a deeper change in farm household decision-making behaviour. Household decision-making of production and consumption is non-separable in subsistence farming while it is separable in market-oriented farming. What to produce and how to allocate time between labour and leisure is differently decided upon in subsistence and commercialized farming.

The most common form in which commercialization occurs in peasant agriculture is through production of marketable surplus of staple food over what is needed for own consumption. Another form of commercialization involves production of cash crops in addition to staples or even exclusively. To have a marketable surplus over the cut-off ratio of, say, 15 per cent normally involves an increase of household output of staples. This can be attained with the same level of inputs through adoption of best practices (technical efficiency), or with the same production function but greater utilization of the existing family labour (allocative efficiency), or with new technology consisting of production technique or product variety (productivity gains). Similar improvements at the farm level also apply to the introduction of cash (Pingali and Rosegrant, 1995).

2.8 Constraints to commercialization

The transformation from smallholder to commercial agriculture is induced on both the demand and supply side. When the economy grows, urbanization takes place and food demand patterns are consequently diversified, there is an increase in the demand for marketed agricultural output. On the supply side, the opportunity cost of labour employed in the household will increase, when the opportunities to find better-paid off-farm employment increase (Pingali 1997). This process assumes that well-functioning markets are in place, transaction costs are reasonably low and information dissemination is efficient (Pingali 1997).

2.8.1 Land

Land is only one component of the operating environment that encourages commercialization. Given land, farmers should be able to produce, which requires channels for the delivery of knowledge, inputs, and machinery to the farms. In Sub-Saharan Africa private property rights over a land – in the shape of legally recognised titles that can be exchanged in the market place – are less developed than elsewhere in the world. Although there are exceptions (e.g. in Kenya), traditional forms of land tenure still hold sway throughout much of the region.

Understanding the social impact of agricultural commercialisation requires an understanding of these complex systems of property rights and how they affect access to land. Whilst land has historically been an abundant resource in Sub-Saharan Africa (allowing agricultural growth to take place through extensification rather than intensification), rapid population growth is now making land scarce. As a result, new forms of property rights and new technologies are needed if land is to be exploited efficiently and sustainably. However, technological change and land reform creates social tensions and has major social and political ramifications, the nature of which determine whether or not the transition from subsistence-orientated agriculture to commercialised production takes place smoothly and in a way that benefits the poor. Platteau (1996) provides a review of the evolution of land rights in Africa, the social and economic implications, and associated difficulties. He notes that

customary land rights often provide protection for the poor including women and ethnic minorities which formal land titling can erode or eliminate

Land is arguably 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 structures 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 (FAO, 2010). 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 land.

Despite the available land policies, few, if any, smallholder farmers have expanded their farms (Aliber and Hart, 2009). Partly, this may be attributed to increasing agricultural risks faced by the rural resourced-poor smallholders globally (Kisaka-Lwayo and Obi, 2012). These risks may be as a result of introduction of new technologies, change in economic environment and uncertainties resulting from changes in public policies (Spio, 1997; Kisaka–Lwayo and Obi, 2012). In order to reduce risks, farmers diversify by growing several crops on small pieces of land. The diversification consequently has resulted into low subsistence agricultural production, less marketable surplus, low household incomes, food insecurity, unemployment and increased poverty levels (Kisaka–Lwayo and Obi, 2012).

2.8.2 Access to credit

For smallholder farmers access to credit is vital to any production, especially large scale for commercial purposes. This both credit to obtain assets over a longer period and production credit cyclical basis. The land bank played a limited role to finance smallholder farmers (May and Carter, 2009).The key revolves around the ability to bank of the applicant. The basis included that blacklisted creditors find it difficult to obtain reassessment of their status as a result of the inefficiency of the credit bureau

system. Any attempts to obtain loans therefore are unsuccessful because of this inefficiency, many poor people do not have credit references nor have had bank accounts, preferring to deal only cash which they have direct control over, or being part of farming arrangements where much of their has been held by white farmers. Many smallholder farmers do not have fixed employment- they are seasonal workers and rely on a variety of income sources which may not be regular but give them a steady supply of income. A number of their income sources, for example, the child support grant, are not recognized by the bank and thus reduces their total income in the determination of the loan and the ability to bank of the applicant. Smallholder farmers therefore complain that the bank does not seriously seek ways of supporting poor smallholder farmers and are frustrated in their attempts to engage in farming (May and Carter, 2009).

The Land Bank was expected to fill the vacuum created by the demise of homeland parastatals. The mandate of the Land Bank has been broadened to include persons that were previously excluded from enjoying the services the bank provided. Machethe (2005) points out that even though the Land Bank has succeeded in reaching more smallholder farmers with loans, the majority of the farmers still do not have access to land. He goes on to explain that the realisation that insufficient progress has been made with regard to improving access to credit for smallholder farmers has prompted the government to establish the Agricultural Credit Scheme aimed at addressing credit needs of smallholder farmers.

The challenge will be to simultaneously achieve the objectives of improving access to credit for smallholder farmers and ensuring financial sustainability of the scheme. In 2006, the Department of Trade and Industry presented a new Micro-Finance Apex Fund (SAMAF) which will provide seed capital, wholesale finance, and institutional development support to micro credit programs in the so called second economy. The SAMAF model together with the Department of Agriculture came up with a new initiative called Micro Agricultural Finance Schemes of South Africa (MAFISA) aimed at reaching down towards the low end credit market. According to Platteau (1996), it was envisaged that MAFISA would consist of a network of public, private and civil society organisations that work in cooperative based systems to provide financial services to farmers' enterprises and households in rural areas.

2.8.3 Access to markets

According to May and Carter (2009) smallholder farmers producing surpluses often do not have access to markets at whatever scale they are producing. In most of the cooperatives there have been restrictions on the size of undertaking of member. Only producers of a certain size or more could be members. This meant that smallholder farmers are excluded from the benefits of an organized marketing system, from a cheaper source of supplies and other benefits linked to the cooperative. It is the general experience that smallholder farmers do not have access to markets for their produce and have problems in association with the marketing of their produce including among many others, transport to the markets. According to Daily Dispatch (2003), roads in some parts of the Eastern Cape were almost inaccessible and vehicles are kept at huge cost. In main instances trucks could barely be used on the roads and tractors and trailers have to e used to load bales of wool May and Carter (2009)

2.8.4 Lack of support

Characteristics of a successful smallholder farmer are not only determined by what is embodied in the farmer himself, there are other external factors which will affect the success of the smallholder farmers. According to Kirsten, Perret, & de Lange (Undated), policy characteristics such as one sidedness, export orientation, research priorities, low agricultural investment, external influence, role of the price mechanism is underplayed, mediocre support services and lack of continuity in policies have emerged and lead to the conclusion that these policies were not perfectly formulated and applied thus they do not address the targeted problem. In addition, Kirsten et. al (1998) suggests that factors such as information sources, uncertainty and compatibility of the development objectives are factors that led to the Farmer Support Programme being rendered unsuccessful to some extent. It therefore follows that the factors affecting the success of smallholder farmers after intervention start right from the implementation stages of the initiative.

Smallholder farmers are typically severed by ineffective support systems, which do not understand, or take seriously the critical role of vigorous smallholder sector in development. This results in a framework unfriendly to smallholders (Bembridge, 1988). Public sector agricultural support systems have limited experience with smallholder agriculture, inadequately trained professionals, poor financial and human resources, and are backed up by limited research in universities.

2.8.5 Transaction costs

Makhura (2001) elaborated on the concept of transaction costs and explained them as those costs that are embodiment of access barriers by resources poor farmers. These transaction costs include searching, screening, bargaining, monitoring, enforcement and transfer of product. Transaction costs also include physical costs of distance, infrastructure and information and have a tendency of widening the price band between selling and buying.

The high transaction costs of providing formal credit in rural markets imply that the costs of borrowing decline with loan size (Van Zyl, 1995). Many commercial banks do not lend to small farmers because they assume the farmers cannot make profit. Raising interest rates on small loans does not overcome this problem, since it eventually leads to adverse selection. For a given credit value, therefore, the costs of borrowing in the formal markets is a declining function of the amount of owned land. However, the amount of smallholder farmers can borrow for consumption are usually tiny, and often only at high interest rates.

Transaction costs in markets are not frictionless and without cost. The role of transaction costs in completely hindering or limiting the level of smallholder market participation has been examined by several authors (Alene, Manyong, Omanya, Mignouna, Bokanga and Odhiambo, 2008; Barret, 2008) among others. Transaction costs can be classified into two types: fixed and proportional transaction costs (Key et al. 2000). Searching, monitoring, screening etc. are some of the fixed transaction costs. This transaction costs are highly household or commodity- specific, non-

variant with the transaction costs, as the name indicates, are proportional to the volume under transaction (Key, Sadoulet and de Janvry, 2000). Using empirical evidence, Renkow, Daniel, Hallstrom and Karanja (2004) showed that fixed transaction costs in maize- producing semi- subsistence households is one of the major deterrents to market participation. According to these authors, fixed costs were estimated to be 15.5% of the price band in maize market prices.

Since the specific types and levels of transaction costs vary by households, locations, and commodities transacted (Pingali, Khwaja and Meijer 2004), there is no single public or private innovation or intervention that can reduce them. Therefore, it is essential to focus on a variety of integrated arrangements that fit into the existing realities on the ground. Among others, these arrangements could include contract farming (Glover, 1994) and development of smallholder organizations aimed at reducing marketing costs (Govereh, Jayne and Nyoro, 1999; Alene et al. 2008) and costs of inter-market commerce (Barrett, 2008), achieving continuous and reliable supply of marketed commodities produced by smallholders (Dolan and Humphrey 2000), and facilitating market information provision via improved telecommunications (Pingali et al. 2004).

2.9 Advantages of commercialisation

Commercial agriculture has contributed to employment by increasing the demand for hired labour (Bembridge and Williams, 1990). During the peak of harvesting time, commercial farmers do employ temporary labour, in this way income redistribution occurs. Van Rooyen, Vink and Chrisodoulou, (1987) observed that intensive agricultural factors associated with commercial agriculture draws family labour and hired labour back to agriculture, and this is favourable. Also, the development of smallholder farmers occurs by learning skills and adopting technology which is used by commercial farmers.

Commercial farmers also offer economies of scale (Van Zyl, 1995). It provides food for the country. It provides food at both national and international levels (Delgado, 1995). It provides raw materials such as wool, mohair, hides, pelts, horns and hoofs

originate from the agricultural sector (Shackleton, Shackleton and Cousins, 2000). These are processed further (forward linkages) to make household articles and clothing such as shoes, leather jackets, blankets, belts, purses and bags, key holders etc. The horns and hoofs are used for the manufacturing of glue. Other materials rejected in abattoirs and butcheries i.e. unfit for human consumption are used to make fertilizers (backward linkages). Also, some crops such as sunflower produce valuable oils which are extracted and processed to make cooking oil. Perfumes are also by-products from crops such as Pteronia incana (Peter, 2001).

2.10 Role of risk in the commercialization process

The role of risk in a smallholder commercialization process can be seen from two perspectives: before and after shifting from subsistence to semi-commercial production system. First, perceived risks in labour and food markets compel subsistence farmers to stick to the self-sufficiency objectives both in their production and consumption decisions. Second, unreliable and costly food markets and fluctuations in market prices put the relatively market-oriented resource allocation decisions of semi-subsistence households at stake due to less reliability of food markets to guarantee household food security (Von Braun et al. 1994; Govereh et al. 1999). Reserving the discussions on the overall impact of risk on household resource allocation decisions for Section 7, this subsection briefly discusses why risks are higher under commercialized agriculture and what implication this has on the overall commercialization process.

Agricultural commercialization leads to a more specialized pattern of production at a household level (Timmer 1997). A specialized production by its nature is highly susceptible to the risks of fluctuating prices and yields which results in fluctuating household income. To continue the commercialization process under unforeseen income shocks, either credit markets have to be easily accessible or semi-commercial households have to put some of their good-year income in a form of quasi-liquid assets for consumption smoothing in a bad year. To mitigate risks related to smallholder commercialization and keep households in the move towards a fully commercialized agriculture, Timmer (1997) stressed that governments have to play a crucial role in designing and implementing the necessary policy measures that

could help smallholders in designing their own risk-management and risk-sharing strategies.

2.11 Sources of risk

Considerable studies have been conducted to identify the sources of risk that affect agricultural producers. Flaten, Lien, Koeslig, Valle and Ebbesvik (2005) argue that smallholder farmers are exposed to additional and different sources of risk compared to commercial farmers. Le Cheong (2010) conducted a study on cat fish farmers to get an understanding of farmer's perception of risk and risk management strategies in catfish farming. The results suggested that, the price and production risks were seen as the most important sources of risk. Salmonu and Falusi (2009) examined the sources of risk in Nigeria for the last three years, and the study identified the five major sources of risk which were classified as market failure, price fluctuations, drought, pest and disease attack and erratic rainfall as the most important sources of risk affecting food crop farmers in Nigeria. Some of the sources were crop diseases, bush fire out break and flood disaster. These had effect on the reduction in farmers' productivity, reduction in farmers' income and food shortage.

Meuwissen, Huirne and Hardaker (2001) studied farmers' perception of risk and risk management strategies among livestock farmers and the results revealed that price and production factors were perceived as the important sources of risk. Insurance schemes were perceived as the relevant strategies to manage risks. Output price and cost were ranked as the highest among the production and financial risks of California agricultural producers (Blank and McDonald, 1995). Irregularity in input availability, fluctuations in market prices, and irregularity in water supply and variability in weather conditions were also identified as major sources of risk responsible for variation in farmers' income in dry season farming.

Many factors including vagaries of nature, diseases, insect infestations, general economic and market conditions contribute to the price, yield or net return variability of agricultural producers (Ostotimehi, 1996). According to Kinsey, Burger and Gunning (1998) harvest failures were identified as major sources of risk of rural households in a resettlement area in Zimbabwe. A few studies have found out that

geographic location, farm type, institutional structures, and other factors affecting the operating environment of farmers influenced farmers' perception of risk and risk management. The study also revealed the complexity and individualistic nature of risk perceptions and selection of management tools (Wilson, Dalhran and Conklin 1993).

2.12 Sources of risk among South African farmers

Studies conducted in south Africa were used to identify the perceived importance of multiple risk sources include studies by Hardman, Darrock, and Ortman (2002), Woodburn, Ortman and Levin (1995). The study by Woodburn et al (1995) was to determine risk sources and strategies, the study suggested that crop gross income, government policy, livestock gross income, credit access, government regulation and costs as the source of risk. Stockil and Ortman (1997) conducted a survey on the perception of risk among commercial farmers and analyzed the importance and dimensions of risk sources. The study concluded that the changes in costs of farm inputs, government legislation (tax, labour, and land redistribution). The rand exchange rate and product prices were the most important sources of risk. The analysis showed that risk exists, including changes in government policy, enterprise gross income, credit access and cost changes.

A similar study among vegetable farmers was conducted in Kwazulu Natal by Bullock, Ortman and Levin (1994) and identified price, climate and yield variability as the major sources of risk in vegetable production. The results showed that governmental policies added to the level of uncertainty faced by vegetable farmers. A comparative analysis among small and large farmers showed differences in their perceptions of risk. Small farmers perceived changes in credit availability and changes in input costs to be more important risk sources than large farmers, while large farmers are more concerned with changing interest rates. Another study revealed that sources and responses to risk in farm production, marketing and financing. The main sources of risk were considered to be varieties in livestock production, rainfall and livestock prices, the threat of land reform, and changes in input costs.

2.13 Risk management strategies

Farmers perception of and responses to risk are important in understanding their risk behaviour (Flaten et al., 2005). Beal (1996) stated that it is to be expected that management strategies adopted by farm managers reflect their personal perceptions of risk and managing such risks is critical for the long term success of individuals and economic systems alike. The specific strategies through which food producers attempt to control risk, however, are varied and diverse. Some combination of diversification and intensification methods for risk management may be employed in a given area, community, or household and neighbouring groups may choose different mechanisms for risk reduction when faced with practically identical subsistence challenges (Hendrich and Mc Elreath, 2002). Risk management can be defined choosing among alternatives to reduce the effects of risk. This requires an evaluation of tradeoff between the changes in risk, expected returns and entrepreneurial freedom among others. For an individual farmer, risk management involves finding the preferred combination of uncertain outcomes and varying levels of expected returns (Boehlje and Lins, 1998). Risk management strategies can reduce the exposure of the farm business such as enterprise diversification; transfers risk to another party through outsourcing certain aspects of the farm operations, such as production contracting, or improve the farmers' capacity to bear risk, such as maintaining liquidity assets (Scarry, 2008). Risk management cannot be viewed as a "one size fits all" action. Several key decision making criteria that play into the risk management planning process include the goals established from the operation, the risk bearing ability of the farm and the managers' attitude towards risk. Each one of these will be different for individual family members and each farming unit (Wilson, et.al, 1993).

The United States Department of Agriculture (USDA) (2000) in a review of risk management strategies used by US farmers established that while enterprise diversification can be efficient for risk reduction for smaller farms it is not necessarily the case for large farms and wealthier operators. The degree of diversification in farming also varies significantly across regions and farm sizes. The reason that

could account for this situation are the differences and limitations in farm resources, expertise, market out let, weather conditions and farmers risk aversion(Harwood, 1999). Alderman and Paxson (1994) presented a whole range of strategies and distinguished between risk management strategies and risk coping strategies. Each category involves a number of specific actions but can be summarised as in Fafchamps (1999). He classified them into 1) to reduce exposure to shocks ex-ante 2) to cope with shocks ex-post (fate), rural households use self assurance via precautionary savings, borrowing, liquidation of assets, smoothing consumption, labour sales and solidatory through risk sharing networks.

When farmers do not have or when they are not willing to sell their productive assets, they increase their labour supply. This includes being engaged in nonfarm activities during less extreme conditions, using child labour and labour bonding during extreme conditions (Fafchamps, 1999). De Weerdt and Dercon (2006) found that risk sharing is mainly achieved through private gifts, private loans and labour transfers. However, risk sharing among households from the same village will not adequately insure them against covariate risks like hurricane, drought or other negative shocks that have a positive covariance between households such as price shocks. All households in the same area are affected at the same time. Therefore, nobody from the same area can help each other. Assistance has to come from outside the affected area.

Although traditional risk management strategies mitigate only a small part of overall risk (Alderman, 2008) in the absence of insurance and financial markets, households use a combination of these strategies as substitutes to deal with agricultural risks. According to Tomek and Hikaru (2001), farmers are assumed to select a combination of strategies, for example, maximize net expected returns (profits) subject to the degree of risk they are willing to accept clearly, risk management strategies in agriculture vary with farm characteristics and the risk environment. Farmers risk perception, risk attitudes, objectives as well as the available resource base, influence their decisions and actions.

2.14 Analysis of smallholder farmers risk preferences in developing countries

Dillon and Scandizzo (1978) measured the risk preferences for 103 subsistence farmers in Brazil. Mind experiments involving choice between risky and sure farm alternatives were used to assess risk attitudes of samples of small farm owners and sharecroppers in Brazil. According to Dillon and Scandizzo (1978), results indicate that most subsistence farmers are risk averse, and that risk aversion tends to be more common and perhaps greater among owners than sharecroppers. In an expected utility context, distribution of risk attitude coefficients (based on mean-standard deviation, mean-variance, and exponential utility functions) was diverse and not necessarily well represented by an average sample value (Dillon and Scandizzo, 1978). Further, econometric analysis done by regressing the risk preference against various socioeconomic variables indicated that income level and other socioeconomic variables influenced peasants' risk attitude.

Binswanger (1980) conducted a field experiment with 330 farmers in rural India for both real and hypothetical gambles using lottery choice tasks. When payoffs were small, about half the respondents were in the intermediate and moderate risk-aversion categories. Binswanger‘s (1980) study found that nearly a third of the respondents were close to risk-neutral or risk-loving, and less than 10% were severely risk-averse. However, as payoffs rose, nearly 80% of the subjects displayed moderate risk-aversion, and risk-neutral or risk-loving behavior almost disappeared. Arrow's prediction held - absolute risk-aversion declined as payoff increased. Here an individual's willingness to accept small bets of a fixed size increased as wealth increased (Arrow, 1971). However, contrary to Arrow's hypothesis, the subjects also displayed decreasing relative risk aversion (Binswanger, 1980).

A series of laboratory experiments were conducted in China by Kachelmeier and Shehata (1992) to elicit people's certainty equivalents for a sequence of lotteries. Ten sessions were conducted with 185 student volunteers at Beijing University. The study differed from Binswanger's (1980) in that here, subjects were not asked to choose between lotteries. Rather, certainty equivalents were elicited for individual

lotteries. Several percentages depicting different win levels were used (not just the uniform 50-50% chances that Binswanger (1980) used). Subjects were presented with a lottery involving a prize of value G with probability P, and zero with probability (1-p). If the subject drew a card with a number less than or equal to p, they were awarded the prize. Kachelmeier and Shehata (1992) found that the average ratios of certainty equivalents to expected values for the high-prize trials were systematically lower than the ratios for low-prize trials, across win percentages. Once again, there was a marked trend from risk-loving or risk neutral preferences to risk-averse, as payoffs increased.

Holt and Laury (2002) presented subjects with simple choice tasks that may be used to estimate the degree of risk aversion as well as specific functional forms. They conducted this experiment under both real and hypothetical conditions, using a menu of paired (Option A and option B) lottery choices, similar to Binswanger (1980). The payoffs for Option A, $2.00 or $1.60, were less variable than the potential payoffs of $3.85 or $0.10 in the "risky" option B. The probabilities were explained using throws of a ten-sided die, and ranged between 1/10 and 10/10(sure win). Holt and Laury (2002) controlled for wealth effects between the high and low real-payoff treatments, by subject being required to give up what they had earned in the first low-payoff task in order to participate in the high-payoff decision. Results from Holt and Laury (2002) showed that most subjects chose the safe option when the probability of the high payoff was small, and then "crossed over" to option B, almost never returning to A. A few more returned in the hypothetical treatment. Once again, the subjects showed increasing degrees of risk-aversion in the high-payoff treatments than the low-payoff treatments.

This result is qualitatively similar to that reported by Kachelmeier and Shehata (1992) and Smith and Walker (1993) in different choice environments. The results indicate that most individuals are risk averse with little variation according to personal characteristics, although wealth has a slight negative effect on risk aversion especially at low pay offs (Holt and Laury, 2002). Distribution of risk aversion was more widely spread at low levels and for hypothetical gambles, suggesting at higher pay offs one is more likely to elicit true risk preferences. The results support the

hypothesis of increasing partial risk aversion with increasing payoff levels similar to Bas-Shira et al. (1997).

2.15 South African research on farmers risk preferences

Lombard and Kassier (1990) conducted a study on risk preferences of farmers in South Africa and found the degree on intertemporal stability in risk attitudes varied between the specified income levels and there seemed to be a negative relationship between the accuracy of the risk interval on the one hand and the consistency of choice on the other hand. The response to two control questions indicated a varying degree of consistency at each income level. Risk averse, risk seeking and risk indifferent attitudes are observed (Lombard and Kassier, 1990).

In their study Meiring and Oosthizen (1993) measured irrigation farmers' absolute risk aversion coefficient by means of the interval approach. The study analysed the influence of adjustment of the absolute risk- aversion scale, as well as the cumulative distributions on respondents' risk preferences. The consistency of risk-attitudes was also determined. Results of elicitation of risk preference established that majority of farmers is extreme risk preference: either risk- seeking or risk aversion. They further established that, the decision makers who completed who completed the questionnaire at the higher levels of bank balances were more constant than those who complete the questionnaire at lower levels. If the width, over which the distributions extend, increases, the preferences of a few farmers tend to change risk- neutral to risk- averse. Meiring and Osthuizen (1993) concluded that by propagating the concept of probability distributions for the evaluation of risky alternatives, a better understanding of risk and risk management can be brought about, which will result in easier obtaining of risk measuring results.

2.16 Conclusion and Chapter summary

Risk and uncertainty are perceived as characteristics of agricultural production. They could arise due to biophysical factors such as inconstant weather events, diseases or pest infections (Adesina and Brosen, 1987). Other factors such as changing economic environment, introduction of new technologies or crops, and uncertainties

surrounding the public institutions and their policy implementation also combine with these natural factors to create a surplus of yield, price and income risks for farmers (Anderson, Dillon, and Hardker, 1985).

There are many obstacles to the growth of smallholder agriculture. One of the obstacles is the persistence to antiquated production technologies because farmers do not adopt to technologies whose benefits are do not well demonstrated and they do not see any incentives to adoption to improved practices.

The importance of agricultural economics research is argued due to the fact that risk and uncertainty are quintessential features in agriculture. The terms are closely entwined to any decision making framework. The different opinions on the importance of risk and uncertainty are argued by various authors. There are different sources and types of risk in agriculture broadly characterised into business and financial risk. These are defined in detail. A review of literature on farmers' source of risks globally and in South Africa is presented. The findings suggest that risks and risk management strategies vary across regions and farm types. As a result modelling should be adopted to the unique conditions of the domain being investigated and go beyond price and yield risks. The agricultural risk management strategies are aimed at mitigating against risk faced by farmers. The literature established that risk management include, exposure of the farm business risk, transferring risk to another party or improving the farmers capacity to bear risk. The chapter concludes by addressing the different methods of measuring risk preferences of agricultural producers, the criticisms and advantages of using such methods.

CHAPTER 3

UTILITY THEORY AND THE MEASURE OF RISK AVERSION

3.1 Introduction

Risk is quintessential in agricultural activities and central to any decision making framework on new agricultural technology adoption. The case of the passage from homestead to smallholder farming exemplifies how a better understanding of risk may provide relevant contributions to fill that frequent gap between technologists and farmers in the evaluation of the possibilities to adopt and upgrade agriculture technologies necessary to achieve a more sustainable agriculture. This chapter commences with the overview of the utility theory and it further explains expected utility theory as defined by Von Neumann and Morgenstern is explored and the measures of risk aversion commonly used in the literature examined. The need to adjust the Arrow Pratt Absolute Risk Aversion is argued with supporting literature and the three common methodologies for eliciting farmers risk preferences are reviewed

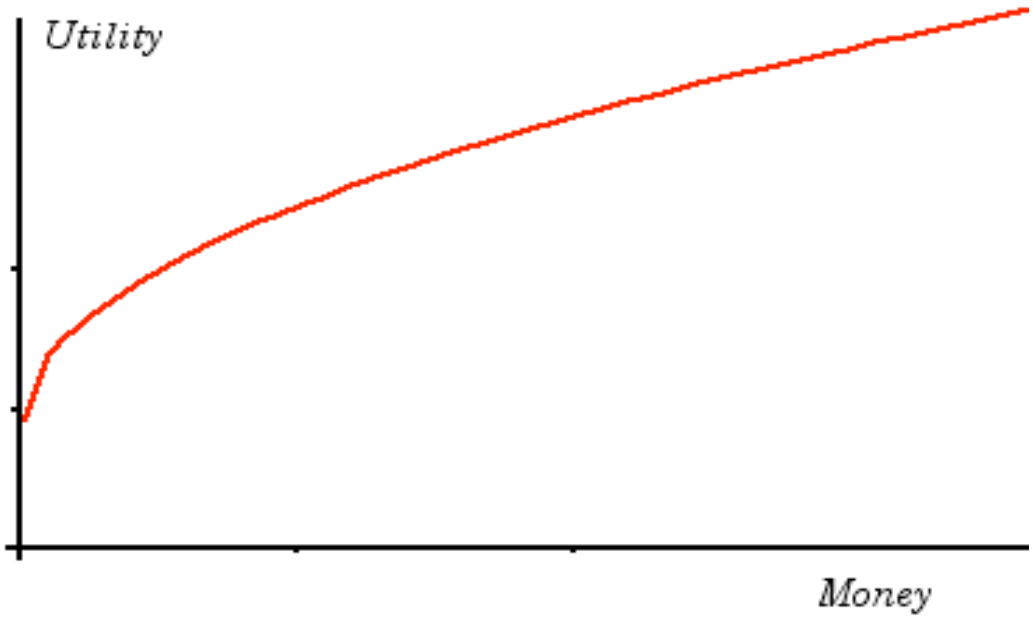
3.2 Utility theory

Utility theory traces its ancestry back to the efforts of economists and mathematicians to develop an applicable theory of how a rational person ought to behave in the face of uncertainty and how, in fact, such a person does act. It was thought for a time that in economic situations people would act to maximize the expected value of money that would accrue to them. Thus the gamble of winning $10 if a fair coin lands heads and winning nothing if it lands tails shows an expected value of

(1/2)($10) + (1/2)($0) = $5.

The rational man, under such a theory, should behave toward this gamble as if it were worth $5.It eventually became apparent that there are many instances when

this idea is not applicable. Daniel Bernoulli (1700-1782), a member of the illustrious Swiss family that produced eight mathematicians in three generations, presents one: "Let us suppose a pauper happens to acquire a lottery ticket by which he may with equal probability win either nothing or 20,000 ducats. Will he have to evaluate the worth of the ticket as 10,000 ducats; and would he be acting foolishly, if he sold it for 9,000 ducats?" In a paper written in 1790, Bernoulli explored the idea that the utility of money— not it's actual value — is what people attempt to maximize. He argued that the utility of a fixed amount of money was different for a pauper than for a rich man. A single dollar is more precious to the poor man than to the millionaire; the poor man would feel the loss of a dollar more than the rich man. The difference in the utilities of $10 and $11 is greater, Bernoulli believed, than the difference in the utilities of $1000 and $1001. In general, a fixed increase in cash results in an ever smaller increase in utility as the basic cash wealth to which the increase is applied is made larger. In mathematical terms, this says that the graph of utility as a function of money is concave.



3.2.1 Graphical representation of the utility curve
Figure 3.1 utility curve

The graph above illustrates the utility of money as a function of amount of money. Each increase in money increases utility, so the function is monotonically increasing. Fixed increases in money bring smaller increases in utility as money increases. Thus, the rate of change of utility is negative and the graph of function must be concave down.

3.2.2 Mathematical representation of utility

According to a standard (Mas-Colell et al., 1995) theoretical microeconomics text, the definition of a utility representation function is the following:
A function *u:X -> R* is a utility function representing preference relation >~ if, for all *x, y* in *X, x >~ y <=> u(x) >= u(y).*
R is the set of real numbers,
X represents some set of alternatives,
x and *y* are possible alternatives, and
x >~ y means that "the consumer" values x at least as much as y.

The various representation theorems deal with proving properties of u given certain properties of the preference relation >~. For example, given so-called rationality conditions on the preference relation (e.g. completeness, transitivity), then it can be proved that a continuous representation function u exists. Further conditions can be used to establish differentiability and other properties. However, these proofs are beside the point. The only thing they establish is that such a function exists, not that there is any equivalence between the preference relation and the utility function "representing" it. In other words, they merely permit one to *restate* in mathematical terms the verbal conditions expressing preference. They in no way establish equivalence between the utility function and the preferences, and so any results derived from the mathematical manipulations of the representation function cannot necessarily be applied to the preferences themselves.

3.3 Expected utility theory and the measure of the risk aversion of producers

Expected utility theory (EUT) was defined by Von-Neumann and Morgenstern (1944) to explain the reasons behind individual choices involving risk. Since then EUT has been the basis for much of the decision-making theory (Gomez-Limon, Arriaza and Riesgo, 2003) and has the support of most agricultural economists (Schoemaker, 1982; Robison and Hanson, 1997). All theoretical aspects of EUT related to agricultural economics have been discussed in classic works such as those of Hardaker et al. (1997), Robison and Barry (1987), Anderson et al. (1985) and Barry (1984). The theory assumes that there is a utility function U that assigns a numerical value to each alternative. As most economic decisions are expressed in monetary terms, the utility function may have wealth as argument (U (W)), measuring the satisfaction obtained from a given amount of money. However, the satisfaction from either a gain or a loss *(U(X))* may also be used (Hardaker et al., 1997). In doing so, EUT allows the ranking of alternatives within the context of risk.

The seminal works of Arrow (1965) and Pratt (1964) paid attention to one of the key elements of decision theory (the measure of risk aversion of the economic agents). Arrow (1965) and Pratt (1964) proposed two indicators that overcame the limitations in the use of a cardinal utility function in order to compare differences in risk attitudes. As such, the Arrow Pratt measure of risk aversion for von Neumann-Morgenstern expected utility function have been used extensively to analyse problems in the micro economics of uncertainty (Ross, 1981). The risk aversion concept in based on the behaviour of individuals whilst exposed to uncertainty. It is the reluctance of an individual to accept a bargain with an uncertain payoff rather than another bargain with more certain, but possibly lower, expected payoff (Gill, 2007 and Levy, 2006). The Expected Utility (EU) theory essentially defines risk aversion in terms of the concavity or convexity of the decision maker¡¥s utility function at any particular point (Cox and Sadiraj, 2006; Eisenhauer, 2006). Friedman and Savage (1948) showed that the local concavity or convexity of to von Neumann-Morgenstern expected utility function *u(x),* indicates the local risk preference of a decision maker.

A decision maker is described as locally risk averse (concave utility function), risk neutral (linear utility) function or risk loving (convex utility function) for a particular outcome level if *u"(x) < 0; =0; or > 0* respectively where *u"(x)* is the second derivative of u *(•)* of the expected utility model of Von Neumann and Morgernstern (1944) which has recently been generalised by Machina (1982). This measure merely indicates the decision makers risk preference, but is not an appropriate measure of risk aversion as *u"(x*) is affected by the linear transformation of *x*, and consequently its magnitude provides no insight into the severity of the risk attitudes (Rabin and Thaler, 2001; Rabin, 2000; Pratt, 1964). Arrow (1971) and Pratt (1964) independently developed equivalent measures of risk preferences that allow for comparisons of interpersonal preferences- the Arrow-Pratt absolute and relative risk aversion coefficients. Arrow developed them from the probability premium (Babcock, Choi and Feinerman, 1993), whilst Pratt worked from the risk premium (Pratt, 1964). A third and relative measure of risk aversion is the partial risk aversion coefficient developed by Menezes and Hanson (1970). These measures are invariant to positive linear transformations of *x*. A decision maker is defined as risk averse, neutral or risk loving if these measures are less than, equal to, or greater than zero (Menezes and Hanson 1970; Pratt 1964).

3.3.1 Arrow-Pratt measure of Absolute Risk Aversion (ARA)

Also known as the coefficient of absolute risk aversion, mathematically the coefficient for the ARA is calculated as:

$$A(W) = -\frac{U''(w)}{U'(w)}$$

$$A(W) = A(x) = -\frac{U''(x)}{U'(x)} \qquad \text{---------- (1)}$$

Where *w* indicates total wealth and *U*'' and *U*' indicate the second and first derivatives of the von Neumann-Morgenstern utility function, respectively. The measure of ARA is appropriate to describe situations in which total wealth has a fixed stochastic part- income and a variable non stochastic part- initial wealth (Bar-Shira, Just and Zilberman, 1997). Arrow (1971) pointed out that it is natural to hypothesize that the individual's willingness to undertake a certain risky project is

greater when he or she is wealthier. In other words, wealthier individuals should have a greater amount of risky assets in their portfolio. Thus the measure of ARA should decrease with wealth.

The coefficient *A(w)* takes either positive or negative values for risk-loving or risk averse economic agents respectively. When the coefficient decreases as monetary value increases we have Decreasing Absolute Risk Aversion (DARA). Alternatively, if the coefficient increases under the same set of circumstances we have Increasing Absolute Risk Aversion (IARA). Finally, if the coefficient does not change across the monetary level, the decision-maker exhibits Constant Absolute Risk Aversion (CARA), which implies that the level of the argument of the utility function does not affect his or her decisions under uncertainty (Menezes and Hanson, 1970); Pratt, 1964). Since *A(w)* is not a non-dimensional measure of risk aversion, its value is dependent on the currency in which the monetary units are expressed. To overcome the impossibility of comparing risk aversion among different economic agents Arrow (1965) and Pratt (1964) devised a non-dimensional measure called the Relative Risk Aversion (RRA) coefficient.

3.3.2 Arrow-Pratt measure of Relative Risk Aversion (RRA)

Also known as the coefficient of relative risk aversion, mathematically the coefficient for the RRA is calculated as:

$$R(w) = -\frac{u''(w)}{u'(w)} = wA(w) = wA(x) \quad \text{---------- (2)}$$

In situations where both the stochastic and non stochastic components of the wealth are changing proportionally, the appropriate measure is R(*w*). Arrow's (1971) hypothesis is that when both initial wealth and the risky project are increased by the same proportion, the individual's willingness to undertake the risky project is smaller. In other words, wealthier individuals should hold a smaller portion of risky assets in their portfolio. The R*(w*) coefficient measures the percentage change in marginal utility in terms of the percentage change in the monetary variable. Hence, relative risk aversion represents the elasticity of the marginal utility function which ranges

from 0.5 (slightly risk averse) to 4 (extremely risk averse). Anderson and Dillon (1992) classify agricultural producers according the R (w) coefficient. Although most authors consider values above 5-10 very unlikely (Kocherlakota, 1996), some studies report values of up to 30 (Kandel and Stambaugh, 1991). According to them, these values can be reasonable when the alternatives in place represent a gain or loss of 1% of the total wealth. As with the absolute risk aversion coefficient, there is Decreasing Relative Risk Aversion (DRRA), Constant Relative Risk Aversion (CRRA) or Increasing Relative Risk Aversion (IRRA) behaviour (Menezes and Hanson, 1970; Pratt, 1964).

3.3.3 Measure of Partial Risk Aversion (PRA)

Also known as the coefficient of partial risk aversion, mathematically the coefficient for the PRA is calculated as:

$$P(wo, \pi) = -\frac{[u''(Wo + \pi)]}{[u'(wo + \pi)]} \quad \text{---------- (3)}$$

Where

Wo denotes non stochastic initial wealth, and

π denotes stochastic income

At the point ($w = wo + \pi$), PRA is related to the measure of ARA and RRA as follows:

$$P(wo, \pi) = \pi A\ (wo + \pi)$$

$$P(wo, \pi) = R(wo + \pi) \quad \frac{\pi}{wo+\pi} \quad \text{---------- (4)}$$

The measure of partial risk aversion is unit less and appropriate to describe situations in which initial wealth is fixed and income is variable. Bar-Shira, et al. (1997) show that Decreasing Absolute Risk Aversion (DARA) implies Decreasing Partial Risk Aversion (DPRA) with respect to initial wealth and that Increasing Relative Risk Aversion (IRRA) implies Increasing Partial Risk Aversion (IPRA) with respect to income. The opposite does not necessarily hold. It is possible to have DRRA and IRRA at the same time. Menezes and Hanson (1970) alludes that partial

risk aversion examines behavior when the prospect changes but wealth remains the same. Increasing Partial Risk Aversion (IPRA) implies a decrease in the willingness to take a gamble as the scale of the prospect increases.

3.4 Using ARA to measure the decision makers risk aversion

The Absolute Risk Aversion Coefficient defined as $A(x) = -u''(x)/u'(x)$ has appeared extensively in literature (Just, 2011; Bar-Shira, et al., 1997; Chavas and Holt, 1996). Although the ARA are invariant to linear transformations of the u (King and Robison, 1981) they are not invariant to arbitrary rescaling of x or a change in the range and scale of x (Raskin and Cochran, 1986), rendering ARA neither employable in secondary studies, nor comparable between studies without prior adjustments (Just, 2011). The Initial work of Pratt (1964) best demonstrates the impact of both scale and range on ARA *[A(x)]*. According to Pratt (1964), to measure a decision maker's local aversion to risk, it is natural to consider his risk premium for a small, actuarially neutral risk $\check{y}$.

Pratt (1964) developed a relationship between risk premium, the variance of the risky prospects and ARA as being:

$$\Pi(x, \check{y}) = \frac{1}{2}\sigma_y^2 A(x) + o(\sigma_y^2) \quad \text{---------- (5)}$$

Where:

$\Pi(x, \check{y})$ is the risk premium given a level of wealth and a risky prospect;

σ_y^2 is the variance of the risky prospect;

$A(x)$ is the Absolute Risk Aversion at level of wealth x; and

$\sigma(_y^2)$ are the higher order terms in the Taylor series expansion of the expected utility function around the mean of x

Solving for $A(x)$ in equation 5 yields:

$$A(x) = \frac{2[\pi(x,\check{y}) - 0(\sigma_y^2]}{\sigma_y^2}$$ ---------- (6)

If, following Tsiang (1972) the dispersion of the risk prospect is assumed small relative to wealth, then $(\sigma_y^2)/\sigma_y^2$ may be neglected.

Thus, *A (x)* is approximately given by:

$A(x) \approx 2\pi(x, \check{y})/\sigma_y^2$ ---------- (7)

This exposition is similar to that presented by Mc Carl and Bessler (1989) as part of their discussion on estimating an upper bound on the ARA when the utility function is unknown. The exact and approximate expression of *A(x)* clearly indicates that *A(x)* is dependent on both *x* and the risk situation, $\check{y}$. Thus the ARA has associated with it a unit, the reciprocal of that unit with which $\check{y}$ is measured since the certainty equivalent is divided by the variance of $\check{y}$. Because σ_y^2 and $E(\check{y})$ affects *A(x)*, the magnitude of *A(x)* is not affected by the use of incremental rather than absolute returns, or vice versa.

Furthermore it is apparent that the change in σ_y^2 will affect ARA. For example a mean preserving increase in risk i.e. σ_y^2 increases whilst *x* and the expected value of $\check{y}$ remain constant will decrease *A(x)*. This discussion provides an explanation to McCarl's(1988) concern that if the magnitude of ARA is unaffected by use of incremental rather than absolute terms as hypothesized by Raskin and Cochran (1986) then one could abandon the wealth concept and only look at income. Cochran and Raskin's (1987) reply agrees with McCarl (1988) without explaining how ARA are a function of both initial wealth and stochastic income.

Given the sensitivity of ARA to the scale of data as well as the range of data it is somewhat surprising that ARA have appeared in so many publications without also providing sufficient information about the source of the ARA coefficients or the range and scale of stochastic wealth to allow comparisons with other studies (Cochran, et al., 1985; Collender and Zilberman, 1985; Danok, McCarl and White ,1980; Holt and Brandt, 1985; King and Oamek, 1983; King and Robinson, 1981; Tauer, 1986; Ye and Yeh, 1995; Zacharias and Grube, 1984).

Arrow Pratt Risk Aversion coefficients are expressed in several studies to five decimal places and ranges from 12.17 (Chavas and Holt, 1996) and 6.0 (Meyer, 1977) to .000000921 (Collender and Zilberman, 1985). Cochran (1986) stated that it "appears reasonable to expect that the preferences of the majority of farmers will be represented with the interval -.0002 to .0015 when measured at after tax net farm annual income levels" However Raskin and Cochran (1986) demonstrate that a pair of decision makers exhibiting seemingly close values of *A(x*) such as .0002 and .0003, respectively, would disagree on the value of the 10,001st dollar by a factor of three and on the value of the 50,001st dollar by a factor of 160. This demonstration emphasizes that researchers should not underestimate the importance of scale.

The need for the explicit specification of the unit of the Arrow-Pratt Risk Aversion might arise when elicited values are used outside the context of the original study (Mac Nicol, 2007; Just, 2011). If a risk aversion coefficient elicited over an outcome space measured in one unit is later applied over outcomes measured in another unit, it must be converted by the appropriate factor (Ferrer, et al., 1997). Raskin and Cochran (1986) propose 2 theorems to guide the approximation to necessary conversions:

THEOREM 1 *A(x) =r(x), Let r(x) = -u''(x)/u'(x). Define a transformation of scale on x such that w =x/c, where c is a constant, x is the outcome variable and w is a wealth level. Then r(w) = cr(x).*

THEOREM 2 *A(x) = r(x). If v = x + c, where c is a constant, and v is a wealth level, then r(v) = r(x). Therefore, the magnitude of the risk aversion coefficient is unaffected by the use of incremental rather than absolute returns (or vice versa).*

The notion that range affects Arrow-Pratt Risk Aversion is not new, Wiesensel and Schoney (1989) stated that Arrow-Pratt Risk Aversion elicited from different income levels is not directly comparable. The notion that range affects Arrow-Pratt Risk Aversion is also implied in Mc Carl and Bessler's (1989) approach of estimating an upper bound on Arrow-Pratt Risk Aversion when the utility function is unknown. Kachelmeir and Shehata (1992) also suggested that risk preferences be measured as the ratio of the certainty equivalent to the equivalent value of the income distribution to permit comparison of risk preferences across lotteries of different range.

Feinerman and Finkelshtain (1996) used a similar approach based on the probability premium. These approaches have a drawback in that results cannot be directly applied to some stochastic efficiency techniques, e.g. mean-variance programming models and stochastic dominance with respect to a function. Babcock, et al. (1993) also note that when the range of wealth distributions varies, the risk premium, expressed as a proportion of gamble size (amount of wealth at risk) and the probability premium convey more information on risk preference than does Arrow-Pratt Risk Aversion. Consequently Eisenhauer (2006) advocates consideration of these measures when selecting Arrow-Pratt Risk Aversion coefficients to demonstrate the effects of risk preferences on decisions. It is apparent from the range of Arrow-Pratt Risk Aversion elicited, borrowed and assumed, even in recent studies that many agricultural economists are unaware of the impact of range on Arrow-Pratt Risk Aversion e.g. Bar-Shira et al. (1997), Chavas and Holt (1996), Saha et al. (1994b), Pope and Just (1991), Chavas and Holt (1990), Lins, Gabriel and Sonka (1981). Despite this suggested amendments to Raskin and Cochran's(1986) first theorem, not all risk situations may easily be adjusted to be represented in terms of Rand income or wealth to enable comparison or analysis e.g. in environmental risk (Just and Pope, 2003). An approach is suggested entailing standardization of the data to uniform scale and range prior to calculating an adjusted Arrow Pratt Absolute Risk Aversion coefficient *(ƛ*)* (Nieuwoudt and Hoag, 1993).

The approach outlined by Nieuwoudt and Hoag (1993) may be extended to multivariate utility analysis and applied to environmental analyses where say both wealth and environmental risks may be important. Elicited values are consistent with the absolute risk aversion matrix, R, derived by Duncan (1977) and defined by: *R(x) = [-Uij /Ui- R*] provides a complete representation of an agent's risk preferences for multiple attributes that is consistent with the Arrow Pratt Absolute Risk Aversion coefficient. The diagonal elements represent the agent's absolute risk attitudes with respect to the *ith* risky attributes.

Whilst Raskin and Cochran (1986) have successfully made agricultural economists aware of the effects of the scale of data on the Arrow-Pratt Risk Aversion many still seem unaware of the effect of range. This discussion has focused on the abilities of the Arrow-Pratt Risk Aversion to convey information about risk aversion assumptions or measurements in research programs. It is shown that an amendment is necessary

for Raskin and Cochran's (1986) first theorem if Arrow-Pratt Risk Aversion is to be adjusted for the range as well as the scale of data. It is imperative that sufficient information regarding the risk situation and the population are reported with elicited risk preferences (Ferrer and Nieuwoudt, 1997). Hence it is important that risk preferences should be reported in a consistent manner such that studies can easily be compared to one another.

3.5 Methods for measuring the risk attitudes of agricultural producers

Several approaches have been used to assess smallholder farmers' risk attitudes. According to Robison, Barry, Kliebenstaein and Patrick (1984), Lins et al.(1981) and Young (1979), there are three basic methods of measuring the attitudes to risk of agricultural producers: i) Direct estimation of the utility function (DEU); ii) Experimental methods (EM); and iii) Observed economic behaviour.

- Direct estimation of the utility function (DEU): This method involves direct interaction with the decision-maker, with the interview procedures designed to determine respondents' points of indifference between certain outcomes and hypothetical risky options. Respondents' preferred choices among alternative options are thus considered to be indicative of their risk preferences. Empirical application of the DEU approach includes Hardaker et al. (1997), Abadi Ghadim and Pannell (1999) and Feinerman and Finkelshtain (1996).

  The DEU method has been criticized as being prone to interviewer bias if conducted using hypothetical rather than real lotteries (Binswanger, 1980), subjectivity involved in the identification of the functional form of the utility function, preferences for specific probabilities (for example a 50:50 bet), confounding from extraneous variables, and negative preferences towards gambling (Young, 1979). Although risk preferences elicited using EM may be more reliable than those elicited using DEU methods (Gunjal and Legault, 1995), budgetary restraints may preclude the researcher from asking meaningful questions (Kachelmeier and Shehata, 1992), in which case use of DEU may be preferred to EM.

- Experimental methods (EM): This can be regarded as a variant of the DEU method, in which real gambles/bets are used instead of hypothetical gains and losses and from their responses, derive the respondents'utility function. Because this approach requires that financial compensation is paid to respondents as a function of their responses to each gamble, this approach has generally been carried out in populations with low per capita income and wealth, example Miyata (2003) in Indonesia, Grisley and Kellog (1987) in Thailand and Binswanger (1980) in India.

- Observed economic behaviour: This method was developed in order to represent risk behaviour, tuning the models to fit actual data by adjusting the risk aversion coefficients, usually along with other coefficients. Furthermore, these models rely on either production theory under uncertainty (econometric models) or cropping pattern selection (mathematical programming). Bar-Shira et al., (1997), Chavas and Holt (1996, 1990); Saha et al. (1994); Pope and Just (1991); Myers (1989), Moscardi and Janvry (1977) and Wolgin (1975) present good examples of the first category, while for the latter we have Brink and McCarl (1978) and Wiens (1976).

This approach is criticised for confounding risk behaviour with other factors such as resource constraints faced by decision makers (Eswaran and Kotwal, 1990), thus making an individual appear more risk averse than he/she truly is (Binswanger, 1982). This is particularly important in developing countries where market imperfections are prominent and production and consumption decisions, therefore, are non-separable (Sadoulet and de Janvry, 1995). Econometric approaches have advanced considerably over the past three decades, but remain data intensive and open to model misspecification problems. The advantage of EM and DEU approaches over econometric approaches is that the researcher can design experiments where many of the features are under the control of the experimenter.

Young's (1979) review shows that the principle uses of elicited risk aversion coefficients are for (a) farm management extension application, (b) technology adoption and rural participation applications, and (c) policy and predictive applications. He concluded that considerable heterogeneity in risk

preferences among individuals; requirements of frequent updating of individual risk preferences in response to changing objectives, information and attitudes; time, cost and practical problems associated with elicitation of risk preferences are likely to limit their use in extension programmes (Young, 1979).

3.6 Chapter summary

This chapter commences by introducing the concept of utility theory and the graphical and mathematical representation of the theory. The expected utility theory is further explained highlighting the pros and cons articulated. The definition of risk aversion by Friedman and Savage (1948) in reference of Von Neumann-Morgenstern expected utility function is outlined as is the measures or risk aversion by Arrow (1971) and Pratt (1964). They independently developed equivalent measures of risk preferences that allow for comparisons of interpersonal preferences. These are absolute risk aversion, relative risk aversion, partial risk aversion and the Arrow-Pratt Absolute Risk Aversion coefficient. The case for and how to adjust the ARA for the range and scale of the data is also presented due to the importance of reporting risk preferences in a consistent manner such that studies can easily be compared to one another. Elicitation procedures are categorised as experimental methods (EM), direct elicitation of utility (DEU) approaches, and econometric methods. The EM and DEU approaches are advanced over the econometric approach in that the researcher can design experiments where many of the features are under the control of the experimenter and suited to the area under study.

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter describes the research methodology for data collection and analysis for the study. A description of the background of the study area in the former Ciskeis' homelands with the following sub- sections: the geographical location, history of the former homeland, demographics, natural resource base, agricultural potential and land use patterns in the area. Information on the sampling framework is presented and data methods and instruments used to obtain socio- economic, demographic, and institutional and household is described. The methodology of eliciting risk preference of sample farmers is also described using the ordered probit model. The chapter concludes by giving the empirical specifications and estimation procedures for the model.

4.2 Study area

Figure 4.1 Map of the former Ciskei homelands of the Eastern Cape

The former Ciskei homelands are represented by the study areas of Melani village, Battlefield village and Binfield village (near Alice town) all situated in the Amatole

District municipality under Nkonkobe municipality. Figure 4.1 graphically show the former homelands of the Ciskei. The Amatole District Municipality is named after the legendary Amatole Mountains (Eastern Cape Tourism Board, 2011). Amatole is a diverse district Municipality in the province. It contains the popular Metropolitan in the country, the Buffalo City Metropolitan, which includes East London, King Williams Town and Mdantsane. Two thirds of the district is made up of the former homelands areas. The Amatole Mountains that lie north- west of King Williams Town give the district its name. The well-watered coastal strip gives way to the former Transkei Hillls (ECDC, 2008b). The district has a moderate Human Development Index of 0.52. This district has over 1,635,433 inhabitants (Community Survey, 2007), and a moderately of 78 people per square kilometre. The population is mainly African with some whites and coloured. Amatole District Municipality has the second highest economy in the province. The private sector is dominated by manufacturing in the areas of motor industry, food processing, textiles and clothing.

The following paragraph and subsections below describe the study areas in terms of geographical location, history of the former homelands, demographics, natural resources base, agricultural potential and land use.

4.2.1 Geographical study area

Figure 4.2 Map of the Eastern Cape Province

The Amatole District Municipality occupies the central portion of the province, boarded by the Eastern Cape districts Cacadu, Chris Hani and OR Tambo, respectively to the west, north and east. The district extends over 23,577.11 km squared and includes several local municipalities and one Metropolitan (Buffalo City, Amahlathi, Nxaba, Nkonkobe, Nqushwa, Great Kei Municipality, Mquma and Mbashe Local Municipality), incorporating 21 former magisterial districts. Amatole District Municipality includes the former administrative areas of the Eastern Cape, namely former Transkei and Ciskei homeland areas and former cape provincial areas. According to the Amatole District municipality Integrated Development Plan (2011), Amatole district is classified as a category C2 municipality, indicating a largely rural character and low urbanisation rate, as well as limited municipal staff and budget capacity. Mbhashe, Mquma and Nqushwa are classified as B4 (rural mainly subsistence), and Great Kei, Amahlathi, Nkonkobe and Nxhaba as B3 (small towns, agricultural) municipalities, reflecting limited institutional capacity and areas characterised by small centres, limited Small Medium Micro Entreprises (SMMEs) and market opportunities, dependence on public support and LED activities that are principally at the level of the small project (Amatole District Municipality Integrated

development Plan, 2011). Buffalo city Municipality is the category B1(secondary city) municipality in the province, reflecting relatively large budgets and staff, as well developed formal business sector and enterprises that have access to market supplied business services (Amatole District Municipality Integrated development Plan, 2011). The study will be conducted in the rural, urban and peri- urban areas of Amatole District Municipality. These are kwezana, Tshatshu peri- urban areas around Alice Town and the rural area of Cata.

4.2.2 History of the former homelands of Ciskei

The former homelands were set up by the South African government prior independence for Xhosa- speaking people (Wikipedia, 2012). The former Ciskei was a Bantustan in the south east of South Africa covered an area of 2,970 square miles, most entirely surrounded by what was then the Cape Province, and possessed a small coastline along the shore of the Indian Ocean. Under South Africa's policy of apartheid, land was set aside for black people in self- governing territories. The former Ciskei was designated as one of two homelands or Bantustan for Xhosa speaking people. Xhosa speaker were resettled there and to former Transkei, the other Xhosa homeland. The former Ciskei had a succession of capitals during its existence. Originally, Zwelitsha served as the capital with the view that Alice would become the long- term national capital. However, it was Bisho now spelled Bhisho that became the capital until former Ciskei reintegration into South Africa.

At the end of the nineteenth century, the area between the Fish and Kei rivers had been set aside for the Bantu and was known as the former Ciskei (Cameroon, 1986). The Europeans gave the name former Ciskei to the area to distinguish it from the former Transkei, the area north of Kei. In 1961 former Ciskei became a separate administrative region and in 1972 was declared a self governing under the rule of chief Justice Mbandla and then Lennox Sebe. In 1978 it became a single- party state under the rule of Lennox Sebe and in 1981 it became fourth homeland to be declared independent by the South African government and its residents lost their South African citizenship. However, there were no border- controls between South

Africa and former Ciskei. In common with other Bantustans its independence was not recognised by the international community.

4.2.3 Demographics

The population of Amatole District is unevenly distributed among seven municipalities and metropolitan city. The number of households is 458,582 (community survey, 2007). According to the Amatole District Municipality Integrated development plan (2011), the majority of its population reside within the Buffalo City Municipality (42.8%), followed by Mnquma LM (16.4%) and Mbhashe LM (16.1%). The two local municipalities with the smallest percentages of the Amatole are Nxuba (1.5%) and Great Kei (2.9%). The population density within the Amatole District municipality has steadily decreased since 2002. While the population density was 70.4 people per square kilometre in 2002, it decreased to 69.2 people per square kilometre in 2009(Amatole District Municipality Integrated Development Plan, 2011).

4.2.4 Natural resources

The natural environment of Amatole district Municipality is similarly diverse, including moist mountainous, well watered coastal and semi- arid Karoo, thornveld, succulent and thick areas. The district includes part of the wild coast and is home to Cwebe and Dwesa Nature reserves, and extends inland to include mountainous areas, centred on the Amatole mountain range. Amatole is the most diverse district municipality in the Eastern Cape. Two- thirds of the district is equally diverse. The climate is moderate for most of the year, but with hot periods from December to February. Although the area receives rainfall throughout the year, it is primarily a summer rainfall region, with the months of June and July being the driest and coldest. The mean annual precipitation varies from 1000mm along the coast to 700mm inland above Butterworth and 1200mm in the Amatole District is considerably dryer, with less than 500 mm per annum, than the Eastern side, which has rainfall as high as 1000 mm per annum along the coast.

4.2.5 Agricultural potential and land use

Agriculture in most part of Amatole district Municipality has not yet developed beyond smallholder farming because of constraints facing agricultural areas. The prospects of agriculture currently look dim because of the lack of inputs, resources and a lack of interest from the youth. The communal farming areas are characterised by low technical input, low cost, low yield enterprises with poor infrastructure and support services. The agricultural enterprises are very limited in their potential to increase the contribution to the Gross Domestic Product of the area due to a number of constraints. The Amatole region is characterised by diverse land use and ownership linked to natural resources as well as past political systems and boundaries. Areas of the homelands are mainly communally owned with high population densities. These exist alongside privately owned commercial farmland with much higher population densities and very different agri- enterprises.

Commercial agriculture is characterised but private ownership, larger more viable farming units, higher levels of technical input and expertise, higher cost structures, higher yields and access to better infrastructure and support systems.

4.3 Melani village

4.3.1 History of Melani village

The village is named after Melani Vela who, together with his followers fought on the side of the colonist in the last centuary and in 1866, was granted the land on which the village is situated (see figure 4.3 below). At that time 19 families were granted residential sites and 19 fields (each of 8 acres) were surveyed and issued as Quitrent land. After the group settled in Melani, other people moved into the village especially after the 1940s. From the 1960s onwards this situation changed a great deal with land scarcity increasing as people settled in the village (Monona, 1997). According to De Wet (1987), in 1963 further land shortages resulted from the implementation of the betterment scheme which decreased the amount of land available to the people. In the late 1960s increasing shortages were experienced in

Melani as many landless people from white owned farms I the neighbouring districts sought and found residential land in the village. These were destitute people who had been evicted from farms or who were not satisfied with farm working or living conditions where they were before. Currently, the village population is still growing and people from outside were getting residential sites in Melani.

4.3.2 Agriculture and land use

Agriculture in the study area consists of crop production and stock farming under dryland conditions and under irrigation in a small government- sponsored project. A small percentage of the village residents have access to arable land. Studies conducted by Monona (1997), showed that 19 percent of the households in the area do not have access to any land, where else the other 30 percent had access to Quintrent fields of about 8 percent one morgen-plots.

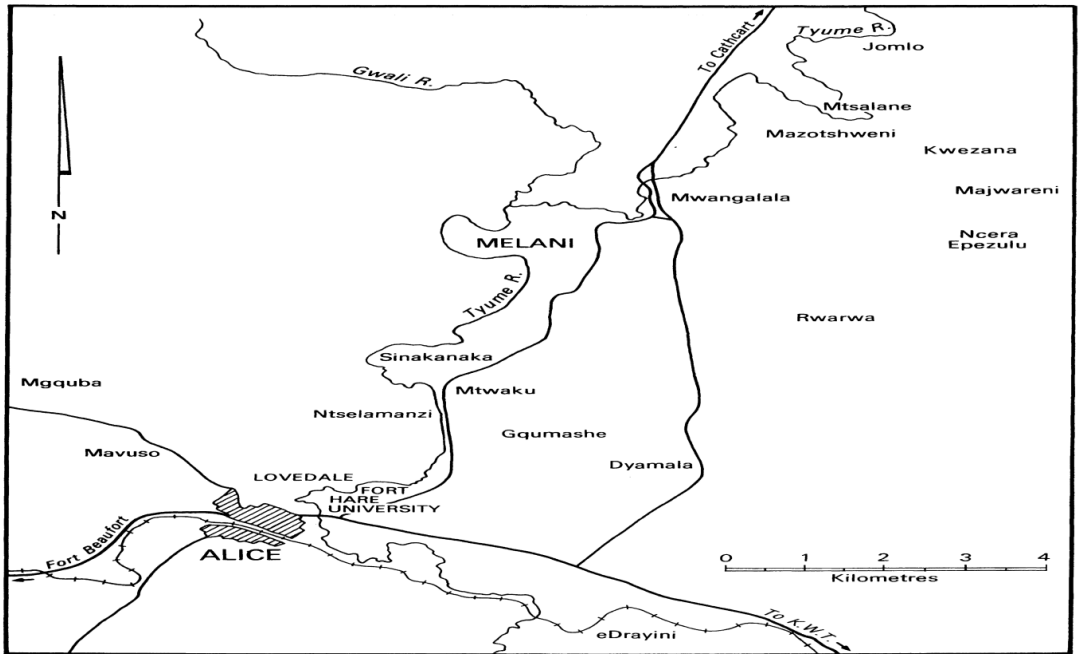


Figure 4.3 Map of Melani village

4.3.3 Battle Dan irrigation scheme

In Melani there is an irrigation scheme named Battle-Dan irrigation scheme which consists of 35 ha of land. This scheme started in the 1960s when a small holding which belong to the white trader was incorporated into the village was then divided into 16 plots which were taken up by residents. These pots are located in an area that is closer to a dam. In 1974 the plot holders were motivated by an extension officer to use the local dam for irrigation. That was when they took the initiative to establish battle- Dan irrigation scheme. Some of the members pointed out that the scheme functioned fairly successfully for two years and they were able to produce a wide range of vegetables. Thereafter they were not able to access a suitable market for their produce, and they started using the land for dry land cultivation.

After 1994 the department of agriculture had a mandate to revitalised irrigation schemes and thus made a provision for irrigation facilities to the scheme. The scheme is currently producing citrus fruits, mainly oranges of which they have a strategic partner who buys from them at a certain price in bulk and sell it to the market. When they have excess produce they sell to local markets including Fruits and Veg market in Alice. The scheme has about 32 members who are actively involved in the production and has created about 19 jobs for permanent works and 10 temporary works who are mostly actively involved during picking periods.

4.4 Sampling Procedure

The selected sample comprised irrigation farmers who are involved in the production of crops, these farmers will be categorised into homestead food gardeners, smallholder irrigation farmers, and or smallholder irrigation schemes in the Amatole District Municipality. Open-ended interviews with community leaders and focus groups were used to gather information on the ideal location to carry out research because of the farming activities taking place in the area. In some cases farmers are sparsely populated. Against the foregoing background, a sample of 102 farming households was drawn from three places in the former Ciskei “homeland” of South Africa, including the Melani, Battlestan and Binfield of the Nkonkobe municipality in

the Eastern Cape Province. These three villages were randomly selected from the Nkonkobe Municipality.

A total of 75 farmers from each of the two production activities (homestead food gardeners and smallholder irrigation farmers) were randomly selected from the farming population of Melani, Battlestan and Binfield village. There was no specific number of farming households per location because the villages generally share the same geographical and institutional setup (Amatole district municipality Integrated Development Plan, 2011).

4.4 Data collection methods

Primary data was collected via interviews using questionnaires and situational analysis. The field work will commence with a situational analysis of the study area to acquire the general information of the Total farming population Random selection Sample institutional set-up of the area. Finally, detailed information required in the study was gathered using a structured questionnaire. A situational analysis was employed in the study to assess the local situation which helped to identify the sample population, designing of the questionnaires and feasibility of the study. The method will involve an observation of the settlement set-up of the study area.

Both qualitative and quantitative data were principally collected through questionnaires. A single-visit household survey using structured questionnaires which will cover a wide range of issues, including demographic information, risk sources, risk information, and adoption of new agricultural technology within concise a broad definition will be employed. Although Bourque and Fielder (2002) assert that questionnaires are used to collect data from people who complete the questionnaires themselves, the enumerator in this study will use the questionnaires to carry out the interviews with farmers. With the help of three enumerators, a total of 101questionnaires were used to collect data from the sample population. Unlike in a posted questionnaire, this interview process ensures direct communication with respondents. In this case, there is clarity whenever a question posed to the interview is not clear. Information from illiterate respondents is also captured using this method. An interview provides the platform to gain cooperation, hence there is

minimal loss of information (Leedy and Ormrod, 2004). The method also ensures avoidance of spoilt or lost questionnaires. Timely response is also achieved using this method.

The data to be captured using questionnaires was utilised for different levels of analysis. Firstly, the data were used to describe the demographic and socio-economic characteristics of the study area. Secondly, the data was used to determine how different factors influence each other. In this regard ordered probit analysis and binary logistic regression was employed to identify variables fitted into the final model for determining the risk preferences of smallholder irrigation farmers. In the latter case (logistic model), four key production variables constituting the definition of adoption of technology were identified and each made a response variable. These variables are: education and training, household size, farm income and land tenure. Lastly, the data was used to find major sources of risk of smallholder irrigation farmers and their implication for new agricultural technology adoption. To find out key constraints affecting smallholder irrigation farmers, a review of the models and variable specifications was done.

Table 4.1: Model variables applied in the analyses

Variables	Unit	Type of Variable	Expected sign +/-
Risk	Farmers' risk attitude	Categorical	+/-
Age	Actual in years	Continuous	+/-
Sex	Sex of the respondent 0 =female; 1= male	categorical	+/-
Household Size	Actual number	Continuous	+/-
Group	Group which respondent belong to 0= homestead food gardener; 1= smallholder farmer	Categorical	+/-
Level Of Education (Leveledu)	Attended formal schooling or not 0 = attended school; 1= did not attend school	Categorical	+
Access to credit	Source of credit 0= other ;1=bank	Categorical	+
Land size (Sizeplot)	Actual size in hectares	Continuous	+/-
Land tenure (tenuresystem)	Type of tenure system, 1=own land ; 0=otherwise	Categorical	+/-
Occupation (Occu)	Employment status apart from farming 0=employed; 1= unemployed	Categorical	+/-
Years of tenure (yrsoftnr)	Number of years in farming	Continuous	+
Livestock damage crops	Farmers perceive it as a risk 0=no risk; 1= riskiness	Categorical	+/-
Financial security (Finscurty)	Farmers financial security 0= no; 1=yes	Categorical	+/-
Information on crop production (infocrp)	Information about producing crops 0=no; 1=yes	Categorical	+/-
Information on markets (Infomrkts)	Information about alternative markets 0=no; 1=yes	Categorical	+/-
Ploughing method (plghmmthd)	Method used for ploughing crops 0=hand tools; 1=own tractor	Categorical	+/-

Source: observations, 2013

4.5 Variable specification and definition

The variables examined in the study are presented in Table 4.1. Previous research has shown that market access is strongly influenced by such factors as the physical conditions of the infrastructure, access to production and marketing equipment, and the way the marketing functions are regulated (Killick, Kydd and Poulton, 2000; IFAD, 2003).

(i) **Age:** This variable is expressed as the actual age of the household head in years. Previous studies, including Bembridge (1984), have established that this variable is a key determinant of behavioural patterns of household and community members. Younger farmers are expected to be less willing to take risks than older farmers who are perceived to have acquired experience of farming and resources. Therefore, it is hypothesized that a higher age is negatively related to risk. This is supported by an observation by Obi and Pote (2012) that older farmers are likely to have more resources at their disposal, which may make them more likely to adopt to technologies more readily than younger farmers, despite being less aggressive to seek out more profitable markets. In that case, age may be related to the measure risk either positively or negatively.

(ii) **Sex:** This variable is articulated as the sex of the respondent. Studies have revealed that the productivity of labour will be altered depending on accessibility of the technology between men and women. In many smallholder farms, technology is mostly at the disposal of men whereas women contribute seventy percent of agricultural production (Lubwana, 1999). According to Doss and Morris (2001) there is no significant association between gender and technology adoption of improved maize technology among farmers in Ghana. In other words sex may or may not have any effect on farmers willingness to take risks.

(iii) **Household size:** Increase in household size might increase the dependency ratio, which in turn affects savings and investment. Conversely, a larger household may mean increased labour availability, which enhances farm

production under the kind of labour-intensive farming systems that prevail in communal agriculture. In turn, increased production increases the chances of market access due to larger economies of scale. Therefore, it is possible for either positive or negative relationships to exist between risk preference and household size.

(iv) **Group:** Studies have revealed that smallholder farmers as opposed to homestead food gardeners tend to be risk takers. Homestead food garderners tend to secure food only for household consume, that is they are only concerned about food security and are only concerned about thus have no aim of profit maximisation where else smallholder are profit driven and tend to take risks to improve their produce and there is a possibility of either negative or positive relations between risk preferences and group.

(v) **Education level:** Studies conducted in several developing countries have confirmed the importance of education in the decision-making process with implications for the socio-economic development and human capital production (Schultz, 1964; Bembridge, 1984; Mushunje, 2005). For the agricultural sector, earlier studies equally established that education plays an important role in the adoption or otherwise of improved practices in traditional agriculture (Bembridge, 1984). The absence of education is therefore expected to have a negative influence on these processes. In the light of that, it can be hypothesized that there is a positive correlation between education and risk preference.

(vi) **Years of tenure:** This variable measures the number of years a farmer has been engaged in farming. It can be hypothesized that the lesser the number of years the farmer is involved in farming, the higher the probability of being technically constrained because certain farming techniques require that the farmer possesses some degree of experience. Thus, there is a positive correlation between risk preference and farming experience.

(vii) **Access to Loans and/or credit:** This variable measures whether farmers had access to institutional finance for the facilitation of production. Foltz (2005) developed a model that links credit access with agricultural profitability and investment in Tunisia. The findings show that credit constraint negatively affects farm profitability. As Reardon, Kelly, Crawford, Jayne, Savadogo and Clay (1996) have noted, farm profitability depends on availability of markets. It can therefore be hypothesized that preference is positively correlated to access to production loans and/or credit.

(viii) **Land size:** This variable refers to the size of land in hectares. Increase in land size may enhance production if the land is effectively utilized. At the same time, land may be available but not being effectively utilized. Effective utilization will entail application of appropriate farm practices that will lead to higher physical output than otherwise would be the case. In the absence of more direct means of assessing effectiveness, this can only be inferred from the results. Intuitively, one can expect higher output if there is effective utilization of available land, and lower output otherwise. It is also reasonable to expect that the more physical output a farmer produces, the more surplus is marketed. Therefore, it is hypothesized that there is either a positive or a negative correlation between risk preference and land size.

(ix) **Occupation:** This variable measures whether the farmer is receiving off-farm income. Off-farm income can help diminish on-farm technical constraints since the farm has alternative capital inputs. Farmers who lack off-farm income are less likely to adopt to new agricultural technologies than those who have. This is also supported by Mashatola and Darroch (2003). Thus, it can be hypothesized that there is a positive correlation between off-farm income and risk preferences.

(x) **Financial security:** This variable defines whether or not the farmers have sources and security for credit.

(xi) **Information on crop production:** This variable explains whether or not farmer have acquired information on the effective crop production.

(xii) Information on markets: This variable explains whether or not farmers have received information on available markets for their produce.

(xiii) Ploughing method: This variable measure the method which is employed to plough crops.

(xiv) Water rate: The variable measures the amount which is paid for water by the farmers.

(xv) Irrigation system: This variable measures the method which is used to irrigate crops.

4.6 Data analysis model

4.6.1The probit model

This section presents the background to the probit model as well as the mathematical representation of the model. The probit model is used to identify the determinants of farmers' decision to take risk.

4.6.1.1 Introduction and application of the model

Multiple response models are used when the number of alternatives that can be chosen is more than two. They are developed to describe the probability of each of the possible outcomes as a function of personal or alternative specific characteristics (Verbeek, 2008). Ordered response models are applied where there exists an ordered or logical ordering of the alternatives. In this case it is assumed that there exists an underlying latent variable that drives the choice between the alternatives (Verbeek. 2008). The results in this case will be sensitive to the way in which the alternatives are numbered. The modelling methodology used to establish the determinants of the farmers risk preference status is the ordered probit model.

The ordered probit is suitable for modelling with a categorical dependent variable (in this study the risk preference status). Multivariate modelling is an especially useful

and informative approach to understanding the farmer‘s decision on their risk preference status. This is because multiple factors contribute to their decision on whether to take risk or not. Ordered probit is especially appropriate in this study because like Ordinary Least Square (OLS) it identifies the statistical significant relationships between the explanatory variables and the dependent variable. BUT unlike the OLS regression, ordered probit discerns unequal differences between ordinal categories in the dependent variable (McKelvey and Zavonia, 1975; Greene, 2003).

4.6.1.2 Mathematical representation of the ordered probit model

In this study, the dependent variable of the risk preference status was placed in two ordered categories in the survey. An ordered probit model is used to determine the factors that influence a farmer‘s riskiness. Based on the review of literature, the model is estimated as follows

(1) farmers’ riskiness = *f* (age, sex*, education, household size, land tenure, location, risk attitudes, type of plot, tenure system, ploughing method, irrigation system, financial security, livestock damage crops, uncertainty in climate, source of water, water rate, paying water*)

The farmer‘s decision on their risk preferences is unobserved and is denoted by the latent variable si*. The latent equation below models how si* varies with personal characteristics and is represented as:

An Ordered Probit model was used to meet the objective. The model is shown as follows:

$y_i^* = \beta' x_i + \varepsilon_i = i, \qquad \varepsilon \sim N[0,1]$ ----------(8)

$y_i = 0$ if $y_i^* \leq \mu 0$

$y_i = 1$ if $y_i^* \leq \mu 1$

$y_i = 2$ if $y_i^* \leq \mu 2$

Where:

y_i^* *is* the observed counterpart of y_i^* ,

β is the vector of coefficients to be estimated,

x_i is the matrix of independent variables,

μ_j *is* the distance variable and

ε_i is the error term.

The variance of error term is assumed to be 1.00 (Greene, 2000).

The ordinal variable y_i is defined to take a value of j if y_i^* falls in the *j th* category:
$y = j \text{ if } \xi_{j-} < y^* < \xi_{j1} \; j = 1, \ldots,$

J where $\xi's$ are unknown threshold parameters that must be estimated along with β assuming $\xi_{-1} = -\infty$, $\xi_0 = 0$ *and* $\xi_j = \infty$.

The probability of obtaining an observation with $y = j$ is equal to $Pr\,ob(y = j) = F(\xi_j - \beta' x) - F(\xi_{j-1} - \beta' x)$
where *F* is the cumulative standard normal distribution function.

The effect of the independent variable on the probability of the *j* th level is given by:$\partial Pr\,ob(y = j) / \partial x = \beta [f(\xi_{j-1} - \beta' x) - f(\xi_j - \beta' x)]$
where *f* is the standard normal density function (Tansel, 2002). The following model was estimated by using maximum likelihood method to have consistent and efficient parameter estimates.

4.7 Multinomial logistic regression model

The multinomial logistic regression model was used to test the different levels of risks, namely no risk, minor risk and severe risk as perceived by farmers in the area.

Multinomial logistic regression can be used to predict a dependent variable, based on continuous and/or categorical independent variables, where the dependent variable takes more than two forms (Hill, Griffiths and Judge, 2001). Furthermore, it is used to determine the percent of variance in the dependent variable explained by the independent variables and to rank the relative importance of independent variables. Logistic regression does not assume linear relationship between the dependent variable and independent variables, but requires that the independent

variables be linearly related to the logit of the dependent variable (Gujarati, 1992). Pundo and Fraser (2006) explained that the model allows for the interpretation of the logit weights for the variables in the same way as in linear regression.

The model has been chosen because it allows one to analyse data where participants are faced with more than two choices. In this study, smallholder farmers are faced with three choices, which are; no risk, minor risk and severe risk. Firstly, the farmers are assumed to decide whether they perceive a certain issue as minor risk, severe risk and/or no risk.

4.7.1 Mathematical representation of the model

As such, the utility maximizing function can be given as:

$$\text{Max } U = U (C_k, R_{fk}, R_{ik}; H_u) \quad \text{.....} (9)$$

Where: Max U denotes the maximum utility that can be attained from agricultural production.

C_k represents the sex*, education, household size, land tenure, location, risk attitudes, type of plot, tenure system, ploughing method, irrigation system, financial security, livestock damage crops, uncertainty in climate, source of water, water rate, paying water…*

From the utility maximizing function, it can be seen that households make decisions to produce, consume and market, subject to risk factors. It follows that if the costs that are associated with using a particular channel are greater than the benefits, households will be discouraged from using it, shifting to another option that maximizes their utility.

O' Sullivan, Sheffrin and Perez (2006) pointed out that it is difficult to measure utility directly; therefore, it is assumed that households make participation choices depending on the option that maximizes their utility. Thus, decisions to participate in either formal or informal markets or even not participating signify the direction, which maximizes utility. With the given assumption, multinomial regression was used to

relate the decisions to participate in formal markets, informal markets or not participating and the factors that influence these choices.

A typical logistic regression model, which was be used is of the form:

$$\text{Logit}(P_i) = ln\,(P_i / 1 - P_i) = \alpha + \beta_1 X_1 + \ldots + \beta_n X_n + U_t \quad \ldots\ldots (10)$$

Where: $ln\,(P_i / 1 - P_i)$ = logit for market participation choices

P_i = denotes the mean

$1\text{-}P_i$ = the variance

β = coefficient

X represents covariates

U_t = error term

4.8 Justification of the econometric model

Multinomial logistic regression model is useful in analysing data where the researcher is interested in finding the likelihood of a certain event occurring. In other words, using data from relevant independent variables, multinomial logistic regression is used to predict the probability (p) of occurrence, not necessarily getting a numerical value for a dependent variable (Gujarati, 1992). Dougherty (1992) explained that the procedure for formulating a multinomial logistic regression model is the same as for a binary logistic regression. Whereas in binary logistic regression, the dependent variable has two categories, in multinomial logistic regression, it has more than two categories. Thus, multinomial logistic regression is an extension of binary logistic regression.

According to Mohammed and Ortmann (2005), several methods can be used to explain the relationship between dependent and independent variables. Such methods include linear regression models, probit analysis, log-linear regression and discriminant analysis. However, multinomial logistic regression has been chosen

because it has more advantages, especially when dealing with qualitative dependent variables.

Linear regression model (also known as Ordinary least squares regression (OLS)) is the most widely used modelling method for data analysis and has been successfully applied in most studies (Montshwe, 2006). However, Gujarati (1992) pointed out that the method is useful in analysing data with a quantitative (numerical) dependent variable but has a tendency of creating problems if the dependent variable is qualitative (categorical), as in this study. Amongst other problems, the OLS cannot be used in this study because it can violate the fact that the probability has to lie between 0 and 1, if there are no restrictions on the values of the independent variables. On the other hand, multinomial logistic regression guarantees that probabilities estimated from the logit model will always lie within the logical bounds of 0 and 1 (Gujarati, 1992). In addition, OLS is not practical because it assumes that the rate of change of probability per unit change in the value of the explanatory variable is constant. With logit models, probability does not increase by a constant amount but approaches 0 at a slower rate as the value of an explanatory variable gets smaller.

When compared to log-linear regression and discriminant analysis, logistic regression proves to be more useful. Log-linear regression requires that all independent variables be categorical and discriminant analysis requires them all to be numerical, but logistic regression can be used when there is a mixture of numerical and categorical independent variables (Dougherty, 1992). In addition, discriminant analysis assumes multivariate normality, and this limits its usage because the assumption may be violated (Klecka, 1980). According to Gujarati (1992), probit analysis gives the same results as the logistic model. In this study, the logistic model is preferred because of its comparative mathematical simplicity and fewer assumptions in theory. Moreover, logistic regression analysis is more statistically robust in practice, and is easier to use and understand than other methods.

4.8 Chapter summary

The study area is the former Ciskei in the Eastern Cape Province. Rural Eastern Cape Province where the study was conducted has high concentration of people who are relatively poor and population resides in communal areas of the former Ciskei homelands. These are characterised by smallholders who rely on subsistence agriculture as an important livelihood option, contributing a significant portion of their household income. Questionnaires are used to collect data from 101 smallholder farmers and the econometric models probit and multinomial models were methods used for analysis are outlined in the text. The researcher decided to iterate with alternative functional forms due to the fact that no study with the exact same problem context exists and the researcher is still trying to explain the apparent incongruity of the failure to transform despite positive and favourable policy and investment environment at the national and provincial level.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Introduction

This chapter presents the results of the analyses of the survey data on Risk preferences of farmers. The data collected for this chapter were derived from interviews with the heads of the household drawn from for the two farmer groups in the study area. Quantitative and qualitative approaches were used to gather and evaluate the data in order to gain deeper understanding of farmers' management decisions and perceptions on risk. The chapter begins with the presentation of summary statistics of the demographic and socio-economic characteristics of the smallholder farmers. Quantitative variables were expressed as averages, whereas the gender and literacy dummy variables were reported as frequencies and percentages. The probit and multinomial results for the determinants of risk preferences are analysed and discussed.

5.2 Description of demographic factors

5.2.1 Description of Household Size

Table 5.1 represents the total number of the respondents in the study area was 101, that is, 63 were homestead food gardeners and 38 smallholder irrigators. The mean household size for homestead food gardeners was found to be 4 family members and 5 members for smallholder irrigators. The median for the two groups was found to be the same which is 5 and the maximum number of homestead food gardeners' household members is 13 and the minimum being 1 and for smallholder irrigators the maximum is 10 members and a minimum of 2 members. The household size is a proxy for family labour which is one of the most important inputs to smallholder farm production. The availability of family labour especially during peak labour demand is important for households that have adopted new agricultural technology that is labour intensive. On the other hand large family sizes also put pressure on

household food demands and hence has implications for the adoption of agricultural technologies that have a bearing on food security and/or commercialization for income sources.

Table 5.1 Household size of respondents

	Smallholder n= 38	Homestead n=63	Overall
Mean	5	4	5
Median	5	4	5
Maximum	13	10	13
Minimum	1	2	1

5.2.2 Description of Household by Sex

Figure 5.1 Shows both results of homestead food gardeners and smallholder irrigators males dominate in homestead food gardens represented by 63%, whereas females dominated in smallholder irrigators with 52%.

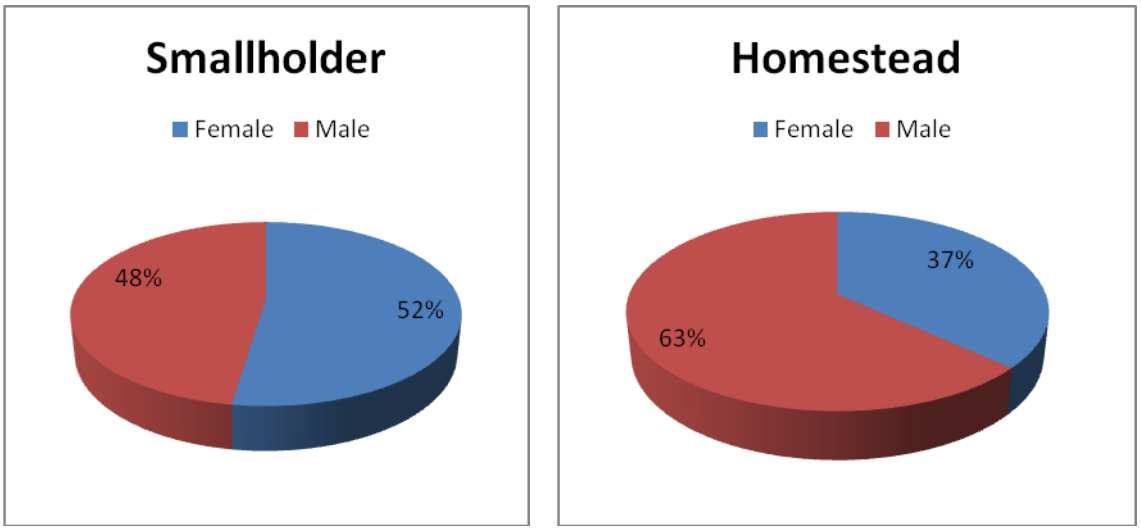


Figure 5.1 Sex distributions of the respondents, Survey data, 2013

5.2.3 Description of household by Age

Figure 5.2 shows that the homestead food gardeners have the youngest individuals involved in farming who are around 20- 29 years and also the oldest age between 81 and above. Furthermore, the results indicate that the age distribution from 70-79 is

similar between the two groups. Kirsten and Jerkins (2003) and Adesina and Baidu-Forson (1999) established that age was either significant or was negatively related to adoption. Older farmers, because of investing several years in a particular practice, may not want to jeopardise it by trying out a completely new method. Farmers' perception that technology development and subsequent benefits, require a lot of time to realise, can reduce their interest in the new technology because of their advanced age, and the possibility of not living to enjoy it

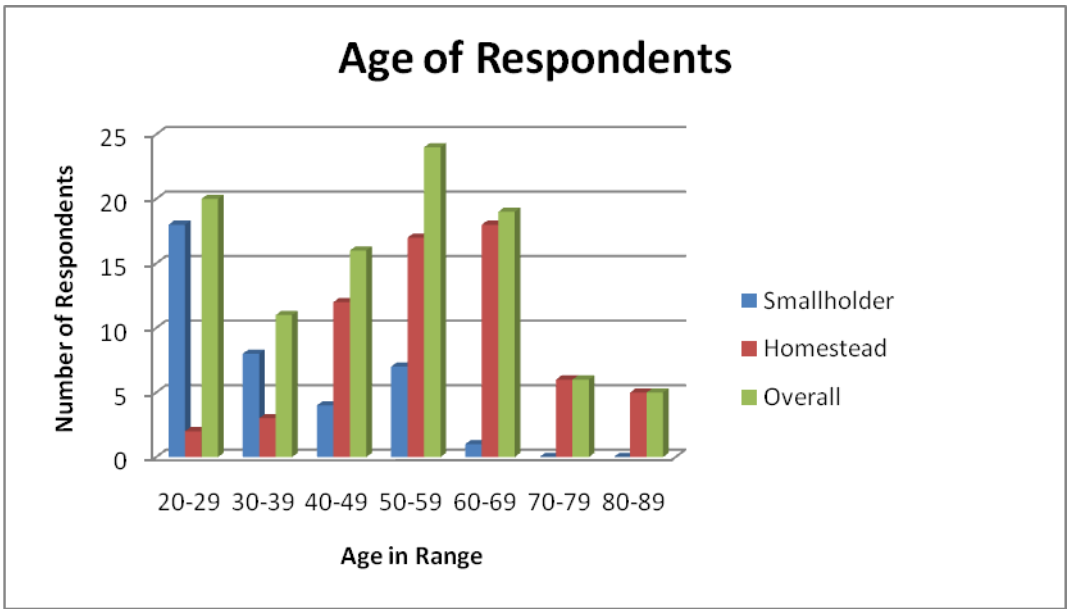


Figure 5.2 Age of household respondents, survey data 2013

5.2.4 Description of Household by Education

The level of education was divided into two segments which are Formal education and no formal education. This is one of the important characteristics because the higher the educational level the easier for the respondents to adopt and use modern technology since they understand technology better. Moreover the flow of agriculture information from one stakeholder to another is easier. Figure 5.3 below clearly indicates the education system received by farmers in the study. 90% homestead food farmers have received formal education, wherelse 3 % of smallholder irrigation farmers have never received formal education. A large percentage of smallholder irrigation farmers in the area seems to have received formal education, hence the 97%. In both homestead food gardening and smallholder irrigation farming a large percentage has received formal education.

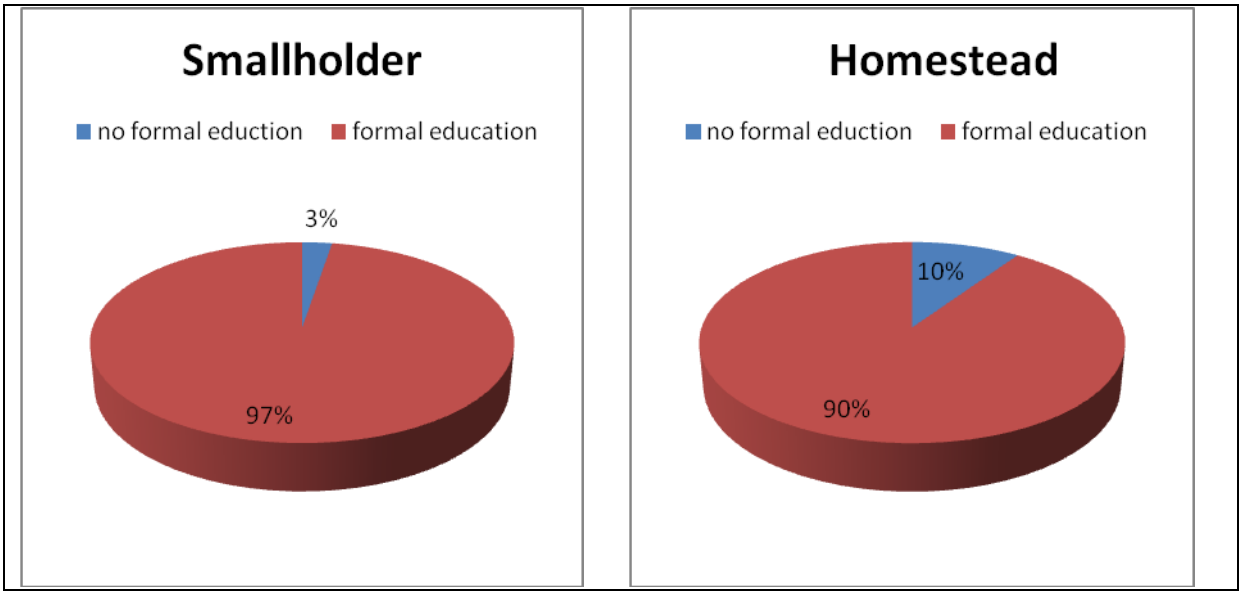


Figure 5.3: Education level of the respondents, survey data, 2013

5.2.5 Description of household by Occupation

In this study the occupation category of the respondents is divided into retired, unemployed and self employed. The respondents have got more retired respondents of about 7 % and 57% of the respondents are self employed. About 21% of the respondents are employed elsewhere and hence have non farming income. Occupation of the respondents is very crucial since income they earn helps the respondents to achieve household food security. To some degree, income is also used to purchase food, clothes and other (Muregerera, 2003).

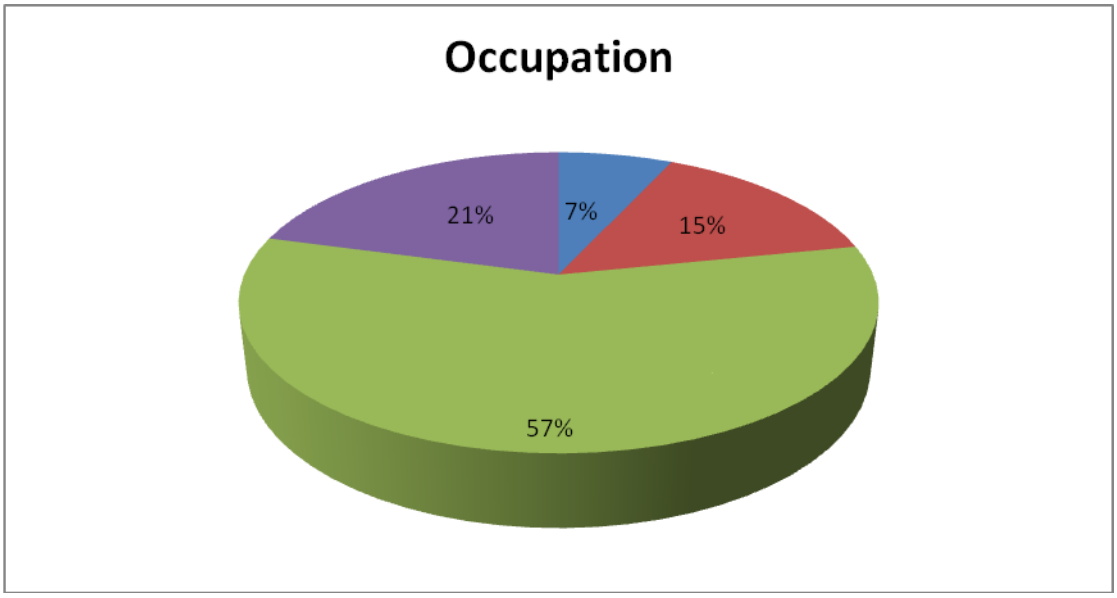


Figure 5.4 Occupation of the respondents, survey data, 2013

5.2.6. Description of household by Income

From the figure below clearly indicates that both smallholders and homestead food gardeners are earning slightly above R1500, this could be because some of the respondents are pensioners, who are eligible to the pension funds, and others may be having other sources of income, and a very low percentage of the farmers are earning above R1500. Both smallholders and homestead food gardeners have the same income of about R500. Access to cash which promotes adoption of risky technologies through the relaxation of liquidity constraints as well as boosts the household's risk bearing ability is hardly available to resource poor farmers for varied reasons (Langyintuo and lowenberg, 2006). Farm income may affect adoption negatively or positively depending on its contribution to household income and farm profitability. Farmers with more wealth and liquidity maybe better able to finance the adoption of new technologies and farming practices (Essa and Nieuwoudt, 2001).

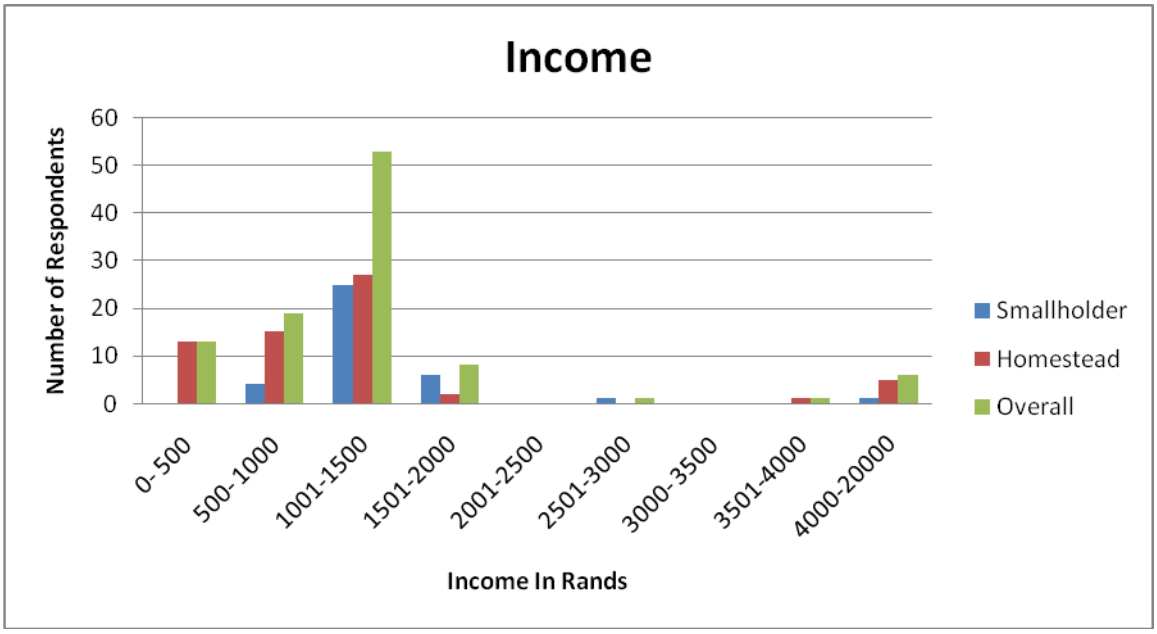


Figure 5.5 Income of respondents, survey data, 2013

5.3 Land use

5.3.1 Number of years farming

A vast majority of homestead food gardeners have been farming for over 16 years as compared to the smallholder's irrigation farmers whose majority of farmers have been farming between 6 to 10 years. Moreover the homestead food gardeners seems to have been in farming for more years as seen in figure 5.7 where smallholder farmers have been farming for not more than 10 years. The number of years in farming is very important in depicting the experience that a farmer has and also in determining whether or not a farmer can easily adopt to new agricultural technology**.**

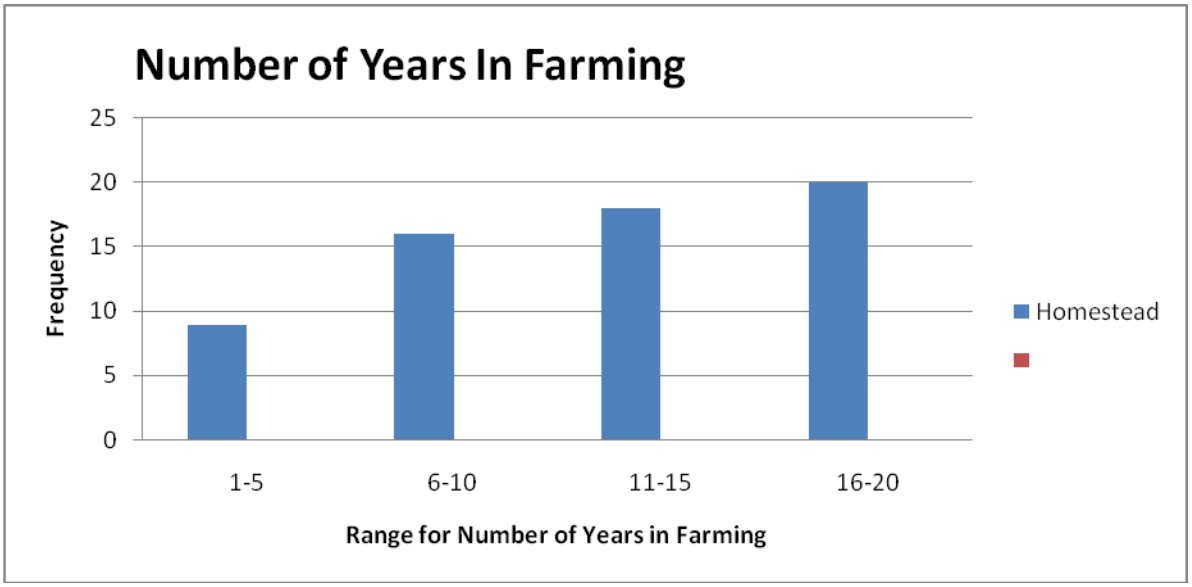


Figure 5.6 Number of year in farming, survey data, 2013

5.3.2 Land tenure system used by the farmers

The figure below illustrates the type of tenure system used by the farmers in the study area. About half of the farmers in the study area have their own land making it easier for them to continue with their farming activities and also the willingness to take risk. However a slightly lower percentage of about 40 % are using communal lands and this is has a negative impact on the willingness to take risks and the adoption of new agricultural technology. If farmers perceive their tenure as secure, they have an incentive to invest in land improvements and maintain existing improvements to increase productivity. However, policies such as the land reform process play a role in finding solutions for problems associated with limited access to land.

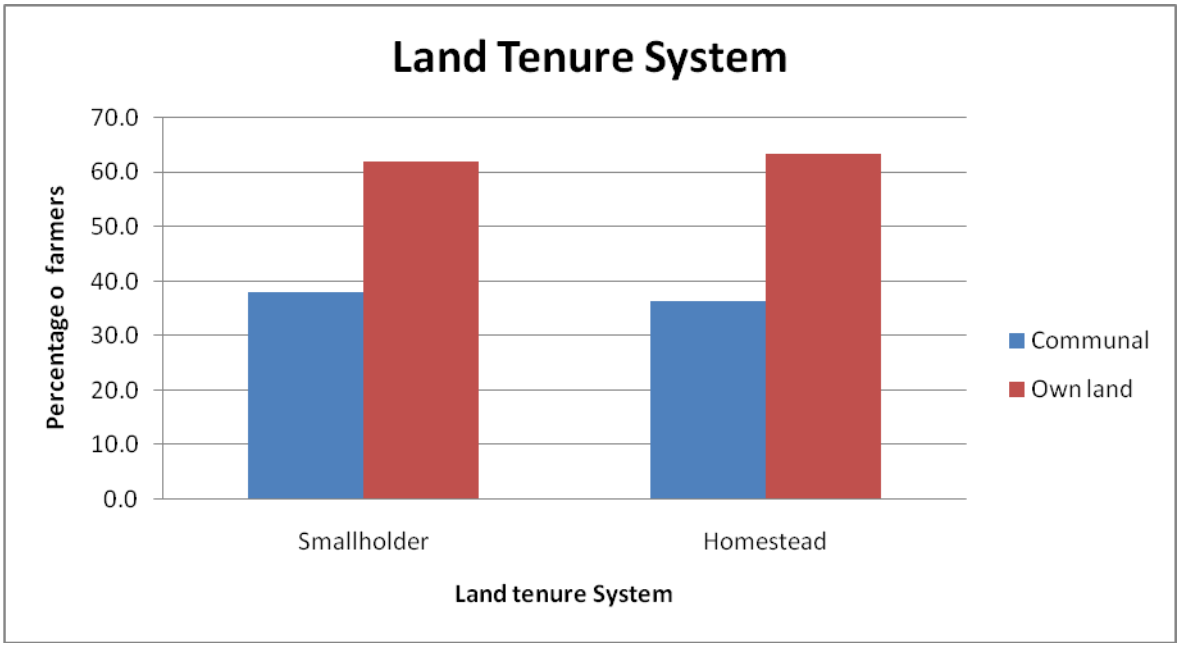


Figure 5.7 Land tenure system of the respondents, survey data, 2013

5.3.3 Land Size

The size of land a farmer owns is usually associated with the amount of produce the farmers will produce even though it's not always the case since most farmers might not utilise all the land that they have been allocated (Muchingura, 2007). Najafi (2003) also goes on to say that land size is also an important aspect when it comes to the food security of household and thus the bigger the land the bigger the production. The average land size obtained in the sample is 1.5 ha there is a difference of about a hectar between the two groups on the land sizes and they ranged from 0.25 to 10 ha.

Table 5.2: Size of land utilised by respondents

	Smallholder n=38	Homestead n=63
Mean	2.27	0.25
Std. Deviation	1.48	1.73
Minimum	0.25	4
Maximum	8	10

5.4 Water use

5.4.1 Source of water

The main sources of water in the former Ciskei homelands of the Eastern Cape are dams, rivers, taps and boreholes. A high percentage of farmers in the area are using water from the dams as most of them are surrounded by dams, however they do not have water rights. Only 4% of the farmers use water from borehole and 155 uses water from taps which are communal taps.

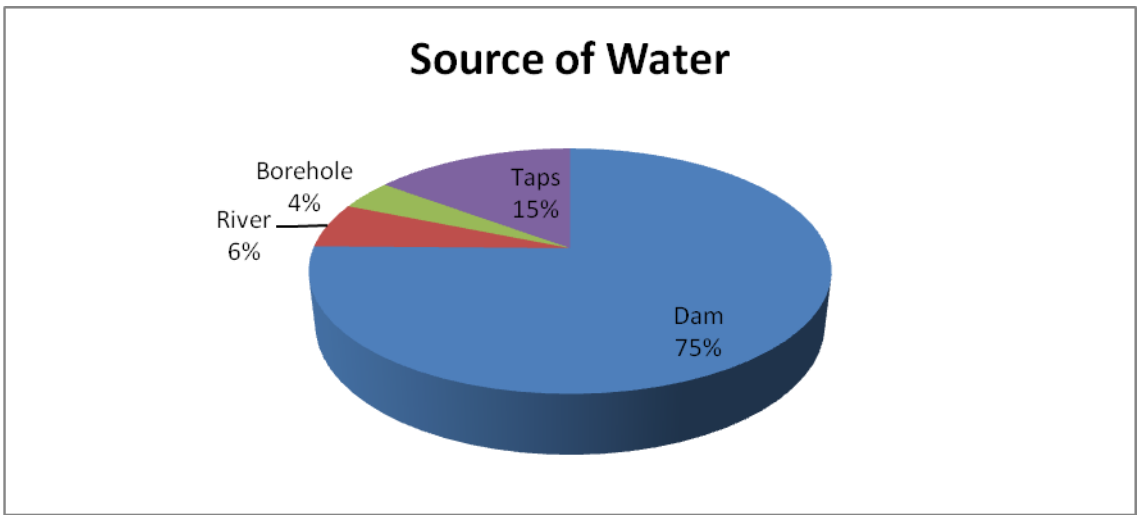


Figure 5.8 Sources of water used by the respondents, survey data, 2013

5.4.2 Type of irrigation system

The most commonly used method of irrigation are water cans which are used mostly by homestead food gardeners,38% of the farmers uses sprinklers which are mainly used by smallholder irrigation farmers. Other irrigation systems include drip irrigation systems and pivots which are also used in the area. This is illustrated in figure 5.9 below

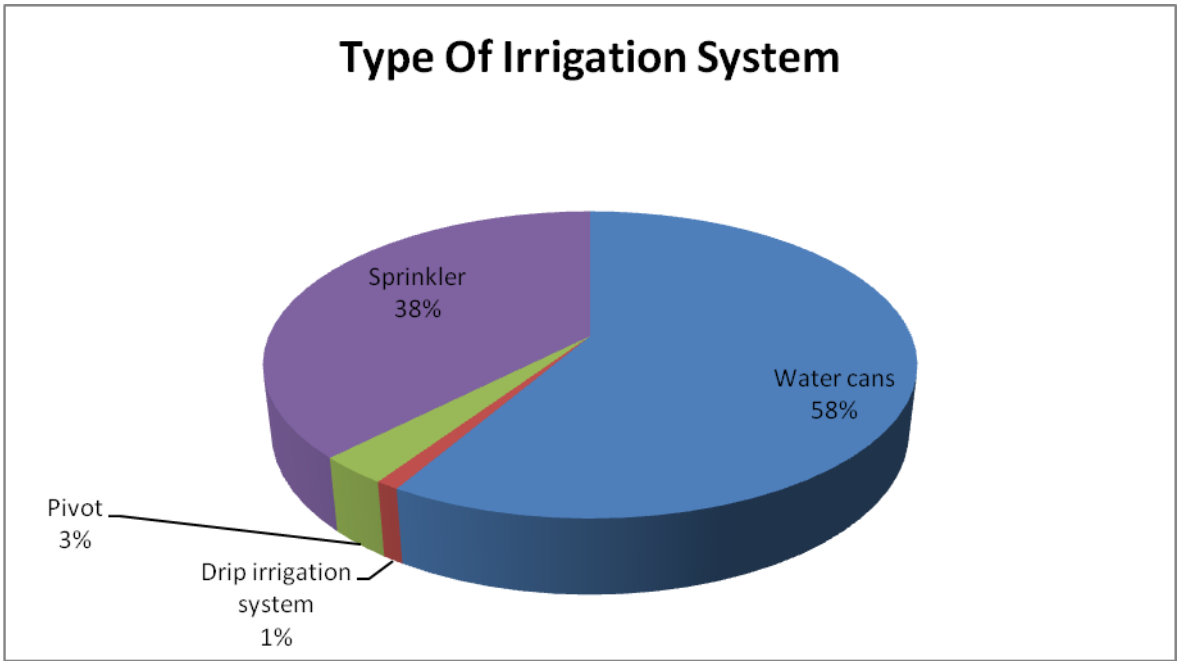


Figure 5.9 type of irrigation system of the respondents, survey data, 2013

5.5 Livelihood strategies

5.5.1 Cash borrowed

Table 4.5 below reflects the amount of money borrowed both smallholder farmers and homestead food gardeners. Over 70 % of the farmers have borrowed money between R1 and R500. Atleast 1% of the respondents have borrowed money from R2501 and R2000; this could be influenced by the fact that most of the farmers are self employed.

Table 5.3: The amount of money borrowed

Amount Borrowed	Frequency	Percentage
1- 500	78	77.2
5001-1000	11	10.9
1001-1500	4	4
1501-2000	1	1
2001-2500	7	6.9

5.5.2 Purpose of credit

Although farmers may have access to informal credit, they have a number of issues they are using it for. This study has discovered that many of the farmers in Ciskei borrow money for the main purpose of family suppose and this is reflected by the 70% in the graph below.

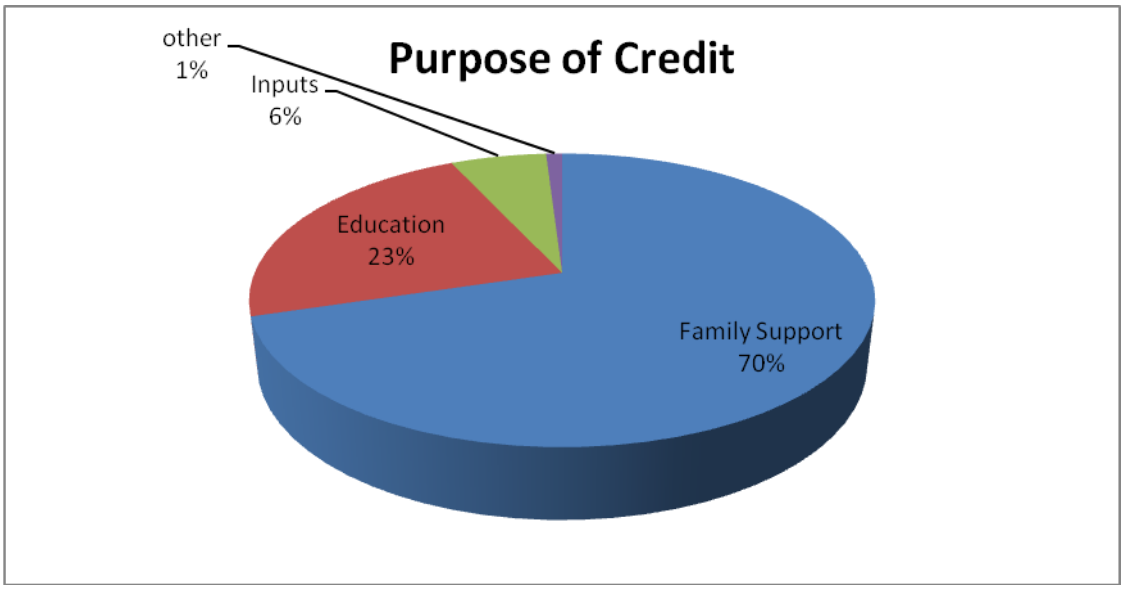


Figure 5.10 Main purposes for credit, survey data, 2013

5.5.3 Source of credit

For smallholder farmers access to credit is vital to any production, especially for commercial purposes. This both credit to obtain assets over a longer period and production credit cyclical basis (May and Carter, 2009).Both homestead food gardeners and smallholder farmers outsource their credit from lenders and just a small percentage of these farmers get their loans from banks. This can have a negative impact on risk and the adoption of new agricultural technology.

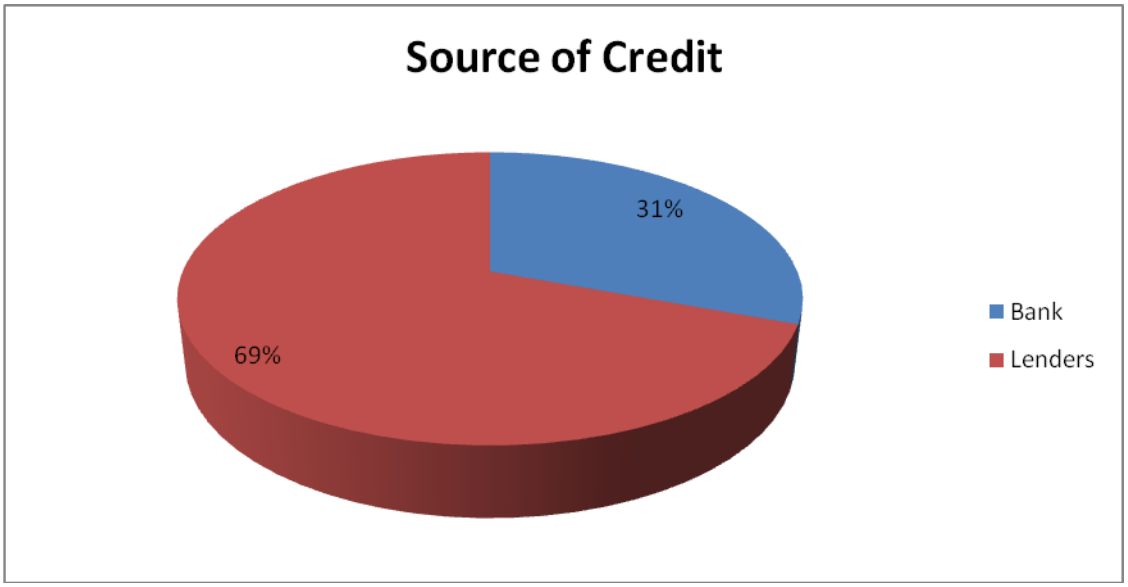


Figure 5.11 Sources of credit, survey data, 2013

5.5.4 Financial security

Figure 5.12 below illustrate whether or not farmers in the study area have financial security or not. Over 70 percent of the respondents do not have financial security, making it difficult for them to access credit and thus more risk averse and less willing to adopt to new agricultural technology.

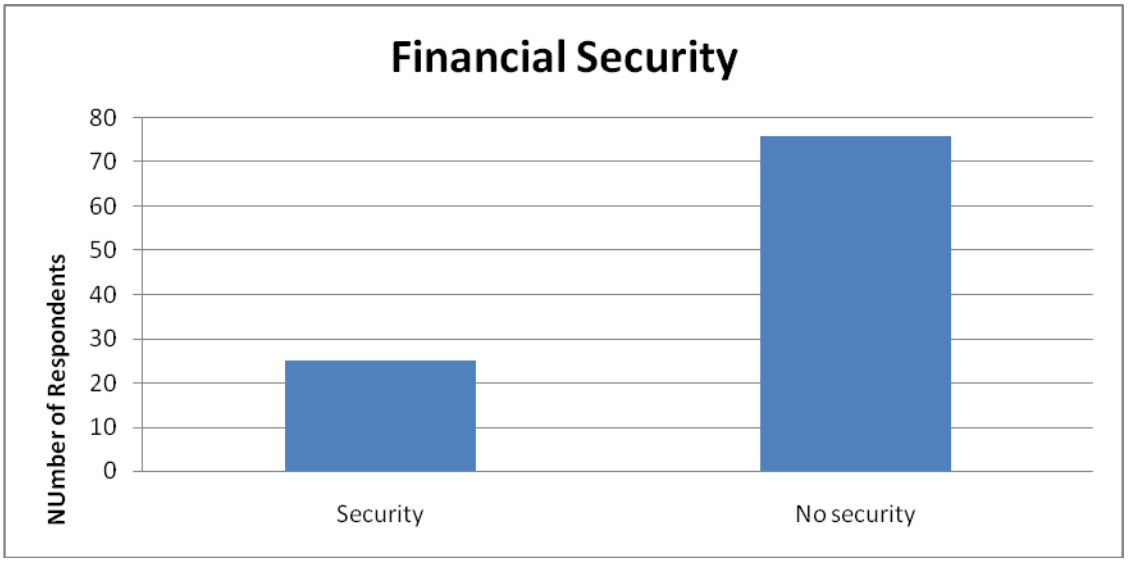


Figure 5.12 Financial securities of the respondents, survey data, 2013

5.6. Empirical Analysis

5.6.1 Determinants of risk: Probit results

The probit model successfully estimated the significant variables associated with the farmers' risk perception. The following variables were found to be significant determinants in the farmers decision to take risk in the study area: sex, age, occupation, type of plot, size of plot(land), tenure system, years in tenure, source of water (water accessibility), water rate and irrigation system. A positive and significant relationship between risk and sex depict that male farmers are at lower risk aversion as compared to their female counterparts, however studies by kisaka- lwayo (2005) did not observe any gender differences in risk propensity towards 'contextual' decisions and concluded that gender stereotype may not reflect male and female attitudes toward risks. Experiments have shown that context matters in relation to gender differences and risk attitudes (Schubert et al., 1999).

Age is significant indicating that older farmers tend to be more willing to take risk. While this is not consistent with findings in most extension studies, in the study area, the average age of the farmers is over 49 years. Similar findings have been recorded by Matungul (2001). Farming in the study area and many rural areas of South Africa is undertaken by older farmers as the younger members of the household migrate to urban areas in search for jobs. Farming in many instances is also considered as an alternative option to retirement from wage employment. A similar relationship between risk and the age of the farmer was found by Hossain *et al.* (1992) who revealed that the probability of taking risk increased with age among farmers in Bangladesh. Similarly in China, Feng and Chenqi (2010) established in their study on Sustainable Agricultural Technologies (SAT) that the adoption of SAT is higher among older farmers than younger farmers. This is probably due to previous knowledge gained as these were earlier technologies introduced in Northern China and hence farmers had more experience in using them.

Occupation i.e. non-farm income is significant and this is due to the fact that farmers who have other income apart from the farm are more willing to take risk or are less risk averse. This is supported by studies by Kisaka-Lwayo (2005) in Kwazulu-Natal

where income was found to be negatively correlated to risk aversion. Type and size of plot were found to be significant to risk due to the fact that farmers tend take risk when there is enough resources available for them and thus if there is enough land available they adopt to new technologies. However cultivating more land could be a risk coping strategy for the risk averse, but as most of the farmers in the study area resource poor, more land means more resources to be allocated to farming and hence this may tend to create less willingness to take risk.

The tenure system (land tenure) security of the farmers is statistically significant. This implies when farmers have security of land tenure the tendency to risk is higher. The farmer‘s perception of tenure security was assessed by the rights the household can exercise on his/her own cropland by building structures. However it should be noted that in the study area, land ownership is customary and farmers have permission to occupy. A study undertaken by Smucker, White and Bannister (2000) on land tenure and the adoption of agricultural technology in Haiti found that formal title is not necessarily more secure than informal arrangements. Informal arrangements based on traditional social capital resources assure affordable and flexible access to land for most people. The perceived stability of access to land via stability of personal and social relationships is a more important determinant of technology adoption than mode of access.

The years of tenure are significant because the more experienced farmers are more willing to take risk as compared to less experienced farmers as they seem to have more knowledge farming. Water rate and source of water are significant and positively related to risk because of the availability of water in the study area as the area is surrounded by rivers and dams, although they may need water rights and good irrigation systems. Information on crop production is positive and significant and this indicates that farmers in the study area have indigenous knowledge on crop production and may also receive it from the extension officers.

Risk preferences could be explained by individual psychological factors and it may be important to estimate individual risk preferences or identify factors that affect the individual’s capacity to bear risk or consider their risk environment.

Table 5.4 Socio- economic statistics variables, Eastern Cape

Variable	Std. error	Z	Significan
HHSIZE	0.024	-0.470	0.638
SEX	0.112	3.127	0.002**
AGE	0.004	-3.510	0.000***
LEVELEDU	0.160	0.664	0.507
OCCU	0.119	-5.117	0.000***
TYPEPLOT	.135	-6.303	0.000***
SIZEPLOT	.037	-10.046	0.000***
TENURESYSTEM	.102	-5.805	0.000***
YRSOFTNR	.008	-19.445	0.000***
SOURCEH2O	.119	3.932	0.000***
H2ORATE	.016	-6.289	0.000***
H20PAYING	.732	6.023	0.000***
IRRIGATIONSYSTEM	.135	-5.841	0.000***
FINCLSCURTY	.092	-0.082	0.935
CLMTUNCRTN	.093	-.0204	0.838
INFOCRP	.111	4.105	0.000***
INFOMRKTS	.105	-3.339	0.001**
PLGHNGMTHD	.125	-4.413	0.000***
INTERCEPT	.394	0.543	0.587
Goodness- of-Fit			
	Chi-Square	df	Sig.
Pearson	5.084E+037	77	.000

Source: results from SPSS version 21, where, *, ** represents statistical significance at 10% and 5% respectively.**

5.6.2 Determinants of Risk preferences: Multinomial results

There is a positive and significant relationship between household size and farmers who perceive farming as severe risk. This finding supports the interpretation that a larger family size implies higher subsistence consumption needs and aversion to risk. Hollaway *et al*. (2002) had a similar result and interpreted it as a confirmation that higher subsistence pressure leads to greater adoption of new agricultural technology aimed at improving food access among households. Feinermann and Finkelshtain (1996) found that larger family size leads to more cautious and conservative behaviour, while Dillon and Scandizzo (1978) found that farmers with larger households were less risk averse. The potential to meet peak labour demand also highlights the importance of the availability of family labour.

Water rate is significant and positively related to risk. This could be because farmers who perceive farming as severe risk are mostly residing in areas which are far from rivers and dams and are unable to easily access water. Irrigation system is also positively and significant to farmers who perceive farming as risky, these is because most of these farmers do not have sufficient and efficient irrigation systems for a good production.

Table 5.5 Risk attitudes of farmers in the former Ciskei homelands, Eastern Cape

VARIABLE	Minor risk			Severe risk		
	B	Std. error	Significance	B	Std. error	Significance
INTERCEPT	-3.015	2.089	0.149	2.093	2.380	0.379
HHSIZE	0.083	0.149	0.580	-0.340	0.182	0.061*
SEX	-.012	0.641	0.986	0.470	0.739	0.525
AGE	0.039	0.023	.0094	-0.016	0.027	0.542
LEVELEDU	0.984	0.959	0.305	1.600	1.331	0.229
SURCEH2O	0.388	0.672	0.564	-0.422	0.807	0.601
H2ORATE	0.027	0.022	0.221	0.083	0.026	0.002**
IRRIGATION SYSTEM	-0.208	0.709	0.769	-2.428	1.043	0.020*
FINCLSCURTY	-0.733	0.681	0.282	-1.207	0.799	0.131
INFOMRKTS	-0.131	0.630	0.835	-0.781	0.689	0.257

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	188.877	182	0.348
Deviance	166.019	182	0.796

Source: results from SPSS version 21, where, *, ** represents statistical significance at 10% and 5% respectively**

5.7 Chapter Summary

In summary smallholder farmers risk preferences is dependent on a number of factors, such as age, income, occupation, water rate, irrigation systems etc. hence this also has an effect on the adoption of new agricultural technology. They are also different farming systems that the farmers use and they have access to land, although they is limited access to inputs such as seeds, fertilisers and pesticides. Both groups are willing to take risks. The probit model successfully estimated the significant variables associated with the farmer‘s adoption decisions and these are: age, sex, tenure system, years of tenure and water rate. The multinomial logit also proved the significance of water rate, irrigation system and the importance of household size in decision making. The study also found that older farmers tend to be adopters supporting findings by Feng and Chenqi (2010).

CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1. Introduction

This chapter summarises the main findings of the study and concludes on the basis of the findings derived from the descriptive analysis and the empirical results. It discusses the extent to which objectives and hypotheses posed at the beginning of the study have been addressed by the analysis. Furthermore it also generates the recommendations on the basis of the results.

6.2. Summary

The summary contextualizes the study by highlighting the state of agriculture, agricultural technology adoption, risk and risk management. Furthermore, it also gives an overview of the methodology used in the study and the results. The results highlight the outcome of analysis for the various models. These establish the determinants of risk and risk management by smallholder farmers and homestead food gardeners. The recommendation of the study outlines the policy implications and areas for further studies.

6.3. Conclusion

Today, Africa appears to have a monopoly on poverty and hunger. New technologies and access to seeds and inputs and better management practices are critical to changing this situation, but they are by no means sufficient. To unlock the potential of smallholder farmers to fight hunger and food insecurity, and to bring prosperity, these innovations must reach farmers. Investment in research and technology development is critical in transforming Africa's agriculture. From the summary findings presented above policy proposals, recommendations and areas for further research are presented below.

6.4 Recommendations

The farmers can also adapt to the use of draught power for ploughing and transporting goods from the field to their homes or the markets. This will help reduce costs of hiring a tractor since it is generally expensive and impossible for some farmers to hire tractor due to lack of funds. Despite the costs, they are few tractors available for high meaning that they cannot cater for the high demand in tractor use, in other words this makes draught power a better option. Furthermore the researcher recommends that farmers can have more access to market information so that they can be able to sell they produce at the current prices and also to be able to know the products that are one demand.

6.5. Policy implications

This study sought to identify among others, independent variables that explain the risk preferences and thereby facilitate policy prescriptions to augment adoption in South Africa and around the world. Risk is an independent variables used in the probit analysis revealed some underlying patterns of influence. Given the limited prospect of identifying such variables through further research, it is concluded that efforts to promote technology adoption will have to be tailored to reflect the particular conditions of individual locales. The propensity of adoption decisions by neighbourhoods to affect others must be given due importance, for price marketing, extension delivery and development purposes, while delineating target domains for introducing new technologies especially where resources are limited. An insight into the sources of risk has clear implications as to how the perceived riskiness may be reduced, thus increasing the likelihood that relatively more risk averse farmers will adopt new agricultural technology.

Nevertheless, the adoption of farming technologies, productivity and growth is a dynamic process that requires persistent research and development programmes. Therefore to maintain and further improve productivity and growth, there should be continued investment in agricultural research aimed at generating new and improving old technologies that could shift the production frontiers and improve the

efficiency of input use. Research and development programmes can be undertaken by Government, development agencies and or research institutions. This will provide a basis for knowledge dissemination and documentation.

Identified sources of risk faced by smallholder farmers provide useful insights for policy makers, advisers, developers and sellers of risk management strategies. This information can yield substantial payouts in terms of the development of quality farm management and education programs as well as the design of more effective government policies. New technologies and rural development programs need to be tailored to the risk attitudes of a particular group of farmers if they are going to be effective. Due to the unwillingness nature of these smallholder farmers, policy makers need to develop strategies that enable them better manage and reduce risk while mitigating against the identified sources of risk.

Some of the sources of risk were common across the farmer groups. These include the uncertain climate and lack of cash and credit to finance inputs. This shows that communication and joint-problem solving may help to address some of the challenges. Investment in water harvesting technologies will ensure availability of water throughout the growing season and alleviate the risk associated with drought. Agricultural credit should be extended to farmers through service cooperatives and extension programmes. Input credit should be widely applied to enable farmers adopt improved agricultural technologies.

While lack of liquidity may remain a risk in the short and medium-term for rural farmers, alternative sources of fund need to be considered through lobbying government to assist with legislation on the acceptance of Permission to Occupy (PTO) documentation as legitimate proof of ownership. Farmers can also access credit through Small Enterprise Development Agency (SEDA) that funds cooperatives and other legally registered farming organizations. Upgrading storage facilities should start at farm level to retail level to increase the shelf life of the produce and also ensure price stability. Improving the efficiency of the distribution channels and forward linkages will result in better turn around time for payment.

Contract farming will limit the risk associated with unreliable market and prices for producers while buyers will have a guaranteed supply of organic produce. More information on market and consumer preferences would enable the farmers better understand how to meet market demand. It is important to note that while information on organic production and marketing are readily available at the Department of Agriculture, South Africa and on the internet through various economic bureaus, the challenge remains accessibility, packaging and dissemination to smallholder farmers. This could be addressed through the use of extension agents, farmer field days and forums for information exchange. Supplementary policy interventions that are aimed at improving access to credit and markets will reduce poverty and impact on risk behaviour of farm households. In the long run, broad based economic development including the development of credit an insurance markets is the most certain way to correct the existing imperfections and reduce the level of risk aversion among farmers. There is also a need for the development and investment in new technical packages which enable yield to withstand unexpected changes in weather condition and are highly reliable in on-farm practice.

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APPENDIX

Appendix I- Questionnaire

UNIVERSITY OF FORT HARE,

DEPARTMENT OF AGRICULTURAL ECONOMICS

Risk preferences of smallholder irrigation farmers in the former Ciskei Homelands of the Eastern Cape, South Africa

Questionnaire number ☐ **Name of Interviewe** ☐ **Local Municipality** ☐

Village ☐ **Smallholder irrigation farme** ☐ **Homestead food gardene** ☐

A.HOUSEHOLD DEMOGRAPHIC INFORMATION

Position in the household	**Head**	**Spouse**	**Child**	**Child**	**Other**	**Other**	**Other**	**Other**	**Other**
1. Gender	M ☐ F ☐	M ☐ F ☐	M ☐ F ☐	M ☐ F ☐	M ☐ F ☐	M ☐ F ☐	M ☐ F ☐	M ☐ F ☐	M ☐ F ☐
2. Age in years									
3. Highest level of education 1-No formal Education 2-Primary 3-Secondary 4-Tertiary 5-Others									
4. Occupation									

1-Retired 2-Unemployed 3- Farmer 4- Employee 5- Self employed 6- School/ pre-school									
5. Salary income (R / mon)									

B. LAND USE AND ACCESS

6. Type of plot 1-Homestead (Water source – e.g. tap at home, communal tap, borehole spring etc) 2-Irrigated land (fields) (Water source, reliability, quantity, timing) 3-Dry land	Size and number (Hectares, acres, square meters	Tenure system 1-Own 2-(communal) 3-Lease 4-Other (Specify)	Time (yrs) for which tenure has been held?	Fees(R) (For water, for land. Specify how much and to whom)				Ploughing Method 1-Own tractor (specify whether hire it out, price, average income) 2-Hire tractor, price, 3-Hand tools 4-Employ labour (specify times, number of people and rates)
				water (R)		land (R)		
				Price (R)	To who	Price (R)	To who	

C. PRODUCTION INFORMATION

7. Fill in the following information on production

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

6-Potatoes								
7- Other (Specify)								

D. IRRIGATION AND SOURCES OF WATER (Please tick the appropriate answer)

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

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

e. harvested water ☐ f. Individual tanks ☐ g. other Specify----------

10. Do you pay for water? a. Yes ☐ b. No ☐

11. If yes, how much(R) is the rate? ☐

12. Which type of irrigation system do you use? a. Sprinkler ☐ b. Drip irrigation ☐ c. Furrowing ☐ irrigation

d. Pivot ☐ e. Others (specify) ☐

E. FINANCIALS

13. Credit and cash loans

A. Amount of cash Borrowed/ credit used	Tick	Main purpose of the loan/ credit	Tick	Source of Credit	Tick	Financial Security	Tick
1.Less than R5000		1.Family support		1.Bank		1.Insurance	
2.R 5001- R10 000		2.Education of Children		2.Lender		2.Other (Specify)	
3.R10 001- R15 000		3.Inputs		3.Governmantal Institutions			
4.R15 001- R20 000		4.Other (specify)		4. Other (Specify)			
5.R20 001- R25 000							

F. RISK

14. Rank the following sources of risk from 1 to 3 where 1 is no problem and 3 is a severe problem (tick where appropriate)

Constraint	1 No problem	2 minor	3 severe	Constraint	1 No problem	2 minor	3 severe
1. Livestock damage crops				9. Inputs not available at affordable prices			
2. Uncertain climate (e.g. draught)				10. Tractor is not available			
3. Uncertain prices for products sold to markets				11. Cannot find labour to hire			
4. More work than the family can handle				12.Cannot access more crop land			
5. Lack of cash and credit to				13.Delays in payment for products			

finance inputs							
6. Lack of information about producing crops				14. Lack of proper transport for products)			
7. Lack of information about alternative markets				15.Other (specify			
8. Lack of proper storage facilities							

15. Compared to other household decision makers in the area, are you more likely, less likely or equally likely to take risks?

a. More likely ☐ b. Less likely ☐ c. equally likely ☐

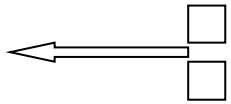
16. If a new farming technology (e.g. a new variety of seeds) were available, compared to other farmers in this area, would you be:

a. Early adopter ☐ b. Would you wait and see attitude ☐

17. The table below lists the six choices, each gamble with an equal chance of realizing the lower or higher pay off. Indicate which of the six choices you would most prefer: A, B, C, D, E or F

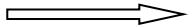
CHOICE	PAYOFF1(RANDS)	PAYOFF 2 (RANDS)
☐ A	100	100
☐ B	90	180
☐ C	80	240
☐ D	60	300
☐ E	20	380
☐ F	0	400

18. If you are faced with an option to take a gamble or the option to receive a sure amount of money, which do you prefer?



Option 1: A coin is tossed: TAIL: You win R380 HEAD: You win 20

Option 2



R220	R200	R180	R160	R140	R120	R80

19. Please consider the gambles below: which of the two gambles would you rather play?

Option A	**Option B**
☐ 50% chance to win R100 50% chance to lose R15	☐ 90% chance to win R100 10% chance to lose R10

20. Please consider the options below: which one is more attractive?

Option A	**Option B**
☐ Receive R250 today	☐ Receive R300 in a week

21. If you are faced with an option to take a gamble or the option to receive a sure amount of money, would you play this game?

Heads	**Tails**	**Yes**	**No**
Loose R50	Win R 100		
Loose R60	Win R 100		
Loose R70	Win R 100		
Loose R80	Win R 100		
Loose R90	Win R 100		
Loose R100	Win R 100		
Loose R150	Win R 100		