Smallholder livestock farmers' willingness to buy index-based insurance in South Africa: Evidence from Ngaka Modiri Molema District Municipality, North West Province

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DECLARATION

I hereby declare that the study "Smallholder livestock farmers' willingness to buy index-based insurance in South Africa: Evidence from Ngaka Modiri Molema District Municipality, North West Province" is my original work and has not been submitted in partial for any degree purposes to any other university. All the sources used or quoted have been indicated and acknowledged by means of complete references.

Name: Mokgethoa Mosebjadi Tlholoe

Signature:..

Date:____/____/20_____

DEDICATION

What words can I use to show great appreciation to the great work that the Lord I serve has done for me? There is none I can say that is enough for His great mercy He showed upon my life. Father, my Comforter I am grateful. With great humbleness, fear and respect, I dedicate this work to Him.

To my son “mommy’s first born” Tebogo Ngwato Sebaka, for the joy he brought into my life. Your birth in this world was indeed a blessing.

Also, I dedicate this work to my mother, Francina Ramakgahlele. I am grateful for the emotional support, undying love, warmness, encouragement and unending prayers, they kept me going.

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ABSTRACT

Livelihoods of rural households in developing countries are threatened by climatic risks. The poor and vulnerable agricultural households, who are generally subsistence farmers, feel the most intense effects of these risks. Farmers, in their attempt to cope with climate variability, have adopted a number of coping strategies. However, these coping strategies often prove to be ineffective. Financial instruments like insurance facilities can help cushion farmers against these risks. The challenge, however, is that insurance markets are underdeveloped and often non-existent in low income countries mainly due to problems of adverse selection, moral hazards, high monitoring and administration costs. For this reason, one innovation, known as index based insurance (IBI), has attracted significant consideration to help farmers better adapt to climate change. Several countries in Africa have implemented the use of IBI. However, South Africa, despite the available evidence of farmers affected by natural risks is yet to introduce IBI. Furthermore, apart from attempts to study the possibility of introducing IBI in South Africa, no empirical evidence has been provided on the acceptability of index based insurance by local farmers who happen to be the key stakeholders in such interventions. To this end, the study investigated the smallholder farmers' willingness to buy IBI, identified livestock farmers' perception on sources of risk and their managerial responses and examine factors underlying farmers' willingness to buy IBI. The used data was collected from Ngaka Modiri Molema district municipality with a sample of 330 livestock farmers collected through the use of a questionnaire survey. To elicit farmers' willingness to buy IBI, farmers were given a brief background of the concept before there were asked if they would be willing to buy IBI or not. About 14.55% of the sampled farmers were not willing to buy index based insurance. A larger proportion of 85.45% was willing to buy index based insurance of whom 65.45% were less willing, while 13.64% and 6.36% were moderately and more willing, respectively. Farmers' perception on sources of risk and their managerial responses to risk were identified through the use of Principal Component Analyses. Ordered logistic regression model was used to examine factors influencing farmers' willingness to buy IBI. The results revealed that farmers' willingness to buy IBI was significantly associated with age of household head, gender of household head, education level, dependency ratio, the extent of livestock diversification, household size, land tenure, experience of loss, financial and marketing risks, elimination of government support and sources of income. Further insight into the factors influencing farmers' willingness to buy IBI stands to benefit policy makers, current, and prospective insurance providers in their design for IBI. Based on the conclusion drawn from the study, it is recommended that the government should make an effort to sponsor IBI under the provision of a subsidy, workshops and surveys that focus on the elements of trust in the designing and implementation of IBI should take place and that greater priority should be in promoting programs to better educate farmers on how to assess risk management tools.

Keywords: Natural risks, drought, Index based insurance, willingness to buy, Ordered Logistic regression model, South Africa

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LIST OF ACRONYMS

AAMP	African Agricultural Markets Program
ARC	African Risk Capacity
DAFF	Department of Agriculture Forestry and Fisheries
FAO	Food and Agriculture Organization
HARITA	Horn of Africa Risk Transfer and Adaptation
IBI	Index Based Insurance
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Center
NDVI	Normalized Difference Vegetation Index
OA	Oxfam America
SSA	Sub-Saharan Africa
SDIB	Sustainable Development Innovation Briefs
WFP	World Food Programme

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Agriculture is an important economic sector in many developing nations providing a source of livelihood and food security to people who reside in the rural areas, particularly in Sub-Saharan Africa (SSA) (World Bank, 2008). In addition, the agricultural sector can stimulate growth and reduce poverty. In developing countries, one of the major challenges is variability in inter-annual rainfall which is not only faced by farmers but also the whole economy. For instance, 95% of the land used for crop production in SSA is dedicated to rain-fed agriculture and more than 90% of the population's basic food requirements are dependent on rain-fed agriculture (FAO, 2000).

The high dependence of agriculture on climate makes producers more vulnerable to weather-related natural disasters (Thornton *et al*., 2008). Therefore, if agricultural production, particularly in SSA countries is adversely affected by climate change, the livelihoods of a large number of the rural poor will be put at risk and their vulnerability to food insecurity increased. Concerns about the additional challenges that climate change poses to agricultural development in order to meet poverty reduction and food security has risen sharply in the international and national policy agenda in recent years (World Bank, 2008).

The occurrence of extreme weather conditions will continue to have serious impacts on the four dimensions of food security (food availability, food accessibility, food utilization and food system stability). Effects are already being felt in global food markets, and are likely to be particularly significant in specific rural locations where crop and livestock enterprises are failing and productivity is declining. Impacts are being felt in both rural and urban locations as supply chains have been disrupted, market prices increase, assets and livelihood opportunities are lost, purchasing power falls, human health is endangered, and affected people are unable to cope (Skees and Barnett, 2006).

With particular reference to farming, the variations in productivity induced by nature cannot be fully accommodated by farmers, particularly smallholders. The literature indicates that for a long time farmers have devised measures to limit the effects of natural risks (World Bank, 2005). Such measures include crop rotation and diversification, intercropping, use of low yield but stress tolerant varieties, tillage systems, share tenancy, livelihood diversification into non-farm sources of income, and informal financial arrangements, among others (World Bank, 2005). Some of these measures rely on risk spreading (Roncoli *et al*., 2001) while others rely on the use of both traditional and scientifically derived seasonal climate forecast (Klopper *et al*., 2006; Patt *et al*., 2007 cited by Patt *et al*., 2009). Furthermore, despite the fact that some of these measures continue to be helpful, agricultural productivity, in general, continues to be negatively affected and income derived from the sector has been very unstable and difficult to project.

Against the backdrop of such threats, a number of researchers and development organisations (e.g. World Bank, 2005; Barnett and Mahul, 2007) posit that agricultural insurance can be used to transfer the risk of extreme weather events from individual producers. Insurers play three key critical roles within the financial sector. They act as underwriters, accepting risks from clients and arranging reimbursement after claims have occurred (World Bank, 2005).

1.2 Research problem and justification for the study

While financial instruments like insurance facilities can help cushion farmers against losses caused by factors beyond their control, the challenge, however, is that insurance markets are underdeveloped and often non-existent in lower income countries (Skees and Barnett, 2006). This is mainly due to poor contract enforcement, asymmetric information, and high transaction costs. Such challenges, particularly information asymmetry, are very common with traditional insurance and generally manifest themselves as a result of moral hazard and adverse selection (Skees and Barnett, 2006).

Adverse selection arises as a result of the potential for *ex ante* opportunism because private information is hidden by one party prior to a transaction. This may happen in insurance markets where potential clients who are most likely to produce an undesirable (adverse) outcome (i.e. high risks) are those who most actively seek insurance cover and stand a chance to be selected as insurance providers may not have the full information in relation to their risk profile (Swinnen and Gow, 1999). Because of the unobservability of such pertinent private information, the insurance company ends up with a set of clients in which the high risk segment of the population is over-represented. As a consequence of this adverse selection, the insurance company could be forced to raise premiums, leading to another version of adverse effects as the insurance provider may become unattractive even to average risk groups (Douma and Schreuder, 2013).

Moral hazard arises as a result of the potential for *ex post* opportunism because of information asymmetry or hidden actions of transacting parties. The anticipation that such hidden actions are possible may also prevent the transaction altogether. When the actions of the farmer (agent) cannot be observed by the insurance company (principal), yet these actions have a direct bearing on the economic return of both, the former has an incentive to act opportunistically in attempting to capture any gains possible, whereas, the insurance company may incur transaction costs in monitoring the actions of the farmer and enforcing the terms of a pre-agreed contractual arrangement (Hobbs and Kerr, 1999).

In an attempt to address such challenges, several developing countries have introduced the use of weather index insurance. Unlike the 'traditional' insurance instruments, index insurance pays indemnities based not on the actual losses experienced by the policyholder, but on realisation of a weather index (created based on an objective measure such as rainfall or temperature) that is highly correlated with actual crop failure or livestock mortality (Barnett and Mahul, 2007). While index insurance has its own shortfalls, largely emanating from basis risk, which is commonly experienced in semi-arid or arid areas where climate variability is relatively high, this innovation reduces the cost of providing insurance thereby allowing insurance providers to reach even poor households. It is also relatively transparent and reduces the likelihood of moral hazard and adverse selection as the index is created based on data that cannot be influenced by the policy holders' actions (World Bank, 2005; Barnett and Mahul, 2007; Giné, Townsend and Vickery, 2007).

In Africa, index insurance has been successfully used in several countries including Ethiopia, Kenya, Malawi, Morocco, Senegal, Tanzania, and Zimbabwe, drawing lessons from Asia and South America (World Bank, 2005; Barnett and Mahul, 2007). South Africa is yet to introduce index insurance despite the available evidence of farmers affected by natural risks, which are beyond their control. Furthermore, no studies have been conducted to provide empirical evidence on the acceptability of index based insurance (IBI) by local farmers. What is currently available are desktop studies (e.g. Mapfumo, 2007), which focused on the possibilities of introducing IBI in South Africa. Worth noting, however, is that the available literature has no information from farmers who are the key stakeholders in this intervention. Farmers' involvement in such studies is very crucial given that if such interventions such as IBI are introduced in the local economy, their long term sustainability will, to a large extent, be determined by farmers' decisions of whether or not to buy the IBI and the different levels of premiums they are willing the pay. Given the fact that available insurance products in South Africa are not index-based, the common perception is that farmers may contend that the available policies fall short of mitigating the effects of their current major sources of risk, and as a result they may be reluctant to use the available packages as part of their risk management strategies. This study, therefore, sought to assess the appropriateness of an IBI facility in South Africa, using evidence from smallholder livestock farmers from Ngaka Modiri Molema district municipality in the North West Province.

Livestock farming in South Africa is an important source of employment. Evidence from the Department of Agricultural Forestry and Fisheries (DAFF) (2006) and Meissner *et al*. (2013), for instance, suggests that the beef industry alone employs about 420 000 people while 2 125 000 depend on it as their main source of livelihood. For semi-arid areas, such as the Ngaka Modiri Molema district municipality, livestock off-take for sales tends to assume greater importance given that arable agriculture, particularly under rain-fed conditions, is less viable and herd owners can hardly rely on crop production for income and food security (Shackleton *et al*., 2005; DAFF, 2006). Given the central role of livestock farming in the rural economy, particularly in semi-arid and arid regions, it is important to find ways of translating livestock dependence into a sustainable and less risky source of income growth.

Overall, the results of the study stand to benefit policy makers, current, and prospective insurance providers in their understanding of farmers' preferred risk management options. Considering the fact that traditional insurance has excluded the majority of smallholder farmers due to high premiums, providing empirical evidence in relation to weather-based index insurance will also help inform the process of developing policy interventions aimed at improving risk management within the smallholder subsector. The study was guided by the following research questions.

1.3 Research questions

i. What are smallholder livestock farmers' perceptions on sources of risk?
ii. What risk management strategies are currently employed by smallholder livestock farmers?
iii. Are smallholder livestock farmers willing to buy index based insurance (IBI)?

iv. What factors influence smallholder livestock farmers' willingness to buy IBI?

1.4 Objectives of the study

The main objective of the study was to investigate smallholder livestock farmers' willingness to buy IBI in North West Province. Specifically, the study sought to:

i. Identify livestock farmers' perceptions on sources of risk;
ii. Identify smallholder livestock farmers' managerial responses to risk;
iii. Investigate smallholder livestock farmers' willingness to buy IBI;
iv. Examine the factors underlying smallholder livestock farmers' willingness to buy IBI.

1.5 Organisation of the dissertation

The rest of the dissertation is organised as follows: The next chapter, Chapter 2, reviews literature related to the subject. Chapter 3 presents the methodology which includes data collection procedure, the empirical model and hypothesised variables. Results are discussed in Chapter 4 including characteristics of survey respondents, risk management strategies of respondents and investigation of factors influencing decisions of respondents of whether or not to buy index based insurance. The dissertation concludes with policy recommendations in Chapter 5.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature related to the study. It begins with a discussion of weather related risks affecting farmers in Africa followed by risk management strategies employed to counter the risks. The third section reviews innovations in agricultural risk management, including index based insurance (IBI). The fourth section describes the application of IBI in the livestock sub-sector. Current status of agricultural insurance is presented in section five, while feasibility analyses of IBI in South Africa is reviewed in section six. The chapter concludes with a review of IBI experiences and a conceptual framework for agricultural insurance uptake by farmers.

2.2 Weather related risks in Africa

Weather related risks are major causes of food insecurity for farmers whose livelihoods are dependent on agriculture in developing countries. These farmers face persistent disastrous climate events such as drought, floods, hail and abnormal wind (Miranda and Farrin, 2012; Maponya and Mpandeli, 2012). There is evidence for the increasing risk of drought as anthropogenic global warming progresses and produces both increased temperatures and increased dry land. The world's extremely dry areas have increased more than twice since the 1970s, and the highest increase was in the early 1980s due to an El Nino Southern Oscillation-induced precipitation decrease and a subsequent expansion primarily due to surface warming, while the world's most wet areas decreased slightly during the 1980s (Dai *et al*., 2004). Together, the global land areas in either very dry or very wet conditions have increased from 20 to 38 percent since 1972, with surface warming as the primary cause after the mid-1980s.

South Africa is dominated by extensive agriculture. It is predominantly arid and exposed to a highly variable climate (du Pisani, Fouche and Venter, 1998). Limiting land degradation, maintaining the financial viability of farms and improving the risk-management skills of farmers are common problems that the South African government and agricultural industry are attempting to address (O'Meagher *et al.,* 1998). South Africa is currently refining its approach to drought management, and has been making substantial use of science in improving the monitoring and assessment of drought, and the management of the land. The approach is being reviewed against the backdrop of a fundamental reorientation of broader agricultural policies in the context of the country's transition to a fully-fledged democracy. The changing approach to drought policy in South Africa can therefore only be fully understood in the context of this broader process of change (du Pisani *et al*., 1998).

Rural communities with less than enough resources face a number of problems that reduce their livelihood options and overall quality of life (Reid and Vogel, 2006). Climate stress in Southern Africa could potentially further curtail the livelihoods of such communities. If the planned response and adaptation options to risks, including climate stress, are not suitable, this could further undermine development efforts in the region. The design and effective implementation of strategies to improve coping and adaptation to possible future risks cannot be undertaken without a detailed assessment of current response options to various risks.

2.3 Risk management strategies employed by farmers

The concern raised by the South African government regarding the risk management strategies was a judicious resolution as the decision will not only facilitate farmers' access to financial security, but also protect farmers against risks such as drought. There are two predominant risks identified to affect income of agricultural producers: price risks; and production risks. The former refers to a variety of market prices for agricultural commodities and production inputs, while the latter involves variety in the quality or size of the product (Sustainable Development Innovation Brief (SDIB), 2007). This study focuses on one of the most persistent production risks, weather related risks.

Weather-related risks affect all parts of the agricultural supply chain, predominantly in economies that are dependent on rain-fed agriculture (Miranda and Farrin, 2012). The effects of weather-related risks are not only felt by agricultural producers, but also circulated through the marketing chain of agricultural production. This happens mostly through contractual relationships. For instance, if a weather-related event occurs, resulting in extensive livestock mortality or forage deficit, agricultural stakeholders (e.g. input suppliers, cooperatives) who play a role in offering farmers with financial assistance or marketing contracts will be at risk of facing a high demand for financial assistance and failure of contract performance by affected farmers. In the case where weather related risks such as drought are left uninsured, efficient agricultural credit markets can be limited, productive farm activity investments can be destabilized and adoption of new technologies can be depressed (Miranda and Farrin, 2012).

Furthermore, the effort made by the poor in developing countries to come out of poverty may be delayed.

The poor and vulnerable agricultural households, who are generally subsistence farmers, feel the most intense effects of weather related risks. Farmers have managed weather related risks by means of traditional measures including application of less risky technologies and risk avoidance producing practices, use of diversification in terms of production activities on-farm and income generating activities and informal and formal risk sharing arrangement (Ligon, Thomas and Worall, 2002; World Bank, 2005; Dubois, Jullien and Magnac, 2008). Informal risk sharing arrangements refer to arrangements that individuals, households or groups such as communities engage themselves in for the purpose of controlling risk. Producers usually opt for complete risk avoidance strategies even in the event where income gains are to be greater than for fewer choices that are risky. To reduce crop failure as a result of weather events, pests or insects, traditional cropping systems such as crop diversification and intercropping are performed. Other arrangements include crop-sharing and risk pooling at community level whereby renting, hiring labour and group members transmit resources among themselves can offer valuable ways of sharing risk among individuals, households or communities (Hazzell, 1992; World Bank, 2001). The above strategies are *ex ante* responses.

In case of the need for risk management mechanism after a risk event, selling of assets (land or livestock) or reallocating labour resources to off-farm labour activities are income-smoothing strategies (World Bank, 2001). The above measures may be helpful, particularly to low magnitude losses that do not affect all households in an area. However, to widespread weather shocks or risks that are severe although infrequent these often prove to be ineffective. Weather-related risks such as droughts to be precise, usually affect the entire community at once, making informal risk sharing arrangement insufficient (SDIB, 2007). Given the above, there is a need for risk management mechanisms that would allow farmers to transfer the risk to insurance markets. Formalized insurance markets that can be able to protect and pay a large number of farmers in a given area against weather shocks are required. This would not only allow agricultural producers to protect themselves against risk, but allow them to have greater access to credit (Africa Agricultural Markets Program (AAMP), 2010; SDIB, 2007).

2.4 Innovations in Agricultural insurance

There are few insurance mechanisms that protect agricultural producers against weather-related risks efficiently. Practiced mostly in developed countries, traditional, multi-peril crop insurance regularly excludes weather shocks such as drought. Traditional agricultural insurance, in the quest to include weather, determines pay-outs on the basis of loss assessment through yield observations during harvest time. During assessment, individual farm visits occur to evaluate the damage of a weather event and the costs of this assessment are more considerable and higher in developing countries when farmers are operating on a small scale (AAMP, 2010). Other costs include obtaining data that is needed to establish accurate premiums and processing claims. In addition, for the purpose of preventing high losses than the initial rating, significant investments are required to monitor farm yields. Furthermore, traditional agricultural insurance needs additional costs for proving reinsurance since it has greater correlated risks. Simultaneously, a block is created between the prices that farmers are willing to pay and the prices that insurers are willing to accept. Given these features, traditional insurance is considered too expensive for smallholder farmers, thus it becomes more appropriate for large commercial farmers. Therefore, newly developed alternatives to the traditional insurance programs have been introduced to make insurance more affordable to smallholder farmers in developing countries. One alternative is the index based insurance (IBI) discussed in the next sub-section.

2.4.1 Index based insurance

IBI is a micro-insurance initiative designed to cover the potential losses that are related to variability of climate experienced by smallholder farmers (Churchill, 2006). Its products are constructed on local weather indices, preferably those that are highly correlated with local yields. Using a combination of measurable objective parameters, a weather index can be constructed using any combination of objective parameters such as measurements of rainfall or temperature on an agreed period of time at a distinct weather station (International Fund for Agricultural Development (IFAD), 2011) that best represents the risk to the agricultural end user.

Historical weather data, yield and related agronomic data are used in IBI to protect households that are vulnerable to specific weather shocks (Osgood *et al*., 2007; Barnett, Barrett and Skees, 2008). Designing an index implies looking at how the objective parameters have or have not influenced yield over time since weather data is gathered.

For an index to qualify as a good index, vulnerability of crops to weather factors during different stages of development must be account for. A farmer can insure production in the case where a sufficient degree of correlation is recognized between the weather index and yield. This could be done by purchasing a contract that pays in the case where the specified weather events occur. As long as the underlying data are of sufficient quality and that the final index can be easily communicated and understood by farmers, then the index possibilities are extensive and sufficiently flexible to match the exposure of the farmer (SDIB, 2007).

Unlike traditional agricultural insurance where the farmer has an advantage of always knowing more than the insurer, with IBI there is a balance of information shared by both the farmer and insurer resulting in less monitoring costs. Furthermore, the need for field visits would be eliminated, resulting in a speedy process of claim settlement and thus reduce transaction and administration costs. IBI can also be reinsured as it is based on an index that is independent, reliable and verifiable (SDIB, 2007).

2.5 Index based insurance for livestock production

Most studies on the uptake of index insurance are rooted on the experience of crop insurance programs. However, the analyses on the demand for IBI including livestock insurance are scarce (Chantarat *et al*., 2013; McPeak, Chantarat and Mude, 2010). Takahashi *et al*. (2016) studied the experimental evidence on the drivers of index based livestock insurance and constructed an index using a standardized Normal Differenced Vegetation Index (NDVI) accumulated during two seasons: the rainy season; and the dry season. NDVI refers to a numerical indicator of the degree of greenness based on remotely sensed data collected by satellites. The insurance contract was designed in such a way that during each sales period, a farmer decides whether to buy index based livestock insurance and how many animals to insure. Take for instance a cow (C), sheep (S) and goat (G) with a value equal to R5000, R700 and R700, respectively. A premium payment is equal to the total insured herd value (TIHV) in South African rands, multiplied by the district or municipality specific insurance premium rate given spatial variety in expected mortality risk. Specifically, the formula below is adopted:

$$(TIHV) = (number\ of\ C\ insured\ \times 5000) + ((Number\ of\ S\ and\ G\ insured) \times 700) \quad 2.1$$

and

$$Payment\ premium = municipality - specific\ insurance\ premium\ rates\ \times TIHV \qquad 2.2$$

A household will be insured from October 1 to September 30 if it buys index based livestock insurance in the August- September sales period and will receive indemnity pay-out in the March and or October of the following year. If the indemnity pay-out is triggered, depending on the NDVI, it will be equal to the minimum premium payment and half of the maximum of TIHV.

2.6 Current status of agricultural insurance in South Africa

Crop insurance in South Africa started in the 1900s and is presently controlled by private insurers (World Bank, 2008). Santraoes, the original cooperative insurer that developed the former multi-peril crop insurance (MPCI) and Commercial Union Agricultural services, initiated the formation of ARS which is the largest existing agency in the local market. Santam later purchased ARS and now acts as its insurer (World Bank, 2008). The second largest market participant is Agricola followed by ABSA and the Mutual and Federal Insurance Company (World Bank, 2008). With crop and livestock insurance being completely voluntary, no type of public support or premium subsidy is available in South Africa. Through a well-developed market, crop hail insurance and MPCI are available in South Africa (World Bank, 2008). A decrease in the quality of the crops as well as their volume is covered, yet cost revenue insurance is not available. Crop insurance covers commodities including cereals, maize, citrus fruits, tobacco and table grapes (World Bank, 2008).

The South African insurance industry has been developed and founded on services offered to commercial farmers. Insurance brokers are the main delivery channel for crop insurance followed by insurers' agents, banks, producer associations and cooperatives. The same delivery channels are also important for livestock insurance, which is growing, however extremely limited. Small and emerging farmers in South Africa have no particular delivery channels. Uncertainties of yield and delivery costs have become factor barriers for small farmers because insurers, due to the same factors, find it difficult to give reason for servicing small farmers.

Just like other farmers in Africa, smallholder farmers in South Africa face high yield variability as a result of weather related risks such as drought, floods and high temperature. The situation becomes worse as they are unable to gain access to high yielding, disease resistant seeds and required inputs such as fertilizers. To have access to the latter, smallholder farmers need to have access to input loans. However, they would need to pledge their assets as collateral to banks in order to have access to the input loans which usually becomes difficult as most of the smallholder farmers do not have the required assets (World Bank, 2008). Therefore, banks usually do not avail loans to smallholder farmers. Medium and large-scale farmers in South Africa do not only have access to finance but also access to risk management mechanisms such as MPCI. The same MPCI available to large-scale farmers has not been attempted to smallholder farmers due to problems such as moral hazards, adverse selection and high administration and monitoring costs (World Bank, 2008).

2.7 Feasibility analysis of index based insurance in South Africa

When designing IBI for a country, the following are relevant: A reliable network of weather stations and quality historical rainfall data covering 30 to 40 years. Where one is using the Water Requirement Satisfaction Index in the crop modelling, evapo-transpiration figures per weather station will also be required; high density of farmers around each specified meteorological station; relatively uniform weather patterns within a specified radius of the weather Station; relatively similar soil water holding capacities for farms insured against a specified Station; institutional delivery channel for reaching farmers who are committed to the project and have the technical capacity to manage this process; ability to provide education and training to farmers; and insurer or risk taker willing to hold risk or act as a market intermediary for the risk (Mapfumo, 2007). It is important for a country to evaluate how it will perform against pre-requites mentioned above before deciding to implement IBI. Table 2.1 indicates whether or not South Africa meets the required pre-requisites.

Table 2.1 Preconditions met by South Africa

Pre-requisite	**Status of South Africa**	**Requisite met or not**
Network of weather station	95 high quality automatic weather stations	Requisite met
Historic data	53 years of good quality data available	Requisite met
Evapo-transpiration data	Available at each of the 95 station	Requisite met
Relatively uniform weather patterns	High co-variance of October to April rainfall figures between stations	Requisite met
Ability to provide education and training	This can be provided by the Opportunity International and the World Bank's Commodity Risk management Group	Requisite met
Institutional delivery channel	To be determined	?
Density of smallholder farmers around weather stations	To be investigated	?
Similar water holding capacities around stations	To be investigated	?
Willing stake holders	Aim of the study conducted by Mapfumo (2007)	?

Source: Mapfumo (2007)

Mapfumo (2007) aimed at evaluating how South Africa performs in terms of the pre-requisites mentioned above and found that IBI is a potential feasible product for smallholder farmers in South Africa provided there are willing stakeholders. Stakeholders could include institutional delivery channels, insurers or reinsurers and project sponsors. This study also aimed at investigating whether or not farmers, who form part of the stakeholders, are willing to participate in the IBI facility.

2.8 Experiences with index based insurance in other developing countries

A pilot humanitarian emergency index insurance project was launched in Ethiopia around early 2006 by the United Nations World Food Programme (WFP) (Skees *et al*., 2004; Mushai, 2008). The WFP purchased drought insurance worth around US$1 million from Axa Re (now known as Paris Re) (Alderman and Haque, 2007). The insurance was structured as a derivative for the purpose of offering reliant financing during the period of March-October season where extreme drought is possible. The value of the insurance was around US$7.1 million and could only pay out in the case of a drought event leading to crop failure. The insurance was later discontinued as famers payed monthly premiums but could not receive any payout because during the season of crop failure, drought was not the problem, thus none of the pilot projects were feasible. Drought has a tendency of occurring in periodic forms. It is not an every year event and it not occurring in one year does not mean the risk has departed. The discontinued use of the weather index insurance by farmers after they did not receive any payout from the insurance signified that education on the operation of weather index insurance was not carried out to the farmers and policymakers. The year when farmers receive good rain undermines the demand for insurance; hence, the significance to design the pilot projects with full information.

In 2009, a more participatory weather index insurance was developed by the Horn of Africa Risk Transfer and Adaptation project (HARITA) of Oxfam America (OA) together with other organizations (local and international). The idea of incorporating the Productive Safety Nets Program (PSNP) activities with the insurance-for-work (IFW) model was supported by farmers and further recommended ways of participation (Skees and Collier, 2008). Although the participation was good with 13 000 farmers in 43 villages participating, the project still faced challenges. With the problem of coming up with a feasible and flexible index that has a high possibility of predicting loss, a more innovative approach will be needed to sustain the model (Tadesse *et al*., 2015). In addition, factors such as basis risk, education and trust have been found to be the significant determinants of weather index insurance in Ethiopia (Hill *et al*., 2010; Clarke, 2011). Limited understanding of insurance can also result in low uptake of insurance.

Kenya tested both index based crop and livestock insurance (World Bank, 2005). Drought related livestock mortality insurance was developed with the use of satellite in the arid and semi-arid lands of northern Kenya. The Normalized Difference Vegetation Index (NDVI) data was the foundation of the index selected for the pilot. The data represented the available vegetation to be consumed by livestock (Mude *et al*., 2009). The relationship between the index and actual loss was estimated by the use of household-level livestock mortality data, fortunately available from the Work Bank-funded Arid Lands Research Management projects among others (McPeak, Chantarat and Mude, 2005). Surveys were conducted after the successful creation of optimal index insurance contracts in five villages randomly. The aim of the surveys was to evaluate the demand, risk attitude and WTP for an index insurance product. Majority (70%) of herders indicated that they would pay premiums 20% over the actual fair prices in order to purchase 30% strike contract (Miranda and Farrin, 2012).

An innovative IBI was initiated by the International Livestock Research Center (ILRI) in 2010 (Barrett *et al*., 2009). The primary results of the initiative showed that high premiums can affect insurance participation adversely with 30 to 40 percent premium paid by clients and another 30 to 40 percent added provided no subsidy is given. Basis risk and risk preferences have also been found to have an effect on insurance uptake (Mude and Barrett, 2012). Mude and Barrett (2012) made similar findings with Chantarat *et al*. (2013) concluding that risk preference, basis risk and expectation of loss to affect WTP for IBI. The use of mobile phones to pay for premiums on time was used to reduce delivery costs. Around 23 000 households were covered in 2011 (Syngenta, 2012). With a 50% premium subsidy available, 185 000 farmers were reached in Kenya and Rwanda and an expansion of a sustainable program was expected by the end of 2016 (Syngenta, 2014).

Another index insurance pilot scheme was launched in Malawi, presenting an example for improving linkages in the value chain for stakeholders reflecting on using index insurance (Skees and Collier, 2008). Before the initiative of the Opportunity International Bank of Malawi (OIBM) to offer weather index insurance to 892 groundnut and maize farmers with the support from World Bank in 2005 (Hess and Syronka, 2005), groundnut farmers experienced drought risk which prevented access to credit (Alderman and Haque, 2007). The drought risk led to high default rates of agricultural loans. The situation worsened when many lenders refused to offer credit (Mapfumo, 2007). When the weather index insurance was launched, weather station records were handful when payouts were due.

Malawi is one of the African member states that recognized a widespread risk management strategy (African Risk Capacity (ARC), 2014) which means that other African countries also stand a better chance to manage disastrous risk without donor agencies. The IBI project in Malawi was the first in Africa to be used on smallholder farmers who perhaps need it most.

Other countries where feasibility studies for introducing IBI have been conducted, including Nicaragua, Tunasia, Argentina, and Mexico. An interesting project was also launched in Mongolia where the main source of rural dwellers was livestock, mainly cattle. Livestock mortality rates were used as index to cover the death of large number of livestock due to drought (Skees *et al.*, 2004). In almost all of the above mentioned projects, World Bank had been assisting implementing countries with preparatory studies and other forms of technical assistance (Mushai, 2008).

2.9 A conceptual framework to study the participation of farmers in agricultural insurance programmes

The representative framework used to estimate the decision to participate in IBI made use of the standard assumption that a farmer maximizes expected utility of end-of-period wealth by choosing production factors, including IBI, subject to physical, technical, and institutional constraints. The following conceptual model, adopted from Sherrick *et al*. (2004), was used to guide the study. The approach assumes that each farmer estimates their conditional insurance premium for the use of insurance under their different production risk, financial risk and risk aversion.

A producer is assumed to evaluate insurance in terms of its impacts on the returns distribution to a set of assets, A, used in production. The assets have stochastic rate of return, r_A, with mean $\overline{r}_A$, and variance $\sigma^2{}_A$, reflecting structural and production risk. Financial risk is introduced through the use of debt capital to lever returns to equity. Using the balance sheet identify A = D + E, and assuming a fixed cost of debt, r_D, the expected return to equity is

$$\overline{r}_E = \overline{r}_A \left(\frac{A}{E}\right) - r_D \left(\frac{D}{E}\right) \qquad 2.3$$

and the variance of the return to equity is equal to:

$$\sigma^2{}_E = \left(\frac{A}{E}\right)^2 \sigma^2{}_A. \qquad 2.4$$

The farmer maximizes the expected utility of end-of-period wealth, or equivalently its certainty equivalent, which under known sufficient conditions can be shown to be well approximated by:

$$W_{CE} = \overline{W} - \gamma\sigma^2{}_w \qquad 2.5$$

where W_{CE} is the certainty equivalent of risky end-of-period wealth, W which has mean $\overline{W}$ and variance ${\sigma^2}_w$, and γ reflects risk attitudes by measuring the rate of trade-off between mean and variance. Maximizing the certainty equivalent of end-of-period wealth is equivalent to maximizing the certainty equivalent rate of returns on equity given by:

$$r_{CE} = \bar{r}_E - \gamma {\sigma^2}_E. \qquad 2.6$$

Insurance effects are captured through changes in the mean and variances of the returns distribution, and through the fixed amount, Pi, farmers pay for insurance product i. With insurance product i, the resulting expected rate of return to assets including indemnity payments is $\bar{r}_{Ai}$, and the variance of the rate of return to the insured assets is ${\sigma^2}_{Ai}$. In this case, the producer pays Pi, the effect of which is to reduce the rate of return on equity by $\frac{P_i}{E}$. Thus the certainty equivalent rate of return to equity under insurance can be written as:

$$r_{CE,i} = \bar{r}_{Ai}\left(\frac{A}{E}\right) - r_D\left(\frac{D}{E}\right) - \frac{P_i}{E} - \gamma \left(\frac{A}{E}\right)^2 {\sigma^2}_{Ai}\ . \qquad 2.7$$

The most a producer would be willing to pay for insurance is the premium that implicitly equates utility with and without insurance. Thus, the reservation premium P_i* can be found by equating the certainty equivalents with and without insurance (equations 2.6 and 2.7) and solving to get:

$$P_i * = A(\bar{r}_{Ai} - \bar{r}_A) - \gamma A\left(\frac{A}{E}\right)({\sigma^2}_{Ai} - {\sigma^2}_A). \qquad 2.8$$

Equation 2.8 indicates that the condition on premium depends on the producer's degree of risk aversion, wealth, financial leverage, and their relative impacts on the mean and variability of returns to assets used in production. Assuming that variance with insurance is less than without insurance then:

$$\frac{\partial P_i *}{\partial E} < 0, \qquad 2.9$$

$$\frac{\partial P_i *}{\partial \bar{r}_{Ai}} > 0, \text{ and} \qquad 2.10$$

$$\frac{\partial P_i *}{\partial {\sigma^2}_{Ai}} < 0, \qquad 2.11$$

and the combined total effect from any factor that influences both $\bar{r}_{Ai}$ and ${\bar{r}^2}_{Ai}$depends on leverage and γ through the rate of substitution in utility of $\bar{r}_E$for ${\sigma^2}_E$. The greater the increase (decrease) in mean return from the use of insurance through $(\overline{r}_{Ai} - \overline{r}_{A})$, the greater (lesser) the willingness to pay. Similarly, the greater (lesser) the reduction in variability from the original returns distribution through $({\sigma^2}_{Ai} - {\sigma^2}_{A})$, the greater (lesser) the willingness to pay for insurance.

The framework also demonstrates that perception can also influence the use of insurance. Thus, socioeconomic and demographic factors that could affect or signal differences in γ, such as age, size, expansion intentions, and diversification indicators, should also be considered as determinants of insurance usage (Smith and Goodwin, 1996).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter outlines the methodology of the study. It includes a description of the study area, sampling procedure as well as data collection methods. Empirical methods are also described including how each research objective was addressed. The chapter concludes with a description of hypothesised variables used in the regression model.

3.2 Study area

The study relied on primary data, which was collected in Ngaka Modiri Molema (NMM) district municipality in the North West Province of South Africa. NMM covers an area of 31039 km^2 and splits South Africa's international border with the Republic of Botswana. It is comprised of five local municipalities namely Mafikeng, Ditsobotla, Ramotshere Moiloa, Tshwaing, and Ratlou. About 34 854 households in NMM district municipality are involved in agricultural production (Statistics SA, 2011). The most part of the area is mainly rural with farming activities including cattle ranching, game farming and crop production. Common crops include maize, wheat, fruits and vegetables.

The climate in the study area is semi-arid with an average annual rainfall of about 300 to 700 mm. Summer usually starts around August to March with temperature ranging between 22 and 34ºC. In winter, the temperature ranges between 2 to 20ºC in a single day. NMM district municipality is classified as flat with the fundamental geology consisting of limestone, dacte and granite which mostly results in water-logging during periods of heavy rainfall (Kabanda and Palamuleni, 2011). Figure 3.1 below shows the location of NMM district municipality in North West Province, South Africa.

Figure 3.1: Map of North West Province

Source: SA Statistics, 2011

3.3 Sampling procedure

The study relied on a list of livestock farmers provided by the Department of Agriculture and Rural Development in NMM district municipality around January 2016. From a list of 2300 livestock farmers in NMM, a representative sample of 330 was drawn following the Krejcie and Morgan (1970) formula expressed as:

$$s = X^2 \frac{NP(1-P)}{d^2(N-1)} + X^2 P(1-P) \qquad 3.1$$

where

s = required sample size;

X^2 = the table chi-square value for 1 degree of 95% confidence level;

N = population size;

P = population proportion to size assumed to have a probability of 0.5; and

d = degree of accuracy, in this case 50% response distribution.

Having stratified the livestock farmers according to location (municipalities), Table 3.1 indicates the number of farmers that were interviewed under each of the five municipalities. These numbers were arrived at after considering the population size from each municipality as well as the total sample size of 330. Individuals interviewed under each municipality were selected from the list of farmers using a random procedure.

Table 3.1: Distribution of sampled livestock farmers per municipality

Municipalities	Population of livestock farmers per municipality	Sample size
Tswaing	1176	169
Mafikeng	196	28
Ditsobotla	278	40
Ratlou	440	63
Ramotshere Moiloa	210	30
Total	2300	330

3.4 Data collection

A structured questionnaire based on the study's objectives was used to collect data (see Appendix A). After compiling data and screening for completeness of the questionnaires, 330 questionnaires were available for analyses. The questionnaire consisted of four main sections:

i. Section A: Household demographic characteristics;
ii. Section B: Household socio-economic characteristics;
iii. Section C: Sources of risk and risk management strategies;
iv. Section D: Willingness to participate in weather index insurance.

The questionnaire was administered by the researcher with the assistance of trained field enumerators to selected farmers. Before the actual field survey, a pre-test was conducted using 10 randomly selected livestock farmers around Mafikeng municipality. Pre-testing was used to improve the reliability of the questionnaire and translation from English to the local language, Setswana. Questions that were ambiguous were appropriately modified using the responses obtained from the interviewed farmers. Response options that were not included in the open-ended questions were added in order to reduce the responses falling under the category 'other'. Data was eventually collected between the months of July 2016 to September 2016 and was captured and analysed using STATA 14.

3.5 Empirical methods

3.5.1 Livestock farmers' perceptions on sources of risk and risk management strategies

A list of possible sources of risk and management strategies were presented to respondents for the purpose of addressing objectives 1 and 2, which sought to identify small-scale livestock farmers' perceptions on risk sources and managerial responses to risk. The possible risk sources and management responses, which were selected based on preliminary field observations and the literature (e.g. Stockil and Ortmann, 1997; Meuwissen *et al*., 2001; Legesse and Drake, 2005), covered a wide spectrum of contextual issues, including natural causes, production issues, financial issues, policy issues and farm-family issues. Sampled farmers were asked to identify sources of risk that relate to their own circumstances and the extent to which they apply.

To elicit the required information from the farmers, the question was phrased as follows: To what extent do you perceive the following factors as sources of risk for your livestock enterprise(s)? The farmers' responses were measured using a Likert-type scale (1 = Not a concern; 2 = very low; 3 = low; 4 = moderate; 5 = high; and 6 = very high). To elicit information on strategies employed by farmers to manage risk, the question was structured as follows: To what extent are the following strategies employed in attempting to manage risk in your livestock enterprise(s)? Where 0 = not employed; 1 = very low; 2 = low; 3 = moderate; 4 = high; and 5 = very high.

Given the number of variables used to study farmers' perceptions on risk sources and management strategies, respectively, Principal Component Analysis (PCA) was used to extract prominent dimensions of these responses under each respective category. PCA is a technique that reduces dimensionality by extracting the smallest number of principal components (PCs), which account for most of the variation in the original multivariate dataset and summarises the data with little loss of information (Koutsoyiannis, 1992). The principal components can be estimated as a linear function of the original variables of sources of risk and of risk management strategies as:

$$PC_i = a_{i1}X_1 + a_{i2}X_2 + \dots + a_{in}X_n \qquad 3.2$$

where

i = number of principal components ranging from 1... n;

$a_{i1} \dots a_{in}$ = the component loadings; and

$X_1 \dots X_n$ = the sources of risk and risk management strategy, respectively.

The PCs were estimated using a covariance matrix as the responses were measured in the same units (Likert-type scale), implying that no variable was likely to have an undue influence on the PCs due to a much larger variance. The prominent PCs, which were identified by having Eigenvalues ≥1(Koutsoyiannis, 1992), are presented and discussed in chapter four and also feature as explanatory variables in the model to analyse farmers' willingness to buy Index Based Insurance (IBI).

3.5.2 Farmers' willingness to buy index based insurance

Given the novelty of IBI in South Africa, respondents were first given a brief background of the concept, highlighting its requirements, benefits and challenges. Thereafter, they were asked if they would be willing (or not willing) to buy IBI if it were to be introduced in their respective areas. This question sought to address objective three. Those whose response was "no" were not asked further questions in relation to IBI except the fundamental reasons for their decision. However, those whose response was "yes" were asked further questions to indicate their level of willingness to buy for IBI as outlined below.

1.1 If index based insurance was to be introduced such that whenever there is rainfall deficit or lack of forage, the insurance will protect you against any loss. Would you buy the insurance to cover 100% of your livestock? Yes[ ] No [ ]
If No to 1.1, please state reasons.
1.2 If "YES" to 1.1. Should the premium increase by 10%, would you still be willing to pay insurance cover for 100% of your stock? Yes[ ] No [ ]
1.3 If "NO" to 1.2. Would you accept if the government offers to pay for the 10% premium increase, allowing you to pay insurance for 90% of the value of your animal stock? Yes[ ] No[ ]

The responses to the above questions led to the following classification:

Z = 0 when respondents are not willing to participate in weather index insurance;

Z = 1 when they are willing to participate, but not willing to cover 100% of their stock (Less willing);

Z = 2 when they are willing to participate and pay insurance to cover for 100% of their animal stock (moderately willing);

Z = 3 when they are willing to participate and pay insurance to cover for 100% of their animal stock even with a 10% increase in premium (More willing).

Consequently, the results of objective three were presented using descriptive statistics.

3.5.3 Factors influencing farmers' willingness to buy index based insurance

The fourth objective of the study was to examine factors influencing smallholder livestock farmers' willingness to buy IBI. Given that the dependent variable, willingness to buy IBI, is discrete and contains more than two categories as indicated in section 3.5.2 above, an ordered-response model appeared to be an appropriate approach to accomplish objective four. The Ordered logit model was, therefore, used to examine factors influencing farmers' willingness to buy IBI.

The Ordered logit model is associated with the proportion odds assumption whereby the effects of each independent variable are proportional with respect to each threshold of the dependent variable (Long, 1997). The brant test was used to determine whether or not the proportional odds assumption was violated. An insignificant chi-square value suggests that the model has not violated whereas a significant chi-square value implies the opposite (Long, 1997). If the proportional odds assumption is violated, the Ordered logit model could be mis-specified. Consequently, a generalized ordered model is preferred in order to avoid misleading results (Williams, 2006; Eluru, Bhat and Hensher, 2008; Eluru, 2013; Eluru and Yasmin, 2015).

The discrete willingness to buy index based insurance levels (y_i) are assumed to be associated with an underlying continuous, latent variable (y_i*), which is naturally specified as a linear function (Eluru and Yasmin, 2015):

$$y_i^* = X_i\beta + \varepsilon_i \text{ for } i = 1,2,..........N \qquad 3.3$$

where:

i (i=1,2..........N) denotes the individual;

X_i denotes the vector of independent variables;

β denotes the vector of coefficients to be estimated;

ε denotes the random disturbance term assumed to be standard logit.

Let j (j=1,2,..........,J) the level of farmers' willingness and τ_j = the threshold associated with these levels. The unknown thresholds are assumed to partition the propensity into j-1 intervals. The unobservable latent variable $y_i^*$is related to the observable $y_i$by the $\tau_s$with a response mechanism of the following form:

$$y_i = j, if\ \tau_{j-1} < y_i^* < \tau_j, for\ j = 1,2, \ldots \ldots \ldots .., J \quad 3.4$$

The thresholds were assumed to be in ascending order in order to ensure well-defined intervals and natural ordering such that $\tau_0 < \tau_1 \ldots \ldots \ldots . < \tau_j$ where $\tau_0 = -\infty$ and $\tau_j = +\infty$. The probability was expressed as:

$$\pi_{ij} = Pr(y_i = j|X_i) = \emptyset(\tau_j - X_i\beta)\emptyset(\tau_{j-1} - X_i\beta) \quad 3.5$$

where $\emptyset(.)$ is the standard normal cumulative distribution function such that the sum of the probabilities is equal to one. The probability took the following form after applying transformation in Eq. 3.5.

$$\pi_{ij} = Pr(y_i = j|X_i) = \frac{exp(\tau_j - X_i\beta)}{(1+exp(\tau_j - X_i\beta))} - \frac{exp(\tau_{j-1} - X_i\beta)}{(1+exp(\tau_{j-1} - X_i\beta))} \quad 3.6$$

The marginal effects of the Ordered logit model were calculated. The significance of marginal effects is that they determine how much of each independent variable changes the probability of respondents falling under each of the four categories (Z=0; Z=1; Z=2;Z=3) of the dependent variable. The marginal effects were expressed as:

$$\frac{\partial P(R=y)}{\partial x_k} = \left[\emptyset\left[\mu_{j-1} - \sum_{k-1}^{k} \beta_k x_k\right] - \emptyset\left[\mu_j - \sum_{k-1}^{k} \beta_k X_k\right]\beta_k\right] \quad 3.7$$

where $\partial P/_{\partial x_k}$ indicates the partial derivation of the probability with respect to independent variable x_k.

A positive sign of a marginal effect suggests that the probability of respondents falling under a specific category of the dependent variable increases with x_k (Boz *et al*., 2011). An ordered logistic regression model was used to examine factors influencing farmers' willingness to buy IBI. However, before interpreting ordered logistic regression results, a brant test was first conducted to ascertain whether or not the proportional odds assumption was violated (see section 3.6 in the methodology for details). The chi-square value of the brant test was 13.34 at 48 degrees of freedom (see Appendix B) and was insignificant suggesting that the proportional odds assumption was not violated. The dependent and explanatory variables were also tested for possible collinearity. As indicated in Appendix D, the highest correlation value was 0.4539, implying that the variables were reasonably independent of one another. In attempting to remedy the effects of heteroscedasticity, largely common with cross-sectional data, the model was estimated with robust standard errors. Based on field observations and evidence from the literature, the following explanatory variables were included in the model.

a) Demographic attributes

Past studies have revealed that factors such as gender, farmers' age and farming experience and farmers' level of education significantly influence demand for insurance by farmers (e.g. Khan *et al*., 2012; Mohammed and Ortmann, 2005). As suggested by Blais and Weber (2001), women are more vulnerable than men and perceive environmental and health hazards more risky than men. It was hypothesized, therefore, that a gender difference in the decision to pay for index insurance would occur, with females perceiving a relatively strong importance of paying for IBI for climatic risks than males. The variable for gender was captured using a dummy variable as: 1 = male; and 0 = female.

The expected sign for household size was positive. The dependence of family members on farm produce increases the responsibility of the farmer to avoid potential loss and be able to provide for the family; hence, increasing the demand for insurance (Mohammed and Ortmann, 2005). Household size was measured using man equivalents where members with less than 9 years = 0; members 9 to 15 years = 0.7; members 16 to 49 years = 1; members above 49 = 0.7 (Langyintuo and Mungoma, 2008). Dependency ratio is a measure of the proportion of household members who are employed and make a contribution to household income to those who are dependent. Dependency ratio was expected to have a positive impact on the purchase for IBI for the reason that those who contribute to household income continue to provide for the dependents even when production is adversely affected.

Farmers' experience in agricultural production and age increases their awareness of various risk sources and management strategies alike. Khan *et al*. (2012) argue that when farmers' experience increases, so does their understanding on the potential of risks on their farming businesses; hence, they are more likely to participate in insurance. Mohammed and Ortmann (2005), however, found that the more years of experience farmers have implies that they would have acquired enough knowledge throughout the years to deal with risk without insurance, making the probability of insurance uptake less. Based on the above argument, a positive or negative sign was expected for the farming experience. Age of household head was expected to have a negative impact on farmers' willingness to buy IBI for the reason that older farmers might have attained ample of knowledge and skills to cope with risk without insurance. The variable for farming experience was captured by asking the respondents the number of years they have been in the livestock industry, while age of the household head was captured by asking the respondents how old they were in years. The continuous variable of age of household head and farming experience ranged from 0 to ∞.

The relationship between the decision to participate in IBI and education level of the farmer was expected to be positive based on the perception that farmers' education increases the potential to understand the effect of risk; hence, increasing demand for insurance. Insurers are generally expected to be better educated for greater responsiveness of insurance use to modern risk management. In this study, the variable for education considered education level of all adult members of the household and not the household head only. The inclusion of other adult household members was that despite the household head being the one to make the final decision on whether or not to buy IBI, the contributions and opinions of other adult members are likely to influence the decision of the household head. The variable was captured such that it considered the proportion of adult household members without formal education, primary, secondary, matric, and tertiary education, respectively.

b) Land tenure security

The variable for land tenure security captured the type of land where the respondents' livestock primarily graze. The variable was expected to have either a negative or positive sign. On the one hand, farmers who do not have secure tenure rights to the land where their livestock graze would be reluctant to purchase insurance due to unaffordability. However, on the other hand, communal grazing increases the vulnerability of farmers to stock theft and animal diseases and thus likely to buy insurance to protect themselves against such risk. A dichotomous variable was created such that 1 = farmers who had their livestock graze on communal land and 0 = otherwise.

c) Size of livestock owned

Xiua, Xiub and Baurer (2012) found that farmers who own relatively less number of livestock are likely to generate less income from their enterprises and are less likely to ensure all their livestock. In contrast, because of drought incidences, farmers who operate on a large scale may experience a huge loss, therefore they are expected to insure their livestock. A positive relationship, therefore, is expected between farmers who own a large size of livestock and demand for insurance since a considerable loss of livestock as well as income may result from natural sources of risk.

Tropical Livestock Unit (TLU) was used to compare livestock holdings of individual farmers. The sub-Saharan African values (FAO, 2002; Njuki, Waithanji and Mburu, 2014) were used to calculate the TLU such that: oxen/bull = 1; cow = 0.8; heifers = 0.5; immature males = 0.6; calves = 0.2; sheep/goat = 0.1; and donkeys = 0.5; pigs = 0.1; and poultry = 0.01. Therefore, for an individual household, the total livestock holding was captured as:

$$Total\ livestock\ holding = \sum_{i=1}^{n} TLU_i \qquad 3.7$$

where:

n = number of species/type; and

$TLUi$ = TLU for species/type i.

In addition to the number of livestock farmers own, the study enquired on the number of livestock sold within a period of 12 months. The intention was to assess whether or not their livestock enterprises was generating income from the sale of livestock. It was hypothesized therefore that those who generated income from their enterprises would be more likely to buy insurance in order to protect their source of revenue. However, they might also be reluctant to buy insurance as they might use the generated income from sold livestock as an ex post risk management tool to cater and feed the remaining livestock. The variable was captured as a continuous variable where farmers provided the number of livestock they sold in the period of 12 months.

d) Farmers' perceptions on sources of risk

Variables of farm risk characteristics are concerned with whether the farm has experienced any type of risk within the past 12 months and the extent of losses incurred (Qin *et al*., 2016). The more frequent the farmer suffers from climatic or weather risk and the greater amount of losses, the more demanding the farmers could be to transfer risks through IBI. An additional variable under this category included farmers' perceptions on sources of risk, which was proxied by the dominant PCs obtained in the analysis for objective one. The variable for experience of loss was captured such that 1 = farmers who experienced loss of livestock from various factors and 0 = those who did not.

e) Crop and livestock diversification

Although numerous methods exist for improving indicators of risk attitudes and risk preferences, self-assessed strength of agreement or strength of rating scales have been shown to be reliable and valid, and are thus most commonly used (Pennings and Garcia, 2001). Diversification acts as an alternative risk management strategy (Mohammed and Ortmann, 2005). However, it is not always that a negative relationship between insurance and diversification occurs. In a situation where both insurance and diversification are available, risk-averse farmers could consider using both. Other than that, if one strategy is not available, the other is used. Therefore, diversification may either have a positive or negative relationship with the dependent variable. For crops, a crop diversification index (CDI) was used. Following Hahn, Riederer and Foster (2009), CDI was computed as:

$CDI = 1 - 1/N$ where N = number of crop enterprises 3.8

The index ranges from zero to one, where one indicates the highest diversification and zero specialization. For those who did not cultivate any crop, a CDI value of -0.001 was inserted in the spread sheet in order not to confuse such households with those that had one crop. A livestock diversification index (LDI) was computed following Mabuza, Ortmann and Wale (2012), which considered the number of livestock enterprises owned by the household divided by the total number of enterprises in the sample. Consequently, LDI was calculated as:

$LDI = \frac{\sum_{i=1}^{n} Di}{N}$ i = 1, 2,..., n (number of livestock enterprises) 3.9

where

Di = denotes the livestock enterprises owned by the household; and

N = denotes the total number of livestock enterprises in the sample.

In this study, livestock ownership considered the number of livestock farmers currently owned, the number of livestock they consumed and the number they sold, which gave a total of how many they had in a period of 12 months. In order to avoid the effects of outliers, for a household to qualify as an owner of a livestock enterprise, the number of livestock owned had to be greater or equal to the sample mean of that particular livestock enterprise.

f) Wealth

Although the poor are less likely to engage in any kind of risk, the rich are more willing to take risk stemming from technology since they benefit more (Mohammed and Ortmann, 2005). It was hypothesized, therefore, that the wealth status of farming households would positively affect farmers' willingness to buy IBI. Wealth index was developed using an asset index methodology developed by Bill and Melinda Gates Foundation (2010). Table 3.2 outlines the procedure of computing the wealth index for individual households.

Table 3.2: Weight and age adjustment for asset index

Assets(g)	Weight (w)	Age adjustment (a)		
		< 3 years	3 to 7 years	> 7 years
Domestic assets				
Coal stove	2			
Kitchen cupboard	2			
Radio	2			
Television	4			
DVD player	4	×1	×0.8	×0.5
Satellite receiver	4			
Chair	1			
Cell phone	3			
Gas stove	2			
Sewing machine	4			
Borehole	12			
Transportation assets		×1	×0.8	×0.5
Car/truck	160			
Motorcycle	48			
Bicycle	6			
Cart	12			
Agricultural assets		×1	×0.8	×0.5
Tractor	160			
Tractor plough	4			
Tractor trailer	12			
Hand hoes	1			
Asset index				

Source: Njuki *et al*. (2014)

Each of the assets (g) was allocated a weight (w) and then adjusted for age such that:

$$Asset\ index = \sum_{g=1}^{G}\left[\sum_{i=1}^{N}(\omega_{gi} \times a\right] \qquad i = 1, 2, \ldots, N;\ g = 1, 2, \ldots, G \qquad 3.13$$

where

ω_{gi} = weight of the i'th item of asset g;

N = number of asset g owned by household;

a = age adjustment to weight;

G = number of assets owned by household.

g) Sources of income

The variable for sources of income captured various sources from which sampled households generate their income. Following Leones and Feldman (1998) and Alemu (2012), the variable was captured using dummies for respective sources of income, including crop production, livestock production, salary, off-farm work, non-farm work and non-labour. Livestock production included beef cattle, dairy, sheep and goat production, piggery, indigenous chickens, and commercial poultry. Temporary agricultural labour and temporary non-agricultural labour were grouped together as off-farm work, while self-employment was labelled as non-farm work. Non-labour work included income from pension, child social grant and disability grant.

It was hypothesised that households whose major income was derived from livestock production would be more willing to buy IBI. Farmers would want to protect their key source of income especially because climate risk such as drought, flood and variability of weather threaten their production. Therefore, they would opt for insurance to provide financial relief to cope with such risk. Table 3.3 below presents a summary of the variables used to address objective four.

Table 3.3: Summary of variables included in the ordered logit model

Dependent variable		
Variable	Type	Unit of measurement
Willingness to buy index-based insurance	Ordered	0 = not willing to buy; 1 = less willing to buy; 2 = moderately willing to buy; 3 = more willing to buy
Explanatory variables		
Age	Continuous	Years
Gender	Dummy	0 = Male; 1 = otherwise
Household size	Continuous	Man equivalents. Where members with less than 9 years were = 0; members 9 to 15 years = 0.7; members 16 to 49 years = 1; members above 49 = 0.7
Dependency ratio	Continuous	Proportion of household members who are unemployed and make a contribution to household income to those who are employed and dependent
Farming experience	Continuous	Number of years involved in livestock farming
Level of education	Continuous	Proportion of adult household members with no formal education; with primary education; with matric; and with tertiary education
Land tenure system	Dummy	1 = Communal; 0 = Otherwise
Size of livestock owned	Continuous	Tropical livestock units (TLU) expressed as follows: Oxen/bull = 1; cow = 0.8; heifers = 0.5; immature males = 0.6; calves = 0.2; sheep/goat = 0.1; donkeys = 0.5; pigs = 0.1; poultry = 0.01
Experience of loss	Dummy	1 = Yes; 0 = No
Number of livestock sold	Continuous	Number of livestock sold in the past two years
Farmers' perceptions on sources of risk	Continuous	Computed using PCA
Livestock diversification	Continuous	Livestock diversification index
Crop diversification	Continuous	Crop diversification index
Wealth	Continuous	Asset index computed based on the value of owned household items, apart from livestock.
Sources of income	Dummy	Income from crop production=1; 0=otherwise Income from livestock=1; 0=otherwise Income from salary=1; 0=otherwise Income from off-farm=1; 0=otherwise Income from non-farm=1; 0=otherwise Income from non-labour=1; 0=otherwise

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is divided into five sections. The first and second sections present the demographic and socio-economic characteristics the respondents. Perceived risk sources and employed risk management strategies are presented in the third section. The fourth section presents respondents' willingness to buy Index Based Insurance (IBI), while the fifth section presents factors influencing smallholder livestock farmers' willingness to buy IBI.

4.2 Demographic characteristics of respondents

4.2.1 Gender of household heads

The results in Figure 4.1 indicate that the study area was characterized by a high proportion of male headed households (74.50%), with the remainder being female headed.

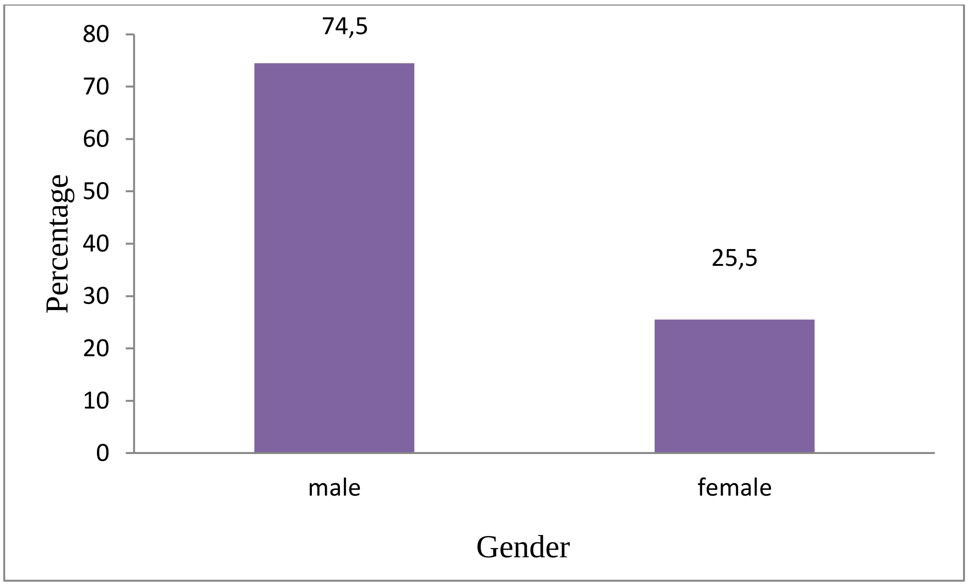

Figure 4.1: Gender of household heads
(n = 330)
Source: Field Survey, 2016

4.2.2 Age distribution of household heads

Maturity enhances a better understanding of business and hence productivity. The age distribution of household heads presented in Table 4.1 depicts that 39.09% of the sampled farmers were between the ages of 50 to 64 years, followed by 18.18% and 14.55% of respondents falling between ages of 65 to 74 and 75 years and above, respectively. This implies that farmers in the sampled area were relatively old.

Table 4.1: Age distribution of household heads

Age distribution	Frequency	Percentage
20 – 29	15	4.55
30 – 39	36	10.91
40 – 49	42	12.73
50 – 64	129	39.09
65 – 74	60	18.18
Above 75	48	14.55
Total	330	100.0

(n = 330)
Source: Field Survey, 2016

4.2.3 Education level of household head

Education is a fundamental factor that can be able to improve the competitiveness of rural households in order to generate farm income. It also enables rural households to better understand basic farm management and agricultural marketing principles and increase the ability of rural households to create business networks. A higher level of education enables a better assessment of risk and hence a greater demand for insurance (Mohammed and Ortmann, 2005). The levels of education of household heads are presented in Figure 4.2.

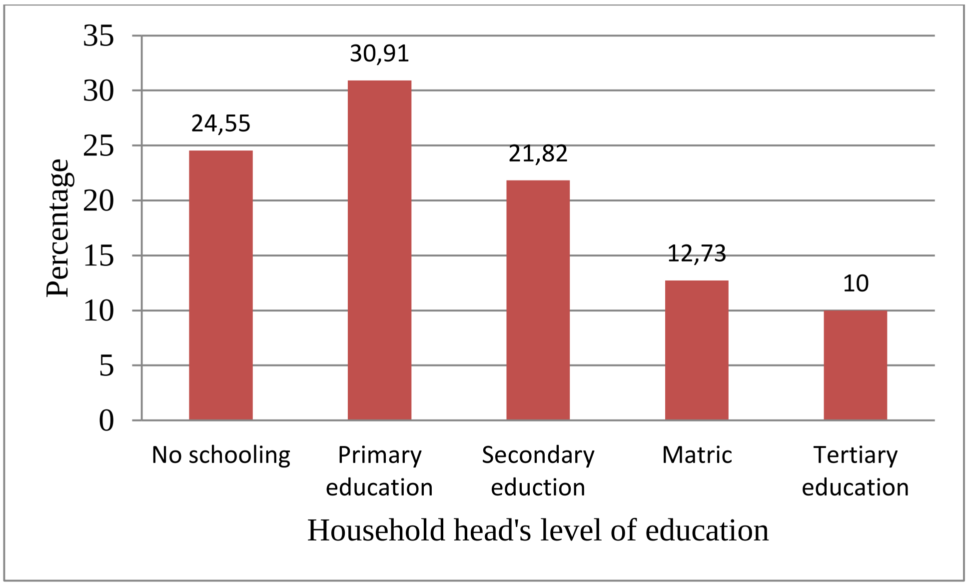

Figure 4.2: Education level of household head
(n = 330)
Source: Field Survey, 2016

The results indicated that 24.5% of the smallholder livestock farmers had no formal education. About 30.9% of the household heads had attained primary education, while 21.8% and 12.7% had secondary and matric education, respectively. Close to 10.0% of the household heads had obtained tertiary education. The low level of formal education of household heads may affect the adoption by farmers of any risk management strategy as they may lack the ability to assess the risk involved, understand risk management strategies and have difficulty in accessing necessary information to obtain insurance.

4.2.4 Years of farming experience in livestock production

Table 4.2 presents the distribution of years of farming experience in livestock production among interviewed smallholder livestock farmers in NMM district municipality.

Table 4.2: Years of farming experience in livestock production

Years of farming experience	Frequency	Percentage
0 – 9	135	40.91
10 – 19	99	30.0
20 – 29	57	17.27
30 – 49	21	6.36
> 50	18	5.46
Total	330	100.0

(n=330)
Source: Field survey, 2016

The results indicated that majority (70.9%) of the respondents had between 0 to 19 years of farming experience in the livestock industry, while 17.3%, 6.4% and 5.5% had between 20 to 29, 30 to 49 and more than 50 years of experience, respectively. It is assumed that the more experience farmers have the more they become aware of various risk management strategies and as a result, the desire to buy insurance could be less (Mohammed and Ortmann, 2005).

4.2.5 Land tenure security

Land tenure security is at the heart of every successful rural society (Mahabile, Lyne and Panin, 2002). Having access to land, total control of the land and utilizing it is very critical for rural livelihoods. Insecure tenure rights discourage farmers to make long-term development investments on their land, as a result, production is affected (Brasselle, Gaspart and Platteau, 2002). Table 4.3 shows that only 9.1% of the respondents had private ownership on the land where their livestock graze.

Table 4.3: Type of land tenure system

Type of land ownership	Frequency	Percentage
Private	30	9.1
Communal	255	77.3
Permission to occupy	27	8.2
Renting	18	5.5
Total	330	100.0

(n=330)
Source: Field survey, 2016

Private ownership allows owners to be more willing and able to investment in inputs and technology given that they have the assurance and collateral effect (Brasselle *et al*., 2002). The results further indicated that 77.3%, 5.5% and 8.2% of the respondents have their livestock graze on communal land, rented land and land that they have permission to use, respectively. The arrangement, however, does not encourage nor make allowance for capable farmers to expand their holdings (Machethe, 2004) because landholding based of communal rights, permission to occupy and rent does not provide farmers with legal secure tittles. This further puts smallholder farmers at a disadvantage because of their inability to offer land as collateral for the purpose of obtaining credit (Shah *et al*., 2002). Furthermore, what is more problematic is lack of clarity among land owners about their rights with respect to their lands than absence of ownership (Shah *et al*., 2002).

4.3 Household socio-economic characteristics

4.3.1 Household heads' employment status

Figure 4.3 shows the employment status of household heads. The findings revealed that 22.73% of the household heads were employed, while 30.0% were unemployed.

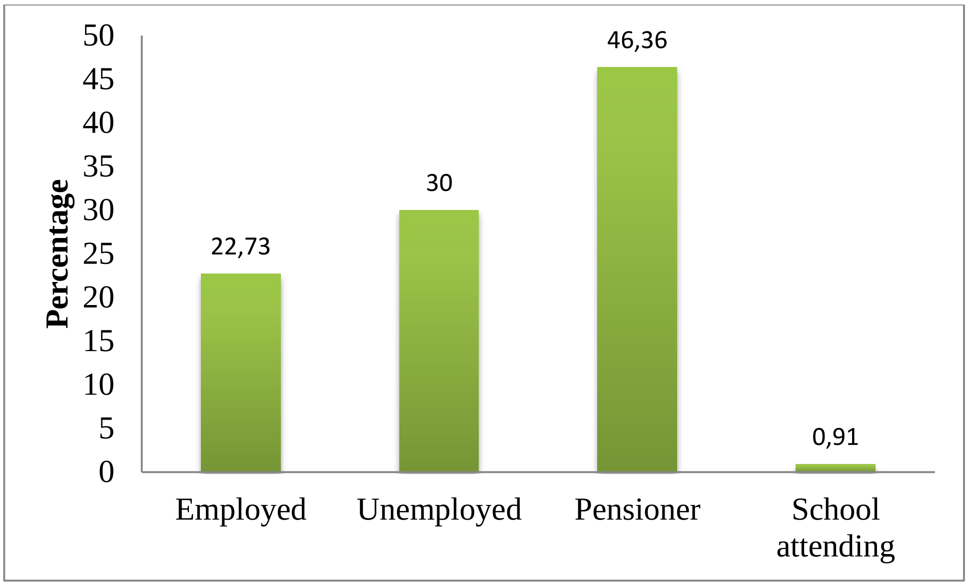

Figure 4.3: Household head employment status
(n = 330)
Source: Field Survey, 2016

About 46.36% of the household heads were pensioners, while the minority (0.91%) were still attending school. Household heads who were still attending school did so with anticipation that acquiring formal education would improve their chances of getting full employment. Employment, either in farming or non-farming is important to rural households as a diversification source of livelihood. It enables households to improve their production even during periods of drought by giving them the opportunity to apply and distribute proper inputs to production and reduce the risk of food shortage during times of drought. The results presented in Figure 4.3 were also used to compile dependency ratio. It was calculated by considering the proportion of household members who were employed and made a contribution to household income to those who are dependent. The dependency ratio was estimated at an average of 1.70.

4.3.2 Sources of household income

Figure 4.4 presents the various sources from which households generate income. The results show that 23.03% of the respondents received income from non-labour work followed by income from salary (22.73%). Non-labour work included pension, child social grant and disability grant. This implies that most famers were above 60 years of age since pension funds are given to beneficiaries 60 years and above. The high prevalence of respondents with this age group is confirmed by Table 4.1. Furthermore, Figure 4.3 also indicated that 46.4% of the respondents were pensioners. The results further revealed that all the farmers who were formally employed (22.73%) as indicated in Figure 4.3, 100% of them had salary as the major source of income.

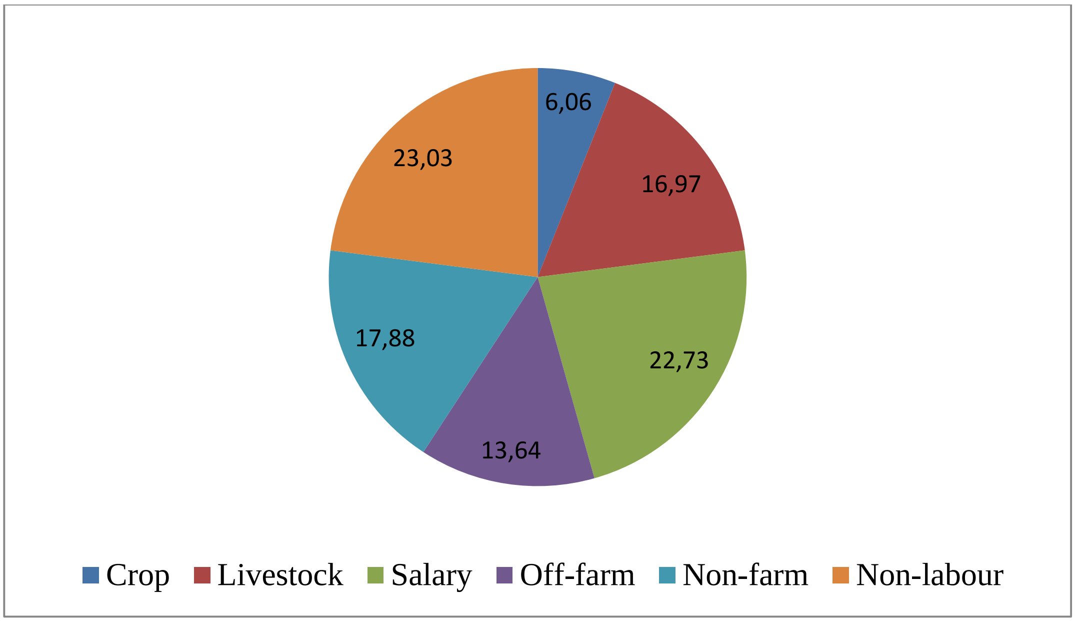

Figure 4.4: Sources of household income
(n = 330)
Source: Field survey, 2016

4.3.3 Types of crops produced by respondents

Table 4.5 reveals crops that were produced in the study area. It was found that the most popular crops produced in Ngaka Modiri Molema (NMM) district municipality were sunflower and vegetables, which were produced by 18.8% of the sampled households, maize, produced by 10.0%, beans, produced by 7.3%, and cereals, produced by 2.7%. Types of vegetables produced by sampled households included cabbage, potatoes, green pepper, lettuce, beetroot, tomatoes and carrots. Cereals produced were wheat and corn. Table 4.4 also revealed that the average total area where the crops were produced amounts to 1.31 hectares, with average total arable land amounting to 1.933 hectares in the study area. This implies that about 0.622 hectares of arable land were left idle, which is almost a third of the average total arable land. Sunflower crops were produced from relatively large areas averaging 3.43 hectares of land followed by maize which occupied an average of 1.73 hectares of land.

Table 4.4: Types of crops produced by respondents

Types of crops produced	Average hectare/ crop	Number of respondents producing each type of crop	
		Frequency	Percentage
Vegetables	0.85	39	11.82
Maize	1.73	33	10
Sunflower	3.43	39	11.82
Beans	0.12	24	7.27
Cereals	0.04	9	2.73
Total	1.31	144	43.64
Average area of arable land = 1.93275			

(n= 144)
Source: Field survey, 2016

4.3.4 Assets and livestock ownership

Asset ownership is often related to poverty reduction and resilience against risk at household level (Njuki *et al*., 2014). Assets are defined by Ford Foundation (2004) as "*stock of financial, human, natural and social resources that can be acquired, developed, improved and transferred across generations*". Doss *et al.* (2011) allege that for rural inhabitants to move out of poverty, they should have access to and ownership of assets in order to increase agricultural production. This section presents descriptive statistics of asset ownership among the respondents, focusing particularly on agricultural and domestic assets.

4.3.4.1 Livestock ownership

A total of ten different livestock species were owned by farmers in NMM district municipality which included pigs, poultry, sheep, goats, donkeys, and cattle by type: oxen or bull, cows, heifers, immature male and calves. Due to the differences in value of different livestock, Tropical Livestock Unit (TLU) as explained in section 3.6.6 was used to compare livestock holdings between farmers.

Table 4.5 presents the average livestock owned by sampled farmers. The results indicated that poultry (11.26) was owned at a larger scale followed by cows (10.17) and goats (6.15). Oxen or bulls were the least (0.59) owned by farmers. However, using TLU to compare the values of different livestock species, poultry had a lower TLU compared to oxen and bulls even though they were the least owned by farmers. This implies that ownership of oxen or bulls was of a higher value than ownership of poultry.

Table 4.5: Average livestock owned by respondents

Type of livestock	Average livestock owned	Average livestock holding in TLU
Cattle-oxen/bull	0.59	0.59
Cattle-cows	10.17	8.138
Cattle-heifers	1.72	0.859
Cattle-immature	0.70	0.420
Calves male	1.68	0.336
Sheep	4.71	0.471
Goat	6.15	0.616
Donkey	1.07	0.536
Poultry	11.26	0.113
Pig	1.61	0.322
Total average	39.945	12.455

(n=330)
Source: Field survey, 2016

4.3.4.2 Domestic and agricultural assets ownership

Wealth is often linked with the greater possession of assets and reflects a farmers' ability to afford insurance premium and cope with risk. In this study, wealth index was based on an aggregation of 18 physical asset characteristics into three indices. These indices are: 'domestic assets index' which included coal stove, kitchen cupboard, radio, television, DVD player, satellite receiver, chairs, cellphones, gas stove and borehole owned; 'transport index' included cars or truck, bicycle and cart owned; and 'agricultural assets index', which included sewing machine, tractor, tractor plough, tractor trailer and hand hoes owned. Weights were allocated to each of the assets and then adjusted for age. Assets that were less than three years of age were multiplied by 1. Those that were between the ages of 3 and 7 years were multiplied by 0.8, while 0.5 was multiplied by those that were more than 7 years of age (Njuki *et al*., 2014). As indicated in section 3.6.7 this implied that the older an asset, the lower the value attached to it. The results are reported in Table 4.6.

The results depicted that greater value was attached to transport assets with a mean value of 80.175 which is more than 50% of the calculated wealth index (121.401). The results suggest that transport assets carry more value than domestic assets and agricultural assets, which accounted for 24.990 and 16.236, respectively, although they depreciate with time.

Table 4.6: Average assets owned by sampled households

Domestic assets	**Average assets owned**
Coal stove	0.50
Kitchen cupboard	1.03
Radio	0.99
Television	1.13
DVD player	0.86
Satellite receiver	0.51
Chair	8.57
Cell phone	1.72
Gas stove	0.46
Borehole	0.38
Domestic assets index	*24.990*
Transport	**Average assets owned**
Car/truck	0.65
Bicycle	0.40
Cart	0.18
Transport assets index	*80.175*
Agricultural assets	**Average assets owned**
Sewing machine	0.24
Tractor	0.13
Tractor plough	0.10
Tractor trailer	0.07
Hand hoes	0.75
Agricultural assets index	*16.236*
Wealth index	121.401

(n=330)
Source: Field survey, 2016

4.4 Sources of risk and risk management strategies

4.4.1 Smallholder livestock farmers' perception of sources of risk

In attempting to address objective one, which sought to identify farmers' perceptions on risk sources, the study considered 33 sources of risk drawn from the literature (see Appendix A). However, some of the variables did not apply in the study area, leading to a total of 8 variables that were eventually considered for analyses. Farmers were asked to score each source of risk on a Likert-type scale from 1 (not a concern) to 6 (very high) to express the extent to which they perceive the variables as sources of risk for their livestock enterprises. Principal Components Analyses (PCA) was used to extract prominent dimensions of farmers' responses. The results of the analyses are presented in Table 4.7.

Table 4.7: Principal component analyses of smallholder livestock farmers' perceptions on sources of risk

Sources of risk	Average* (n=330)	Principal components		
		1	2	3
Low rainfall	4.68	-0.029	**0.579**	-0.046
Very high temperature	4.64	0.280	**0.574**	0.152
Credit availability	2.89	**0.480**	-0.014	-0.208
Elimination of government support programmes	3.76	**0.325**	-0.114	**0.683**
Livestock pests and diseases	4.65	0.088	**0.513**	0.108
Inflation	3.70	**0.449**	-0.163	0.264
Consumer preferences	3.05	**0.457**	-0.181	-0.097
Changes in labour legislation	2.20	**0.408**	0.026	**-0.612**
Eigenvalues		1.985	1.457	1.145
Total variance explained		24.82	18.22	14.31
Barlett's test of sphericity chi-square		268.724***		
Kaiser-Meyer-Olkin's measure of sampling adequacy (KMO)		0.591		

*Likert-type scale: 1=not a concern; 2=very low; 3=low; 4=moderate; 5=high; 6=very high
Component loadings greater than ±0.30 are highlighted in bold print

The Kaiser-Meyer-Olkin's measure of sampling adequacy (KMO) and Barlett's test of sphericity chi-square were 0.591 and 268.724, respectively, suggesting that PCA was an appropriate tool to provide significant reduction in the number of variables. The 8 original variables are listed in column one of Table 4.7 and are compared against the three extracted principal components (PCs) that achieved eigenvalues of at least one. The three PCs explained almost 57.4% of the variance of the original variables. Of these PCs, those that had a PC loading of greater than ±0.30 were considered significantly associated with the extracted components as proposed by Koutsoyiannis (1992) for observations greater than 50. These loadings are highlighted in bold print in Table 4.7.

The average scores of farmers' perception on sources of risk were calculated and presented in Table 4.7 in the second column. The calculated average perception scores show that the most perceived source of risk was low rainfall with a mean value of 4.68, followed by animal pests and disease (4.65.82) and very high temperature (4.64). The results also show that changes in labour legislation is the least perceived source of risk (2.20), followed by credit availability with a mean value of 2.89.

The three dominant PCs were named in consideration of the original variables with relatively high factor loadings. The first significant principal component (PC1), which accounted for

24.8% of the total variation of the original variables, was referred to as ‘financial and marketing’ risk that smallholder farmers face in their production activities. Financial risk mainly comes from changes in credit availability and inflation. The former refers to the money that a farmer can borrow to assist in carrying out daily farming activities particularly in the period of forage shortage due to low rainfall, while the latter includes unpredictable prices of important agricultural inputs such as animal vaccines and feed supplements. Marketing risk involves consumer preferences and taste towards different animal products. For instance, some may prefer indigenous to commercial poultry, while others may prefer meat from a heifer to meat from a cow, given that a heifer is a cow that has not given birth. The perception is that the market could have a demand for products that a farmer is unable to supply. Changes in labour legislation are issues mostly raised by relatively wealthy farmers who employ farm workers and herders to guard their livestock. The perception was that, changes in labour legislations such as compensation for occupational injuries, health and safety given the type of activities involved in agricultural production, and the basic conditions of employment acts such as the working hours and minimum wages would neither favour them nor allow them to run their farms productively. Stockil and Ortmann (1997) also found changes in labour legislation under the factor “government policies” as a great threat to farm business.

The second significant principal component, which was referred to as ‘drought and health risk’, explained 18.2% of the total variation of the original variables. Drought can be defined as a deficiency in precipitation over a defined period of time (National Drought Mitigation Centre, 2007). The variables: low rainfall, very high temperature and livestock pests and diseases reflect the possibility of an occurring drought as a result of very high temperature and low rainfall which often leads to disasters such as veld fires and the spread of animal diseases (Van Riet, 2012). In Zimbabwe, for instance, Estrada-Pena *et al*. (2008) found that the tropical bont tick (*Amblyomma variegatum)* was spread by the progressive increase in temperature towards areas outside of zones that had prolonged dry periods. The sampled farmers’ perception was that low rainfall and extreme high temperatures affect the nature and distribution of pests and diseases which results in adverse impacts on livestock and animal health. Therefore, ‘drought and animal health risk’ is a significant source of risk perceived by smallholder farmers.

The third significant PC represents ‘government support’ and explains 14.31% of the variation of original variables. PC3 is dominantly indicated by high loadings of elimination of government support programs (0.683) and changes in labour legislations (0.612). The results suggest that government support is important in providing a regulatory framework that gives smallholder farmers access to risk management tools such as government emergency credit, encouragement of the provision of agricultural insurances through government funded programmes and ensuring that government extension officers are available to offer training to farmers. As a perceived source of risk, possible elimination of government support could negatively affect the ability of smallholder farmers to access important agricultural inputs and credit to sustain livestock production and run daily farming activities. However, there are some government policies that hinder production of smallholder farmers. The dominant perception was that reliability on government support would be accompanied by adoption of changes in labour legislations that would not favour them given the unpredictable productivity of smallholder farm businesses.

4.4.2 Other sources of risk encountered by respondents

Disasters are consequences of social, economic and natural events or hazards that have adverse effect on human activities. Disastrous events such as drought, flood, fire, storm, among others, are more perceptible to poor rural residents as their social, economic and environmental attributes do not allow them to alleviate nor prevent the impact of the events (Takahashi *et al*., 2016). Figure 4.5 presents the sources of risk that were not considered in the questionnaire but were identified by respondents. About 24.6% of the respondents perceived animal theft as one of the sources of risk in the livestock enterprise, followed by fire and lightning which were indicated by 3.64% and 1.82% of the total sampled farmers, respectively.

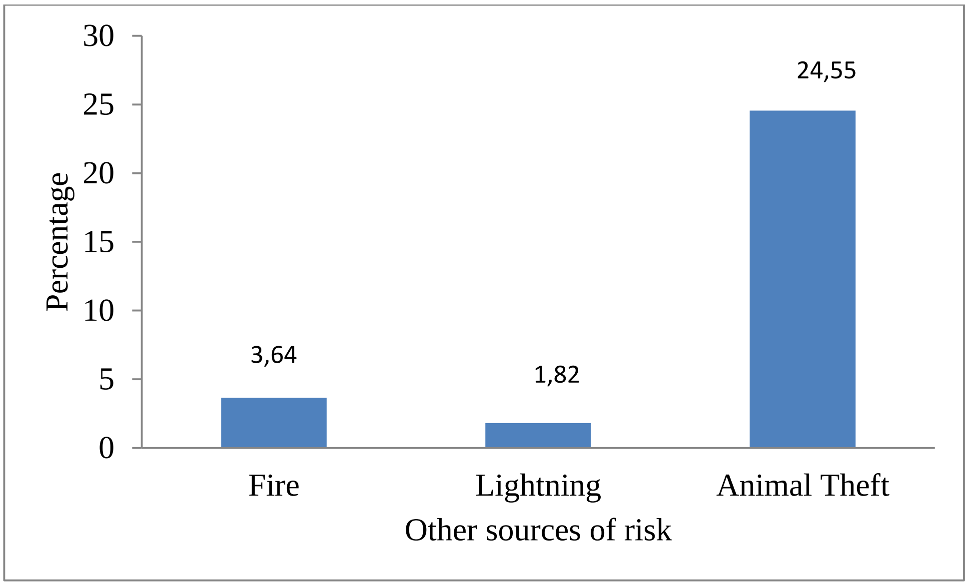

Figure 4.5: Other sources of risk perceived by respondents
Source: Field survey, 2016

4.4.3 Animals lost due to sources of risk

Results in Table 4.8 indicate the number of animals lost by smallholder livestock farmers due to sources of risk in the past 2 years. Although livestock does not need much of the fertile land to survive, it suffers risk such as infectious animal disease and high mortality rate during dry seasons (Estrada-Pena, Horal and Petney, 2008). The results showed that 29.39% of the respondents lost their animals due to low rainfall followed by 12.73% of the respondents who lost their livestock due to animal diseases and 6.36% due to high temperature.

Table 4.8: Number of animals lost due to identified sources of risk

Number of animal lost due sources of risk	Low rainfall (n=97)		High temperature (n=21)		Animal diseases (n=42)	
	Freq	Percentage	Freq	Percentage	Freq	Percentage
1 – 9	70	21.21	18	5.45	42	12.73
10 – 19	12	3.64	3	0.91	0	0.0
> 20	15	4.55	0	0.0	0	0.0
Total	97	29.39	21	6.36	42	12.73

Source: Field survey, 2016

4.4.4 Risk management strategies employed by respondents

Sampled farmers were asked the extent to which they employed a number of identified risk management strategies presented to them to manage risk in their livestock enterprises. The responses were measured using a Likert-type scale ranging from 1 (not employed) to 6 (very high). The purpose was to address objective two which sought to identify managerial responses to risk by farmers. A total of 12 risk management strategies were presented to the farmers and seven of them as summarised in Table 4.9 were identified by the respondents. To identify dominant risk management strategies, PCA was employed and the results are presented in Table 4.10 below.

Table 4.9: Principal component analyses of smallholder livestock farmers' extent of employment of identified risk management strategies

Risk management strategies	Average* (n = 330)	Principal components			
		1	2	3	4
Production at lowest possible cost	3.127	**0.510**	**0.425**	**-0.734**	0.066
Forward contracts	1.355	0.100	0.235	0.198	0.158
Off-farm investment	1.545	0.205	0.233	**0.418**	0.002
Insurance purchase	1.727	0.152	**0.652**	**0.371**	**-0.354**
Enterprise diversification	1.773	**0.318**	0.013	0.259	0.268
Government emergency credit	2.127	**0.427**	-0.197	0.190	**0.656**
Application of strict production rules	3.145	**0.618**	**-0.497**	0.079	**-0.585**
Eigenvalues		4.629	2.724	1.933	1.420
Total variance explained		35.66	20.98	14.89	10.94
Barlett's test of sphericity chi-square		353.773***			
Kaiser-Meyer-Olkin Measure of sampling		0.677			

*Likert-type scale: 1=not a concern; 2=very low; 3=low; 4=moderate; 5=high; 6=very high
Component loadings greater than ±0.30 are highlighted in bold
Source: Field survey, 2016

Calculated mean values show that all the risk management strategies presented to farmers were not commonly employed. The results suggest that farmers preferred to apply strict production rules (3.145) to manage risks, followed by production at the lowest possible cost (3.127) and use of emergency credit supplied by the government (2.127). The least employed risk management strategies were identified as the use of forward contracts (1.355), followed by off-farm investments and enterprise diversification with mean values 1.545 and 1.727, respectively.

The results in Table 4.9 indicate that four PCs with eigenvalues ≥ 1, explaining 82.5% variation of the total original variables were extracted. Reading from KMO's measure of sampling adequacy and Barlett's test of sphericity chi-square which were estimated at 0.677 and 353.773, respectively, the results indicated that PCA was an appropriate tool to provide significant reduction in the number of variables.

The first PC explained 35.7% of the variation in the original variables and could be best described as 'production cost minimisation'. Dominant variables under PC1, which had relatively high factor loadings comprised of 'enterprise diversification', 'application of strict hygiene rules', 'government emergency credit' and 'producing at lowest possible cost'. The results suggest that minimisation of cost of production includes producing at the lowest possible cost whereby farmers tend to: make use of farming inputs that are relatively cheaper; utilize family members as labourers to avoid employing farm labourers as they will incur more costs in labour payment; and rather have their livestock graze on communal land than produce feed for them. Application of strict production rules is another method used to minimise costs of production. Strict production rules relate to production procedures that need to be followed for the production of livestock in the production cycle, for instance, chickens from hatching require feed supplements such as starter and grower, among others, to assist them to grow and by pass environmental conditions that could adversely affect their growth. The farmers' perception is that when strict production rules are used, they decrease the need to use animal vaccines to prevent certain animal pests and diseases because everything would have been done by the book to avoid the contact of potential viruses, bacteria and pests.

Government emergency credit includes provision of agricultural production inputs to smallholder farmers to help them in hard times, particularly in the event of drought. Supplies such as forage for livestock are often given for free to farmers whereby they just need to follow the process of accessing them through extension officers. The amount of credit depends on the number of livestock owned. This contributes to minimising costs of production because farmers do not have to spend on agricultural inputs such as vaccines, forage and feed supplements.

Enterprise diversification is also significantly related to minimisation of production costs. It is perceived that when farmers diversify their production practices, for instance, when a farmer is involved in a variety of production of crops and livestock, the farmer can use part of the gains in crop production as inputs in the livestock in a form of feed. In addition, livestock extras such as cow dung can be used as organic fertilisers to grow crops. In this way the farmer would actually be saving capital used to purchase fertilisers and feed for livestock, thus producing at the lowest possible cost. In summary, the dominant perception is that applying strict production rules, producing at the lowest possible cost, opting for government emergency credit and diversification would minimise the cost of livestock production.

The second PC explained 21.0% of the total variance of the original variables. PC2 had positive factor loadings of insurance purchase and producing at the lowest possible costs. This suggested that respondents made use of financial risk transferring strategies to manage potential financial risk such as changes in credit availability and inflation rate as described previously in the sources of risk perceived by sampled smallholder farmers in NMM district municipality.

Insurance is known as a form of a risk transferring mechanism, whereby potential financial consequences of farmers are transferred to policy holders. Producing at the lowest possible cost, as described earlier, mainly comes from farmers minimising production costs so that they could be able to use part of the costs realised from farm outputs to pay for insurance premiums. By so doing, they do not have to use capital from other sources to pay for premiums, instead, reduce the production costs. Also for this PC, loadings suggest that it refers to insurance purchased for personal risks that have nothing to do with farm business hence the negative high loading of the on-farm strategy of applying strict production rules.

The third PC explained 14.9% of the total variance of the original variables and was referred to as ‘off-farm investment’. Sampled smallholder farmers in NMM district municipality indicated that the reason for participating in off-farm investment was to increase the household income used to raise and provide for the household members provided that on-farm income is not sufficient to satisfy the daily needs of all household members. This is supported by the high loading of the production at lowest possible cost variable which includes on farm activities. The results imply that production at lowest possible cost has a negative relationship with off-farm investments. The variable ‘purchase of insurance’ however, has a positive relationship with PC3. The perception is that when farmers do not claim for a certain period of time, the insurance policies refund them a certain percentage of the premiums paid, therefore they use insurance as a form of risk transferring mechanism in case they incur any insured risk and as an investment if they do not claim.

The fourth significant risk management strategy, PC4, was referred to as ‘government assistance’. It explained 10.9% of the variable of the original variables. Government assistance in this context is given to farmers in a form of an emergency credit as a relief during hard times. The significant loadings of application of strict hygiene rules and purchase of insurance suggest that when farmers stick to strict production rules and are policy holders of any insurance then they would not need government assistance as the insurance could reimburse them for any risk encountered. Applying strict production rules makes way for reduced animal pests and diseases which could result in less risk due to hygiene related factors.

4.4.5 Responses of smallholder livestock farmers to statements on the satisfaction of their current employed risk management strategies

Farmers’ satisfaction on the use of risk management strategies reported previously in Table 4.9 for protection against weather-related risks was also studied. Farmers were asked to rate the extent in which they agreed with the statement presented in Table 4.10 on a Likert-type scale, ranging from 'strongly agree' to 'strongly disagree'. The results showed that 30.9% of the sampled households strongly agreed that the employed strategies were reliable, however, they strongly disagreed that they are satisfied with the level of protection, which was reported by 29.1% of the respondents. This suggests that, excluding its satisfaction on the level of protection, the mere fact that a mechanism is readily available for use means it is reliable. The results also indicate that 47.3% of the sampled population expressed strong disagreement that they are reimbursed when their farm yield or output is affected adversely. About 30.3% of the sampled respondents strongly disagreed that the strategies that they used were less costly, while the minority (13.5%) strongly agreed that it was less costly. In summary, for all statements, the majority of respondents indicated that they strongly disagreed with the statement with the exception of the statement 'the strategy is reliable', where the majority showed strong agreement with the statement. This implies that most sampled respondents perceived the extent to which they are satisfied with their current risk management strategy against weather-related risks as unsatisfactory, none compensative and costly, though reliable.

Table 4.10 Responses of smallholder livestock farmers to statements on the satisfaction of their employed risk management strategies

Statements	Percentage of respondents in each category				
	Strongly agree	Agree	Unitary	Disagree	Strongly disagree
The strategy is reliable (n=330)	30.9	23.6	21.8	4.5	19.1
I am satisfied with the level of loss protection received (n=330)	11.8	28.2	23.6	7.3	29.1
My farm yield/output is not affected, though when affected I am always reimbursed (n=330)	12.7	10.0	10.0	20.0	47.3
It is less costly (n=330)	13.5	19.1	20.0	15.5	30.3

Source: Field survey, 2016

4.5 Willingness to buy index based insurance

4.5.1 Smallholder livestock farmer's willingness to buy index based insurance

The study intended to investigate farmers' willingness to buy IBI. With the intention of achieving that, farmers were first asked whether they would buy IBI if it were to be introduced in South Africa or not. Those who responded "no" were not asked any further questions except the reasons for their decision which are reported in the next discussion on Table 4.11. Those who respondent yes were asked further questions. Up on answering the questions, level of willingness by farmers was obtained which led to three levels of willingness: less willing; moderately willing; and more willing.

Descriptive statistics was used to report the results as presented in Table 4.11. About 14.6% of the respondents were not willing to buy IBI while the remaining 85.6% of the sampled households were willing to buy IBI. The results are incomparable to or higher than that of Takahashi *et al*. (2016) that presented 29.5% of livestock farmers that bought index-based livestock insurance in the 2013 survey conducted in Southern Ethiopia. In the midst of farmers who reported that they were willing to buy IBI, majority (65.5%) were less willing to buy IBI, while 13.6% and 6.4% were moderately and more willing to buy IBI, respectively. In summary, the results indicated that more farmers were willing to buy IBI but not to cover 100% of their stock. This could be an indication that they first want to test the feasibility of IBI by insuring some of their livestock rather than all of them at the same time.

Table 4.11: Smallholder livestock farmer's willingness to buy index based insurance

Willingness to buy index based insurance	Frequency	Percentage
No	48	14.55
Yes	282	85.55
Level of willingness to those who respondent "yes"		
Less willing	216	65.5
Moderately willing	45	13.6
More willing	21	6.4

(n=330)
Source: Field survey, 2016

4.5.2 Important reasons reported by farmers for not willing to buy index based insurance

As reported on Table 4.11 that 14.6% of the total sampled farmers were not willing to buy IBI, these farmers were subsequently asked why they were not willing to buy IBI. Table 4.12 shows the various reasons given by the respondents.

Table 4.12: Important reasons reported by farmers for not willing to buy index based insurance

Statement	Frequency	Percentage
Not making enough income from production to consider insurance	18	37.5
Sources of risks are manageable without insurance	1	2.1
Lack of money to purchase any insurance	7	14.6
Can rely on own capital for protection against any risk	3	6.3
Lack of trust from insurance schemes	6	12.5
Insufficient number of livestock to consider insuring them	13	27.1
Total	48	100.0

(n=48)
Source: Field survey, 2016

According to the farmers, the important reasons for their unwillingness to buy IBI were due insufficient income derived from livestock production, insufficient number of livestock and insurance affordability reported by 37.5%, 27.1% and 14.6% of the 14.6% smallholder livestock farmers, respectively. The results are similar to those of Takahashi *et al*. (2016), with lack of cash to spend on insurance being one of the top three reasons reported for non-purchase of index-based livestock insurance by 2013 survey respondents in the first sales period and insufficient number of livestock in the second sales period. Table 4.12 also shows that only a few (2.08%) respondents reported that they can manage sources of risk without relying on insurance, while others (6.3%) reported that they can rely instead on their own capital for protection against any risk, be it, production risk, and weather-related risk or price risks. Lack of trust from insurance companies was also reported by 12.5% of the farmers who were not willing to buy IBI.

4.6 Factors influencing smallholder farmers' willingness to buy index based insurance

4.6.1 Descriptive statistics of variables used in the regression model

The fourth objective of the study was to examine the factors influencing farmers' willingness to buy IBI. Before presenting the regression results, the discussion commences with descriptive statistics of variables used in the regression model to illustrate the relationship between independent variables with the level of willingness to buy IBI.

4.6.1.1 Categorical variables included in the regression model

The results of descriptive statistics of categorical variables included in the ordered logit regression are reported in Table 4.13.

Table 4.13: Descriptive statistics of categorical variables used in the regression model

Categorical variables						
Variable	[A] % of Total sample (n=330)	[B] % of [A] from *Z = 0* (n=48)	[C] % of [A] from *Z = 1* (n=216)	[D] % of [A] from *Z = 2* (n=45)	[E] % of [A] from *Z = 3* (n=21)	Chi-square value
Percentage of male	74.55	77.08	67.13	100.0	90.48	24.598***
Percentage of female	25.45	22.92	32.87	0.0	9.52	
Communal grazing(% of yes)	76.97	60.42	76.39	100.0	71.43	21.289***
Income from crop production(% of yes)	6.06	20.83	4.17	2.22	0.0	22.279***
Income from livestock production(% of yes)	16.97	6.25	18.98	11.11	33.33	9.622**
Income from non-farm labour(% of yes)	17.88	10.42	21.30	11.11	14.29	5.127
Income from off-farm labour(% of yes)	13.64	4.17	14.81	22.22	4.76	8.131**
Income from salary(% of yes)	22.73	29.17	17.13	37.78	33.33	12.136***
Income from non-labour(% of yes)	23.03	29.17	24.07	15.56	14.29	3.477
Experience of animal loss(% of yes)	48.48	47.92	45.83	48.89	76.19	7.071*

Source: Field survey, 2016

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

Z=0 denotes unwillingness to buy; Z=1 denotes less willing; Z=2 denotes moderately willing; and Z=3 denotes more willing

Analyses of categorical variables indicated that there was a significant difference between levels of willingness to buy IBI in gender, communal grazing, experience of loss, income from crop production, livestock, off-farm and salary. The variable for gender had a significant difference across levels of willingness to buy IBI of whom 74.55% were males, while 25.45% were females. The results showed that out of 21 respondents who were more willing to buy IBI, majority (90.48%) were male. Furthermore, none of the female respondents were moderately willing to buy IBI.

Land tenure security is at the heart of every successful rural society. It was gathered during interviews that farmers spend less on production costs when farming on communal land even though they face more risk of livestock theft. The chi-square results presented in Table 4.13 indicated that there was a significant difference between levels of willingness and communal grazing. The results indicated that out of all the respondents who were more willing, majority (71.43%) of them had their livestock graze on communal land. All the respondents who were moderately willing were farming on communal land, while among those who were not willing, majority (60.42%) of them were also farming on communal land.

Experience of loss had a significant difference at $p<0.1$ with levels of willing to buy IBI. The result shows that out of the total respondents who were not willing to buy IBI, majority (52.08%) of them did not experience any loss, while 47.92% of them had lost their livestock within a period of two years. It was also revealed that out of the total respondents who were more willing, most (76.19%) of them had experienced loss.

The chi-square values of variables of sources of income indicated that there was a significant difference between levels of willingness and income from crop and livestock production, salary and off-farm labour. However, an insignificant difference was indicated on income from non-farm labour and non-labour work. The results showed that of all farmers who were more willing, none of them indicated crop production as their major source of income, while 33.33% had acquired their major source of income from livestock. The result also revealed that 70.83% and 95.83% of the respondents who were not willing to buy IBI did not acquire their major income from salary and off-farm, respectively.

4.6.1.2 Continuous variables included in the regression model

Table 4.14 presents descriptive statistics of continuous variables included in the regression model.

Table 4.14: Descriptive statistics of continuous variables to be included in the regression model

Continuous variables							
Variable	Unit	Total sample mean (n=330)	Mean for *Z = 0* (n=48)	Mean For *Z = 1* (n=216)	Mean for *Z = 2* (n=45)	Mean for *Z = 3* (n=21)	F-value
Age of Household head	Years	57.45	57.31	59.93	50.53	47.14	9.06***
Dependency ratio	Ratio	1.701	1.406	1.778	1.637	1.714	0.66
Household size	Man-equivalent	3.43	2.42	3.65	3.39	3.51	5.39***
Proportion of adult household member with no formal education	Percentage	0.57	0.31	0.68	0.53	0.14	4.65***
Proportion of adult household members with primary education	Percentage	1.14	0.88	1.19	1.13	1.14	1.03
Proportion of adult household members with secondary education	Percentage	1.09	1.06	1.06	1	1.71	2.46*
Proportion of adult household members with matric	Percentage	1.12	0.75	1.22	1.20	0.71	2.33*
Farming experience	Years	14.68	18.38	14.40	13.27	12.14	1.79
Financial and profit-related risks	PC1	-2.235e-09	-0.35	0.10	-0.56	0.97	7.34***
Drought and health risks	PC2	1.905e-10	0.02	0.05	-0.28	0.06	0.92
Government support	PC3	1.829e-09	0.10	-011	0.38	0.10	3.01**
Livestock diversification	Index (LD)	0.33	0.42	0.30	0.38	0.29	9.99***
Crop diversification	Index (CDI)	0.08	0.08	0.07	0.03	0.19	2.66**
Livestock size	TLU	12.34	14.47	11.74	15.20	7.50	1.79
Lost animals	Numbers	4.47	4.61	4.19	5.62	4.63	0.27
Wealth index	Index	121.40	80.24	129.47	134.03	105.37	1.10

Source: Field survey, 2016

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

Z=0 denotes not willing; Z=1 denotes less willing; Z=2 denotes moderately willing; and Z=3 denotes more willing

Analyses of continuous variables indicated that there was a significant difference between levels of willingness to buy IBI in age of household head, household size, Proportion of adult household members with no formal education, secondary education and matric, PC1, PC2, CDI and LD. The results indicated that the average age of household head was around 58 years. Expressed in man-equivalent, household size was estimated 3.42 with a mean dependency ratio of 1.38. However, there was no significant difference in between levels of willingness to buy IBI in dependency ratio.

In comparison with proportion of adult household with tertiary education, the variable for level of education of adult household indicated that a higher proportion (1.71) of those with secondary education were more willing to buy IBI, while a proportion of 0.68 and 1.22 was indicated for those with no formal education and matric, respectively. There was no significance difference between levels of willingness to buy IBI and proportion of adult household members with primary education.

Regarding farmers' perception on sources of risk, a higher (0.97) mean rate of respondents being more willing to buy IBI was depicted from financial and marketing risks, which implies that those who perceived financial and marketing risks as sources of risk to their enterprises were more willing to buy IBI. An average of 0.09 was indicated for elimination of government support as high source of risk. However, there was no statistical difference between drought and health risks by level of willingness.

Also highlighted in Table 4.14 is that farmers who were more diversified in terms of livestock were less willing to buy IBI compared to those with relatively lower rate of livestock diversification. The difference is statistically significant at $p<0.1$. The result also revealed that the average livestock diversification was 0.33 which is four times larger than crop diversification of the sampled farmers which had a mean value of 0.08. Although this is not surprising as the study focused mainly on smallholder farmers who owned livestock enterprises, those who were more crop diversified were more willing to buy index based insurance than those who were diversified in term of livestock production. Mohammed and Ortmann (2005) reported that diversified farmers are less likely to purchase insurance. Given that a higher mean rate of livestock diversification was indicated by Table 4.9, it would be expected that relatively more diversified farmers would be unwilling to buy IBI. This was confirmed by the results, which indicated that farmers who are diversified in their livestock enterprises had a high (0.42) mean rate of not willing to buy IBI, while a higher (0.19) crop diversification mean rate was indicated for farmers who were more willing. The method of calculating livestock diversification has been used in previous studies to classify farmers' level of diversification such that livestock diversification is equal to livestock enterprises owned by the household divided by the total number of enterprises in the sample (e.g Mabuza *et al*., 2012). In this study, a total of seven livestock enterprises were identified, including beef cattle production; goat production; sheep production; piggery; commercial poultry; indigenous chicken production and dairy production.

4.6.2 Ordered logistics regression results of factors influencing farmers' willingness to buy index based insurance

The estimated chi-square value of the ordered logistic regression model was 108.98 (degrees of freedom = 24), which was significant at 1% level of probability, indicating that the model fitted the data well. The results of the ordered logistic regression are summarized in Table 4.15.

The results depicted that age of household head, gender of household head, proportion of adult members with matric education, dependency ratio, household size, communal grazing, livestock diversification, financial and marketing risk, government support and sources of income significantly influenced farmers' willingness to buy IBI. The estimated coefficient for age (significant at $p<0.01$) of household head was negatively related to the willingness to buy IBI. It appears, therefore, that young and less experienced smallholder farmers had a greater probability of buying IBI than older and more experienced farmers. These results could suggest that younger and less experienced farmers might not have gained enough knowledge and skills related to the livestock enterprise and are therefore less aware of alternate risk management strategies apart from insurance. As a result, the desire among young and less experienced farmers to buy insurance is high. Similar results were reported by Mohammed and Ortmann (2005) in Eritrea, concluding that it may not be economical for the National Insurance Corporation of Eritrea to charge all farmers a fixed premium as older and more experienced (less risky) farmers may be unwilling to pay the same rate as high-risk farmers (young and less experienced). As such, a variable premium was recommended. The marginal effects of the estimated coefficient for age of household head indicated that an additional year in household head's age reduces the possibility of the household to be moderately and more willing to buy IBI by 0.4 and 0.16 percentage point, respectively. The same additional year increases the probability of not willing to buy IBI or be less willing to buy IBI by 0.38 and 0.18 percentage point, respectively.

The estimated coefficient for gender of household head was found to have a significant effect on farmers' willingness to buy IBI ($p<0.01$). The result suggests that male-headed households, compared to their female counterparts, had a lower likelihood of buying IBI. However, the marginal effect suggests that in comparison with female headed households, the probability of male headed households to be moderately and more willing to buy IBI decreased with 5.5 and 2.1 percentage point, respectively. In addition, having a male headed household reduces the probability of not willing to buy IBI by 6.7 percentage point.

The results depicted that dependency ratio is significant at $p<0.1$ and has a negative relationship with willingness to buy IBI. A higher dependency ratio implies that members who are employed have more responsibility of catering for the household dependents. If the number of those who are employed and make a contribution to household income does not match the increase of household dependents, such households will more likely use their income to provide for dependents in the family instead of paying insurance premiums. The marginal effect of the estimated coefficient for dependency ratio suggests that there is less (0.013) probability for families with relatively more dependents to be moderately willing to buy IBI.

In conformity with previous expectations, the estimated coefficient for household size showed a significant positive effect on willingness to buy IBI. This result suggested that the higher the household size, the more desire to purchase IBI. Sampled farmers depended on agricultural production such that they produced primarily for own consumption and sold relatively less proportion to cater for other household needs. This increases the responsibility of the farmer to avoid potential loss on production in order to be able to provide for the family. If production is to be adversely affected by risks, this could negatively affect the ability of the farmer to provide both for the household and for the running of the farm. Given the above, such households are likely to resort to risk transferring strategies to protect themselves; hence, they could be more willing to buy IBI. Worth highlighting, while most farmers wish to benefit from insurance pay-outs, this could be an unrealistic expectation for poor farmers given the current substantial insurance premiums. The marginal effect of the estimated coefficient for household size indicated that a unit increase in adult equivalents reduces the likelihood of not buying IBI by 3.9 percentage point and less willing by 1.8 percentage point. Instead, the same additional unit increase in IBI increases the likelihood of being moderately and more willing to buy IBI by 4.1 and 1.6 percentage point, respectively.

The results highlighted the significance of education level towards willingness to buy IBI. A household with a higher proportion of household members with matric education had less likelihood of willing to buy IBI compared to those with tertiary education (reference category). The marginal effect of the estimated coefficient for proportion of household members with matric education indicate that a unit increase in proportion of household members with matric education compared to those with tertiary education reduces the probability of a household being moderate or more willing by 2.6 and 1 percentage point, respectively. The same unit increase in proportion of household members with matric education compared to those with tertiary education increases the probability of not willing to buy IBI by 2.47 percentage point.

The results also highlight the significance of land tenure security towards willingness to buy IBI. Farmers who had their livestock graze on communal land compared to their counterparts who had other grazing arrangements had a greater likelihood of buying IBI. It is no doubt that farmers whose livestock graze on communal land are at high and continuously increasing risk (Mahabile *et al*., 2002); hence, the desire to buy IBI. This could be justified by the intention to improve their collateral effect as financial institutions are averse about supporting them without a reliable mechanism ready to reduce the risk of default. The marginal effect for the estimation coefficient of communal grazing indicates that in comparison with other land tenure arrangements, those whose livestock graze on communal land were less likely not to be willing to buy IBI by 15 percentage point. Instead, the probability of them being moderately and more willing to buy IBI increases with 9.4 and 3.5 percentage point.

The estimated coefficient for livestock diversification showed a significant ($p<0.05$) and negative effect on willingness to buy IBI, indicating that diversified livestock farmers are less likely to be willing to buy IBI. Farmers who have a relatively large number of livestock enterprises may have lower income variability. For instance, income loss as a result of livestock loss from one enterprise may be compensated for by another enterprise with higher income. Mohammed and Ortmann (2005) suggested that insurance should be targeted to farmers that are not diversified as diversification acts as an alternative risk management strategy resulting in diversified farmers to have a lower probability of participating in insurance. The marginal effects of the estimated coefficient for livestock diversification indicate that a unit increase in livestock diversification index increases the probability of not participating in IBI by 15.8 percentage point. The same unit increase in livestock diversification index reduces the likelihood of a household being moderately or more willing to buy IBI by 16.6 and 6.5 percentage point, respectively.

The estimated coefficient for experience of loss showed a positive and significant influence on farmers' willingness to buy IBI. The results depict that farmers who experienced loss of livestock within a period of 12 months were more likely to buy IBI than those who did not experience any loss. The marginal effects for the estimated coefficient of experience of loss indicated that the likelihood of farmers who experienced loss of livestock to be moderately or more willing increased by 4.1 and 1.6 percentage point, respectively. A probability of farmers who experienced loss of livestock not to buy IBI decreases by 3.9 percentage point.

The results further revealed that farmers' perceptions on sources of risk significantly influence their willingness to buy IBI. Financial and marketing risks had a significant ($p<0.05$) positive relationship with the willingness to buy IBI. This implies that smallholder livestock farmers who perceived financial and marketing risks as high sources of risk for their livestock enterprise were more willing to buy IBI than farmers who perceived them as low sources of risk. Marginal effect results show that the probability of farmers who perceived financial and marketing risk as high sources of risk not to buy IBI decreases by 2.2 percentage point. On the one hand, the probability of these farmers to be moderately willing increases with 2.3 percentage point, while on the other hand the probability of them being more willing to buy IBI increases by 0.93 percentage point.

The results provided evidence that elimination of government support played a very influential role in farmers' willingness to buy IBI. This is in reference to Table 4.16 where the estimated coefficient for government support significantly ($p<0.05$) and positively influenced willingness to buy IBI. Apparently, smallholder farmers receive government emergency credit (forage, fertilizers, and important agricultural inputs) especially during drought, training and support from extension officers. Extension officers facilitate farmers' access to free consultation from professional veterans who offer advice and recommendations that involve animal health risks. Elimination of government support would mean that farmers would not be receiving any benefits from the government which would mean that they should seek alternative risk transferring strategies. For that reason, with possible elimination of such support, there is a high chance of farmers buying IBI. Mushai (2008) also indicated that farmers are less motivated to manage risks through strategies such as insurance knowing that the government would provide food for them in events of risks such as drought. The results further revealed that the probability of farmers who perceived elimination of government support as a high risk source for their enterprises not to be willing to buy IBI decreases by 2.5 percentage point. In addition, a probability of such farmers to be moderately and more willing increases by 2.6 and 1.0 percentage point, respectively.

The results also highlighted the significance of major sources from which farmers obtain their income towards their willingness to buy IBI. Farmers whose major source of income was from livestock, salary, off-farm, non-farm and non-labour were more willing to buy IBI compared to those whose major source of income was crop production (reference category). The marginal effect for the estimated coefficients of sources of income indicated that in comparison with farmers whose major source of income was from crop production, the probability of those who derived income from livestock, salary, off-farm, non-farm and non-labour not to be willing to buy IBI decreased by 11.91, 11.36, 10.65, 9.68 and 8.48 percentage point, respectively. The probability of those whose major source of income was livestock and salary to be more willing to buy IBI when compared to those who derived their income from crop production increases with 18.23 and 16.72 percentage point.

Table 4.15: Ordered logit regression results of factors influencing farmers' willingness to buy IBI and the level of willingness to buy IBI

Variables	β	Robust Std. error	Marginal effects							
			P(Z=0) dy/dx	Std. error	P(Z=1) dy/dx	Std. error	P(Z=2) dy/dx	Std. error	P(Z=3) dy/dx	Std. error
Household demographics										
Age of household head	-0.045***	0.010	0.004***	0.001	0.002*	0.001	-0.004***	0.001	-0.002***	0.001
Gender of household head (male = 1)[a]	-0.682***	0.247	-0.067**	0.027	0.009	0.014	-0.055***	0.021	-0.021***	0.008
Dependency ratio	-0.002*	0.001	0.000	0.000	0.000	0.000	-0.000*	0.000	-0.000	0.000
Household size (in man-equivalents)	0.455***	0.132	-0.039***	0.014	-0.018*	0.009	0.041***	0.012	0.016***	0.005
Proportion of adult household members with no formal education	-0.046	0.143	004	0.012	0.002	0.006	-0.004	0.013	-0.002	0.005
Proportion of adult household members with primary education	0.002	0.122	-0.000	0.010	-0.000	0.005	0.000	0.011	0.000	0.004
Proportion of adult household members with secondary education	-0.161	0.151	0.014	0.014	0.006	0.006	-0.026	0.014	-0.006	0.005
Proportion of adult household members with matric education	-0.289**	0.143	0.025***	0.013	0.011	0.008	-0.000**	0.013	-0.010*	0.005
Farming experience	-0.019	0.016	0.002	0.001	0.001	0.001	-0.002	0.001	-0.001	0.001
Land tenure system										
Communal grazing (Yes = 1)[a]	1.306***	0.386	-0.049*	0.025	-0.049	0.041	0.066***	0.043	0.032***	0.022
Diversification										
Livestock diversification	-1.847**	0.876	0.158**	0.082	0.074	0.047	-0.166**	0.078	-0.065**	0.035
Crop diversification	-0.334	0.941	0.029	0.082	0.013	0.037	-0.030	0.085	-0.012	0.033
Livestock ownership										
Livestock size (in Tropical Livestock Units)	0.002	0.013	-0.001	0.000	-0.001	0.000	0.001	0.001	0.000	0.001
Experience of loss (Yes =1)[a]	0.455*	0.246	-0.039	0.022	-0.019	0.014	0.041*	0.023	0.016*	0.010
Number of animals sold	0.003	0.011	-0.000	0.001	-0.000	0.001	0.000	0.001	0.000	0.000

Table 4.15 Continued

Variables	β	Robust Std. error	Marginal effects							
			P(Z=0) dy/dx	Std. error	P(Z=1) dy/dx	Std. error	P(Z=2) dy/dx	Std. error	P(Z=3) dy/dx	Std. error
Wealth										
Wealth index	0.000	0.001	-0.000	0.000	-0.000	0.000	0.000	0.000	0.000	0.000
Perceptions on sources of risk										
Financial and marketing risk (PC1)	0.261**	0.106	-0.022**	0.009	-0.010	0.007	0.024	0.010	0.009**	0.005
Drought and animal health risk (PC2)	-0.116	0.107	0.010	0.009	0.005	0.005	-0.010	0.010	-0.004	0.004
Government support (PC3)	0.298***	0.118	-0.025***	0.010	-0.012	0.008	0.027	0.012	0.011***	0.005
Major sources of income										
Income from livestock (Yes=1)[a]	2.315***	0.675	-0.119***	0.030	-0.318**	0.126	0.255***	0.062	0.182*	0.096
Income from salary (Yes=1)[a]	1.864***	0.701	-0.114***	0.034	-0.207*	0.120	0.205**	0.081	0.115	0.071
Income from off-farm (Yes=1)[a]	2.135***	0.693	-0.107***	0.027	-0.301**	0.138	0.241***	0.069	0.167*	0.097
Income from non-farm (Yes=1)[a]	1.647**	0.653	-0.097***	0.031	-0.190*	0.114	0.185**	0.077	0.101	0.066
Income from non-labour (Yes=1)[a]	1.246*	0.652	-0.085**	0.037	-0.115	0.089	0.135*	0.078	0.064	0.047
Thresholds										
Cut1	-2.109									
Cut2	1.904									
Cut3	3.410									
Measures of fit										
Log pseudolikelihood	-282.62621									
Wald chi^2 (24)	108.98***									
Pseudo R^2	0.1477									
Brant chi2 (48)	13.34									
Number of observations	330									

Note: *, ** and ***means significant at 10%, 5% and 1% levels, respectively

Z=0 denotes not willing; Z=1 denotes less willing; Z=2 denotes moderately willing; and Z=3 denotes more willing

[a] dy/dx is for discrete change of dummy variable from 0 to 1

Source: field survey, 2016

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Recap of research objectives and methodology

Measures such as crop rotation and diversification, inter-cropping, use of low yield but stress tolerant varieties, share tenancy, and informal financial arrangements have been devised by farmers in order to limit the effects of uncertain risks and unpredictable climatic conditions driven by natural disasters such as floods, hail storm, drought, and high temperatures. However, agricultural productivity continues to be negatively affected and income derived from the sector very unstable and difficult to project implying that these measures are inefficient. Agricultural insurance has been suggested by development organisations and researchers to transfer the risk of extreme weather events from individual farmers. In lower income countries, however, insurance markets are underdeveloped and often non-existent mainly due to problems of asymmetric information and high transaction costs. As such, Index based insurance (IBI) was introduced in several African countries in an attempt to address such problems. IBI, unlike traditional insurance, pays indemnities based on the realisation of a weather index preventing problems of asymmetric information as it cannot be influenced by the policy holder. South Africa, despite evidence of farmers affected by natural risks, is yet to introduce IBI. Apart from attempts to study the possibility of introducing IBI in South Africa (Mapfumo, 2007), no empirical evidence has been provided on the acceptability of IBI by local farmers who happen to be the key stakeholders in such interventions. This study, therefore, sought to investigate smallholder farmers' willingness to participate in IBI. It also provided an opportunity to help inform the process of developing policy interventions aimed at improving risk management within the smallholder subsector.

The specific objectives of the study were to: identify livestock farmers' perceptions on sources of risk; identify livestock farmers' managerial responses to risk; investigate livestock farmers' willingness to participate in IBI; and study factors underlying livestock farmers' willingness to buy IBI.

Farmers' perceptions on sources of risk and managerial responses were studied using Principal Component Analyses (PCA). Given the numerous variables considered to study objective 1 and 2 to PCA was adopted for the purpose of reducing dimensionality by extracting the smallest number of principal components (PCs) and summarizing the data with little loss of information.

The PCs extracted from sources of risks that had Eigenvalues of greater or equal to one were later used in the regression model to examine the possibility of them influencing farmers' willingness to buy IBI. Farmers' willingness to buy IBI was studied with the use of descriptive statistics. Farmers had to first decide whether or not they were willing to buy IBI. Those who were not willing were not asked further questions. However, those who were willing were asked questions to indicate their level of willingness which led to four categories. The first category comprised of farmers who were not willing to buy IBI, whereas the second category was those that were willing to buy IBI but not to cover 100% of their stock. The third category included farmers that were willing to buy IBI and cover 100% of their stock, while the last category comprised those who were willing to buy IBI and cover 100% of their stock even with a 10% premium increase. Given that the dependent variable (farmers' willingness) was discrete and had more than two categories, the Ordered Logistic regression model was used to address objective four. The relevance of the model was confirmed through a brant test of proportional odds whose results indicated that the proportional odds assumption was not violated.

The remaining sections are organised as follows: Section 5.2 presents conclusions drawn from empirical results, whereas Section 5.3 provides policy recommendations. The chapter concludes with limitations of the study followed by suggested areas for further research.

5.2 Conclusion

5.2.1 Smallholder livestock farmers' perception on sources of risk

Using PCA to identify smallholder livestock farmers' perception on sources of risk, three dominant PCs were identified considering the original variables with relatively high factor loadings. The PCs were identified as financial and marketing risks, drought and animal health risks and government support. Dominant factors in the first PC comprised of consumer preferences, credit availability, inflation, and changes in labour legislation, while in the second PC dominant factors comprised of low temperature, very high temperature, and livestock pests and diseases. The latter suggests that farmers perceived low rainfall and extreme high temperatures to have an impact in the distribution of pests and diseases and reflect the possibility of an occurring drought, while the former suggests that farmers perceived marketing and financial risks as high sources of risk. The third PC was referred to as 'government support' due to high factor loadings of elimination of government support and changes in labour legislation. Government support includes a regulatory framework that gives farmers access to risk management tools such as government emergency credit. Possible elimination of such support would negatively affect the ability of farmers to access agricultural inputs and credit to sustain their livestock production.

5.2.2 Risk management strategies employed by farmers

The second objective of the study was to identify farmers' managerial responses to risk. This objective was also achieved with the use of PCA. The results indicated that farmers employed strategies such as production costs minimisation, insurance, off-farm investments and reliance on government assistance. This is evident from the results of the PCA which identified four dimensions of risk management strategies. Although farmers employ different strategies to cope with risks, production continues to be adversely affected, particularly due to natural risks such as drought. This suggests that the strategies employed by farmers are inefficient to cope with such risks. Thus, greater reliance should be on *ex ante* risk management mechanisms, such as IBI.

5.2.3 Smallholder livestock farmers' willingness to buy index based insurance

Descriptive statistics were used to investigate farmers' willingness to buy IBI. Major findings showed that though 14.55% of the sampled farmers were not willing to buy IBI, a larger proportion of 85.45% were willing. Among those who were willing, 65.45% were less willing, while 13.64% and 6.36% were moderately and more willing, respectively. The higher proportion of respondents falling under the category 'less willing' shows that farmers are in doubt concerning the feasibility of IBI; hence, they were willing but not prepared to cover 100% of their animal stock. Also, premium increase incentive through government subsidy would effectively increase willingness to buy IBI. This is because farmers who previously responded 'no' to the possibility of a 10% premium increase later responded 'yes' when the offer of government paying for the 10% premium increase was made, allowing them to pay only 90% of the insurance premium.

One of the most reported reasons for farmers' decision for not willing to buy IBI was that they were not generating enough income from livestock production to consider insurance. Smallholder farmers, especially those who farm on communal land, tend to generate low income from the sale of livestock because of market related constraints including lack of information and failure to attract buyers. Farmers are often vulnerable to better informed buyers due to lack of market information including type of product demanded, quality, quantity, and market price. As a result, they end up making irrational price decisions, thus generating less income from livestock than they would if they were better informed. This implies the need for training and provision of marketing information to farmers.

5.2.4 Factors influencing smallholder farmers' willingness to buy index based insurance

The fourth objective was to investigate factors influencing farmers' willingness to buy IBI. This objective was addressed using the Ordered Logistic regression model. The major findings indicated that farmers' willingness to buy IBI was positively and significantly affected by household size, land tenure, experience of loss, financial and marketing risks, elimination of government support, and sources of income. Farmers' decisions were also negatively and significantly influenced by gender of household head, age of household head, education level, dependency ratio, and the extent of livestock diversification.

Farmers who had their livestock graze on communal land predominantly have open access to land. However, they lack assurance and collateral as landholding based on communal rights does not provide secure tenure rights. Since majority of farmers had lack of collateral, IBI would act as a form of collateral to financial institutions or banks, increasing their chances to obtain loans; hence, the positive influence of communal grazing on willingness to buy IBI

Smallholder livestock farmers who have experienced loss of livestock had a greater probability of willing to buy IBI, implying the need to target farmers who have lost their animals due to series of low rainfall, high temperatures and animal diseases. Moreover, farmers that were diversified were less likely to buy insurance given that livestock diversification was used as an alternative risk management strategy. This implies the need to target farmers that are not diversified. Furthermore, the livestock size in Tropical Livestock Units, although not significant but positive, implies that farmers who own a larger livestock size are more likely to buy IBI than those with a smaller livestock size.

Farmers who perceived financial and marketing risk as high sources of risks to their enterprises had a greater probability of willing to buy IBI. This highlights the importance of the design of IBI such that its products are developed to better reflect on types of risks that would encourage farmers to buy IBI. In addition, farmers who perceived elimination of government support as a high source of risk to their enterprises were more willing to buy IBI. This suggests the need to integrate government support into an *ex ante* risk management plan such as IBI and not necessarily to eliminate such support.

Lastly, the significant positive effect of sources of income highlights the importance of acquiring income from a variety of sources. This confirms that farmers are willing to buy IBI provided that the source from which they could obtain income is guaranteed which would relatively increase their ability to afford insurance premiums.

5.3 Policy recommendations

In line with the findings of the study, the following recommendations are made:

- The study recommends that workshops and surveys focusing on the elements of trust in the designing and implementation of the IBI should take place. Pilot projects such as those conducted in Malawi could also be conducted in South Africa, where researchers were tasked to ensure that farmers understood index insurance contracts. Worksheet comprised of key characteristics of previous years' contract, the amount of rainfall needed for a pay-out and what the amount would be were developed and presented to farmers (Patt *et al*., 2009). This would not only increase local farmers' understanding of the insurance contracts but would also create a platform for farmers to make insurance design recommendations.

- Given the findings that farmers became more willing to buy IBI when the condition of the government paying for the 10% premium increase was presented to them, it is recommended that the government should make an effort to sponsor IBI under the provision of a subsidy. Through a premium subsidy, insurance premium rate can be maintained at a profitable level for insurance companies since there often compelled to lower their premium rate in order to improve demand for insurance.

- Institutional developments including supply of market information, development of contractual agreements and organisational support should be given attention. This could be done through farmers engaging in group marketing arrangements as this could reduce costs of transportation to market place and increase their marketable output. The government could also support this arrangement by investing in public facilities such as market places and telecommunications.

- Farmers should be better educated to assess risk management strategies that are better suited to cope with natural risks than *ex post* measures that they are currently relying on as they are inefficient and can often distort domestic food markets. The study therefore, recommends that greater priority should be in promoting programmes to better educate farmers on how to assess risk management tools. Greater reliance should be on *ex ante* risk management tools such as IBI.

5.4 Limitations of the study

The study was based on an unfamiliar concept, index based insurance. As such, interviewers had to first give a brief background of the concept, highlighting its requirements and benefits before responses from farmers could be drawn. Therefore, the interviews were long, making farmers reluctant to participate in the study. Most farmers were old and illiterate which even took longer to complete the questionnaire, especially since the questionnaire contents had to be translated to the local language of Setswana.

5.5 Suggested areas for further research

The researcher may consider conducting a study on the willingness of other stakeholders (financial institutions, government, and insurance companies) to participate in index based insurance.

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APPENDIX A

QUESTIONNAIRE

Smallholder Livestock Farmers' Willingness to buy Index Based Insurance in South Africa: Evidence from Ngaka Modiri Molema District Municipality

Note to respondents: The information captured in this questionnaire is strictly confidential and will be used for research purposes at North West University, Mafikeng Campus. Participation in the survey is voluntary and respondents are free to withdraw from the study at any time if they so wish.

Name of municipality: ....

SECTION A: FARMER'S DEMOGRAPHIC CHARACTERISTICS

	Household members (start with the household head)	Relation with household head	Gender	Age	Highest level of education	Employmen t status	Does member contribute household income? Yes =1 No = 0
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

NB: Use the codes below

Relation with household head	Gender	Highest level of education	Employment status
1 = spouse 2 = daughter/son 3 = daughter/son in law 4 = grandchild 5 = hired worker 6 = other	1 = male 2 = female	1 = no schooling 2 = primary education 3 = secondary education 4 = matriculated 5 = tertiary education	1= employed 2= unemployed 3=pensioner 4=school attending

SECTION B: HOUSEHOLD SOCIO-ECONOMIC CHARACTERISTICS

Land tenure system (*please indicate where your livestock graze*)?

Private		Lease	
Communal		Renting	
Permission to occupy		Other (*specify*)	

Please provide information on the major sources of household income on a monthly basis.

Source of household	Not applicable	R0-R499	R500-1499	R1500-2499	R2500-3499	R3500-4499	R4500 and
Crop production							
Beef cattle							
Dairy							
Goat production							
Sheep							
Piggery							
Indigenous							
Commercial							
Formal/salary							
Temporary							
Temporary							
Self-							
Pension							
Child social							
Disability grant							
Other (specify)							

What type of livestock do you own and how many? (*Please indicate number owned in appropriate box. Complete table below*)

Type of livestock	Number currently owned	Number sold in the past 12 months	Number consumed in the past 12 months
Cattle-oxen/bull			
Cattle-cows			
Cattle-heifers			
Cattle-immature			
Calves male			
Sheep			
Goat			
Donkeys			
Poultry			
pigs			

Other assets

Domestic assets	Number owned	Less than 3 years	3 to 7 years	Above 7 years
Coal stove				
Kitchen cupboard				
Radio				
Television				
DVD player				
Satellite receiver				
Chair				
Cell phone				
Gas stove				
Sewing machine				
Borehole				
Transport		Less than 3 years	3 to 7 years	Above 7 years
Car/truck				
Motorcycle				
Bicycle				
Cart				
Agricultural assets		Less than 3 years	3 to 7 years	Above 7 years
Tractor				
Tractor plough				
Tractor trailer				
Hand hoes				

How many years have you been practising livestock production?........

Besides livestock production, what type of crops do you produce?

Type of crop	Total area (Ha)
Total	

What is the total area of the arable land? ....

Please indicate the following:

Main source of energy for cooking	Main source of energy for lighting	Main sources of water: 1=human consumption and 2= livestock			
		1=human consumption	Condition	2= livestock	Condition

NB: Use the codes mentioned in the table below to answer the above table

Main sources of energy for cooking 1=Electricity 2=Gas 3=Paraffin 4=Wood 5=Other specify	Main sources of energy for lighting 1=Electricity 2=Gas 3=Paraffin 4=Candles 5=Other specify	Main sources of water 1=Borehole 3=Dams 4=Streams/Rivers 5=Ground water 6=Hand dug wells 7=Rain water harvesting 8= Tap water 9= Other specify	Condition of main sources of water 1= Poor 2=Very Poor 3=Good 4=Very good

SECTION C: SOURCES OF RISK AND RISK MANAGEMENT STRATEGIES

To what extent do you perceive the following factors as sources of risk for your livestock enterprise? (*please indicate, 0= Not a concern, 1=Very low,2= Low, 3= Moderate, 4=High, and 5= Very high)*

	Sources of risk	0	1	2	3	4	5	No. of animals lost due to source of risk in past 2 years.
1	High rainfall							
2	Low rainfall							
3	Drought							
4	Operating input costs							
5	Credit availability							
6	Credit costs							
7	Technology							
8	Government programs							
9	Government policies							
10	Inflation							
11	Animal welfare policies							
12	Health status of farm family							
13	Exclusion from government support							
14	Very high temperature							
15	Very low temperature							
16	Hail storms							
17	Flood							
18	Strong wind							
19	Pests and diseases							
20	Changes in costs of farm inputs							
21	Variation in crop yields							
22	Changes in environmental regulations							
23	Further land redistribution/restitution land reform							
24	Changes in tax legislation							
25	Deregulation of domestic product market							
26	Land rent							
27	Ability to redeem loans							
28	Consumer preference							
29	Changes in interest rate							
30	Death of farm operator							
31	Family relations							
32	Possible loss of tenure rights							
33	Changes in labour legislation							
34	Other (*specify*)							

Which of the above sources of risks would you purchase insurance for? (*please indicate five 5*)

1. 2. 3. 4. 5.

To what extent are the following strategies employed in attempting to manage risk in your enterprise? (*please indicate, 0= Not employed, 1=Very low,2= Low, 3= Moderate, 4=High, and 5= Very high*)

Characteristics	0	1	2	3	4	5	No. of years strategy has been employed
Production at lowest possible cost							
Hedging							
Forward contracts							
Off-farm investment							
Purchasing personal insurance							
Production practice diversification							
Debt management							
Government emergency credit							
Market information							
Credit reserves							
Futures and options market							
Application of strict producing methods							
other (*specify*)							

Are you aware of any agricultural insurance scheme that can insure you against the following risks?

	Yes	No	If yes, are you a member of that scheme?		If no, why are you not a member?
			Yes	No	
Weather risks					
Price risks					
Production risks					

SECTION D: WILLINGNESS TO BUY INDEX BASED INSURANCE

Please rate the extent to which you agree with the following statements pertaining to the satisfaction of your current most employed risk management strategy for weather related risks (*please indicate, SA= strongly agree, A= agree, U= unitary, D= disagree, SD= strongly disagree*).

Characteristic	SA	A	U	D	SD
The strategy is reliable					
I am satisfied with the level of loss protection received					
My farm yield/output is not affected, though when affected I am always reimbursed					
It is less costly					

Index based insurance is an innovative product that protects against shared risk rather than individual risks such as risks associated with weather fluctuations, disease outbreaks or price loss. It offers you a payout based on the external indicator that triggers a payment within a geographical defined space. The insurance is designed to protect you against prolonged forage scarcity, which will help you maintain your livestock in the face of severe forage scarcity as a result of drought.

2.1 If index based insurance was to be introduced such that whenever there is rainfall deficit or lack of forage, the insurance will protect you against any loss. Would you buy the insurance to cover 100% of your livestock? Yes[ ] No [ ]
If No to 2.1, please state reasons.
2.2 If "YES" to 2.1.Should the premium increase by 10%, would you still be willing to pay insurance cover for 100% of your stock? Yes[ ] No [ ]
2.3If "NO" to 2.2. Would you accept if the government offers to pay for the 10% premium increase, allowing you to pay insurance for 90% of the value of you animal stock? Yes[ ] No [ ]

THANK YOU
FOR PARTICIPATING IN THIS STUDY

APPENDIX B

ORDERED LOGISTIC REGRESSION BRANT TEST OF PARALLEL REGRESSION ASSUMPTION

```
. ologit IBI Gender Age_hhh Prop_NoSchool Prop_Primary Prop_Secon Prop_Matric Dependency HHsize Experience  Te
> nu_Secure Live_size Lost_an Animal_sold PC1 PC2 PC3 Live_diverse Crop_Diverse Wealth Inc_Livestoc Inc_Salary
>  Inc_Off Inc_NonF Inc_NonL, robust

Iteration 0:   log pseudolikelihood = -331.58801
Iteration 1:   log pseudolikelihood = -287.03664
Iteration 2:   log pseudolikelihood = -282.65729
Iteration 3:   log pseudolikelihood = -282.62622
Iteration 4:   log pseudolikelihood = -282.62621

Ordered logistic regression                     Number of obs     =        330
                                                Wald chi2(24)     =     108.98
                                                Prob > chi2       =     0.0000
Log pseudolikelihood = -282.62621               Pseudo R2         =     0.1477
```

IBI	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Gender	-.6818233	.2472025	-2.76	0.006	-1.166331	-.1973153
Age_hhh	-.044567	.009721	-4.58	0.000	-.0636198	-.0255141
Prop_NoSchool	-.0461503	.1432431	-0.32	0.747	-.3269016	.2346011
Prop_Primary	.0021544	.1221114	0.02	0.986	-.2371797	.2414884
Prop_Secon	-.1612696	.1512337	-1.07	0.286	-.4576821	.135143
Prop_Matric	-.2885682	.1428735	-2.02	0.043	-.5685952	-.0085413
Dependency	-.0015158	.0008733	-1.74	0.083	-.0032275	.0001959
HHsize	.4554381	.1319963	3.45	0.001	.1967301	.7141461
Experience	-.0190249	.0155749	-1.22	0.222	-.0495511	.0115013
Tenu_Secure	1.306495	.386212	3.38	0.001	.5495336	2.063457
Live_size	.0019326	.014108	0.14	0.891	-.0257186	.0295838
Lost_an	.4550939	.246184	1.85	0.065	-.027418	.9376058
Animal_sold	.0030586	.011185	0.27	0.785	-.0188636	.0249807
PC1	.2614838	.1056165	2.48	0.013	.0544792	.4684884
PC2	-.11641	.1065467	-1.09	0.275	-.3252377	.0924176
PC3	.2979031	.117843	2.53	0.011	.066935	.5288712
Live_diverse	-1.847086	.8762029	-2.11	0.035	-3.564413	-.1297603
Crop_Diverse	-.3337322	.9410339	-0.35	0.723	-2.178125	1.51066
Wealth	.0004072	.0007789	0.52	0.601	-.0011194	.0019338
Inc_Livestoc	2.315386	.6748686	3.43	0.001	.9926677	3.638104
Inc_Salary	1.864655	.700839	2.66	0.008	.4910359	3.238274
Inc_Off	2.135667	.692808	3.08	0.002	.7777881	3.493546
Inc_NonF	1.646996	.6533087	2.52	0.012	.3665344	2.927457
Inc_NonL	1.264208	.6523489	1.94	0.053	-.0143719	2.542789
/cut1	-2.109095	.8877689			-3.849091	-.3691004
/cut2	1.903708	.8802469			.1784562	3.628961
/cut3	3.409997	.914976			1.616677	5.203317

```
. brant

Brant test of parallel regression assumption
```

	chi2	p>chi2	df
All	13.34	1.000	48
Gender	20.02	0.000	2
Age_hhh	12.20	0.002	2
Prop_NoSchool	10.53	0.005	2
Prop_Primary	1.55	0.460	2
Prop_Secon	12.83	0.002	2
Prop_Matric	0.37	0.830	2
Dependency	2.60	0.272	2
HHsize	8.12	0.017	2
Experience	7.96	0.019	2
Tenu_Secure	1.25	0.536	2
Live_size	7.30	0.026	2
Lost_an	4.71	0.095	2
Animal_sold	6.84	0.033	2
PC1	31.54	0.000	2
PC2	6.84	0.033	2
PC3	6.83	0.033	2
Live_diverse	16.85	0.000	2
Crop_Diverse	19.63	0.000	2
Wealth	15.18	0.001	2
Inc_Livestoc	2.81	0.245	2
Inc_Salary	3.82	0.148	2
Inc_Off	2.54	0.281	2
Inc_NonF	2.81	0.245	2
Inc_NonL	0.27	0.874	2

```
A significant test statistic provides evidence that the parallel
regression assumption has been violated.

.
```

APPENDIX C

MARGINAL EFFECTS AFTER ORDERED LOGISTIC REGRESSION

```
. mfx

Marginal effects after ologit
      y  = Pr(IBI==0) (predict)
         =  .09473449
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
Gender*	.0673272	.02743	2.45	0.014	.013569	.121085	.254545
Age_hhh	.0038221	.00086	4.46	0.000	.002141	.005503	57.4545
Prop_N~l	.0039578	.01229	0.32	0.747	-.020131	.028046	.572727
Prop_P~y	-.0001848	.01047	-0.02	0.986	-.020704	.020334	1.13636
Prop_S~n	.0138305	.01361	1.02	0.310	-.012846	.040507	1.09091
Prop_M~c	.0247476	.01316	1.88	0.060	-.00105	.050545	1.11818
Depend~y	.00013	.00008	1.65	0.100	-.000025	.000285	170.082
HHsize	-.0390583	.01374	-2.84	0.004	-.065997	-.012119	3.42636
Experi~e	.0016316	.00138	1.18	0.238	-.001079	.004342	14.6818
Tenu_S~e*	-.1505446	.05558	-2.71	0.007	-.259477	-.041612	.769697
Live_s~e	-.0001657	.00121	-0.14	0.891	-.002536	.002205	12.3417
Lost_an*	-.0389741	.02195	-1.78	0.076	-.082004	.004056	.484848
Animal~d	-.0002623	.00096	-0.27	0.785	-.002147	.001622	4.47252
PC1	-.0224248	.00881	-2.55	0.011	-.039686	-.005163	-2.2e-09
PC2	.0099833	.00918	1.09	0.277	-.008013	.027979	1.9e-10
PC3	-.0255481	.01015	-2.52	0.012	-.045446	-.005651	1.8e-09
Live_d~e	.1584059	.08164	1.94	0.052	-.001599	.318411	.325
Crop_D~e	.0286208	.08178	0.35	0.726	-.131659	.188901	.075075
Wealth	-.0000349	.00007	-0.51	0.610	-.000169	.000099	121.401
Inc_Li~c*	-.1191365	.02976	-4.00	0.000	-.177471	-.060802	.169697
Inc_Sa~y*	-.1136642	.03418	-3.33	0.001	-.180663	-.046665	.227273
Inc_Off*	-.1065505	.02692	-3.96	0.000	-.159305	-.053796	.136364
Inc_NonF*	-.0968291	.03113	-3.11	0.002	-.157847	-.035811	.178788
Inc_NonL*	-.0847746	.03774	-2.25	0.025	-.158743	-.010806	.230303

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx compute, predict(outcome(1))

Marginal effects after ologit
      y  = Pr(IBI==1) (predict, outcome(1))
         =  .75792999
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
Gender*	.0090159	.01371	0.66	0.511	-.017857	.035889	.254545
Age_hhh	.0017768	.00106	1.67	0.095	-.00031	.003864	57.4545
Prop_N~l	.0018399	.00581	0.32	0.752	-.009549	.013229	.572727
Prop_P~y	-.0000859	.00487	-0.02	0.986	-.009635	.009463	1.13636
Prop_S~n	.0064295	.00637	1.01	0.313	-.006062	.018921	1.09091
Prop_M~c	.0115046	.00756	1.52	0.128	-.003317	.026326	1.11818
Depend~y	.0000604	.00004	1.40	0.162	-.000024	.000145	170.082
HHsize	-.0181574	.00943	-1.93	0.054	-.036641	.000326	3.42636
Experi~e	.0007585	.00066	1.15	0.251	-.000536	.002053	14.6818
Tenu_S~e*	.0207291	.03439	0.60	0.547	-.04667	.088128	.769697
Live_s~e	-.000077	.00057	-0.14	0.892	-.001185	.001031	12.3417
Lost_an*	-.0185959	.0138	-1.35	0.178	-.045638	.008447	.484848
Animal~d	-.0001219	.00045	-0.27	0.785	-.001	.000756	4.47252
PC1	-.0104248	.00746	-1.40	0.162	-.025047	.004198	-2.2e-09
PC2	.004641	.00493	0.94	0.347	-.005026	.014308	1.9e-10
PC3	-.0118768	.00827	-1.44	0.151	-.028092	.004338	1.8e-09
Live_d~e	.0736395	.04704	1.57	0.117	-.01856	.165839	.325
Crop_D~e	.0133052	.03661	0.36	0.716	-.058443	.085053	.075075
Wealth	-.0000162	.00003	-0.54	0.590	-.000075	.000043	121.401
Inc_Li~c*	-.3180065	.12628	-2.52	0.012	-.565517	-.070496	.169697
Inc_Sa~y*	-.2066712	.12008	-1.72	0.085	-.442023	.028681	.227273
Inc_Off*	-.3012635	.13787	-2.19	0.029	-.571489	-.031039	.136364
Inc_NonF*	-.1896931	.11393	-1.66	0.096	-.413001	.033615	.178788
Inc_NonL*	-.1146103	.08902	-1.29	0.198	-.289081	.059861	.230303

(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx compute, predict(outcome(2))

Marginal effects after ologit
y = Pr(IBI==2) (predict, outcome(2))
= .1104354

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Gender*	-.0552823	.02087	-2.65	0.008	-.096188	-.014377	.254545
Age_hhh	-.004015	.00102	-3.95	0.000	-.006006	-.002024	57.4545
Prop_N~l	-.0041576	.01293	-0.32	0.748	-.029498	.021183	.572727
Prop_P~y	.0001941	.011	0.02	0.986	-.021362	.021751	1.13636
Prop_S~n	-.0145287	.01379	-1.05	0.292	-.041559	.012502	1.09091
Prop_M~c	-.0259969	.01306	-1.99	0.047	-.051598	-.000396	1.11818
Depend~y	-.0001366	.00008	-1.76	0.078	-.000288	.000015	170.082
HHsize	.0410301	.01229	3.34	0.001	.016945	.065115	3.42636
Experi~e	-.0017139	.0014	-1.23	0.221	-.004456	.001028	14.6818
Tenu_S~e*	.0944212	.02666	3.54	0.000	.04217	.146672	.769697
Live_s~e	.0001741	.00127	0.14	0.891	-.002322	.00267	12.3417
Lost_an*	.0411827	.02271	1.81	0.070	-.003328	.085694	.484848
Animal~d	.0002755	.00101	0.27	0.785	-.001701	.002252	4.47252
PC1	.0235569	.00969	2.43	0.015	.004563	.042551	-2.2e-09
PC2	-.0104873	.00986	-1.06	0.287	-.029805	.00883	1.9e-10
PC3	.0268379	.0116	2.31	0.021	.004111	.049565	1.8e-09
Live_d~e	-.1664027	.07777	-2.14	0.032	-.318837	-.013968	.325
Crop_D~e	-.0300657	.08497	-0.35	0.723	-.196596	.136465	.075075
Wealth	.0000367	.00007	0.52	0.601	-.000101	.000174	121.401
Inc_Li~c*	.2547589	.06241	4.08	0.000	.132441	.377077	.169697
Inc_Sa~y*	.2054955	.08128	2.53	0.011	.046198	.364793	.227273
Inc_Off*	.2405973	.06858	3.51	0.000	.106191	.375003	.136364
Inc_NonF*	.1852242	.07737	2.39	0.017	.033577	.336871	.178788
Inc_NonL*	.135176	.07763	1.74	0.082	-.016968	.28732	.230303

(*) dy/dx is for discrete change of dummy variable from 0 to 1

. mfx compute, predict(outcome(3))

Marginal effects after ologit
y = Pr(IBI==3) (predict, outcome(3))
= .03690013

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Gender*	-.0210608	.00805	-2.62	0.009	-.036834	-.005287	.254545
Age_hhh	-.0015838	.0005	-3.16	0.002	-.002566	-.000602	57.4545
Prop_N~l	-.0016401	.0051	-0.32	0.748	-.011643	.008363	.572727
Prop_P~y	.0000766	.00434	0.02	0.986	-.008435	.008588	1.13636
Prop_S~n	-.0057313	.00542	-1.06	0.290	-.016346	.004884	1.09091
Prop_M~c	-.0102553	.00528	-1.94	0.052	-.020606	.000095	1.11818
Depend~y	-.0000539	.00003	-1.61	0.107	-.000119	.000012	170.082
HHsize	.0161856	.00541	2.99	0.003	.005573	.026798	3.42636
Experi~e	-.0006761	.00054	-1.26	0.209	-.00173	.000378	14.6818
Tenu_S~e*	.0353944	.0107	3.31	0.001	.014427	.056362	.769697
Live_s~e	.0000687	.0005	0.14	0.891	-.000911	.001048	12.3417
Lost_an*	.0163873	.00992	1.65	0.098	-.003048	.035822	.484848
Animal~d	.0001087	.0004	0.27	0.784	-.00067	.000887	4.47252
PC1	.0092927	.0047	1.98	0.048	.000085	.018501	-2.2e-09
PC2	-.004137	.00372	-1.11	0.266	-.011421	.003147	1.9e-10
PC3	.010587	.00461	2.29	0.022	.001543	.019631	1.8e-09
Live_d~e	-.0656427	.03491	-1.88	0.060	-.134062	.002777	.325
Crop_D~e	-.0118603	.03288	-0.36	0.718	-.076304	.052583	.075075
Wealth	.0000145	.00003	0.53	0.598	-.000039	.000068	121.401
Inc_Li~c*	.1823841	.09561	1.91	0.056	-.005003	.369771	.169697
Inc_Sa~y*	.1148399	.07056	1.63	0.104	-.023454	.253133	.227273
Inc_Off*	.1672167	.097	1.72	0.085	-.02289	.357324	.136364
Inc_NonF*	.101298	.06575	1.54	0.123	-.027576	.230172	.178788
Inc_NonL*	.064209	.04692	1.37	0.171	-.027751	.156169	.230303

(*) dy/dx is for discrete change of dummy variable from 0 to 1

.

APPENDIX D

```
. corr IBI Age_hhh Gender Dependency HHsize Prop_NoSchool Prop_Primary Prop_Secon Prop_Matric Prop_Tertiary Ex
> perience Tenu_Secure Crop_Diverse Live_diverse Live_size Lost_an Animal_sold PC1 PC2 PC3 Wealth Inc_Crop_01
> Inc_Livestoc Inc_Salary Inc_Off Inc_NonF Inc_NonL
(obs=330)
```

	IBI	Age_hhh	Gender	Depend~y	HHsize	Prop_N~l	Prop_P~y	Prop_S~n	Prop_M~c	Prop_T~y
IBI	1.0000									
Age_hhh	-0.2062	1.0000								
Gender	-0.1629	0.1432	1.0000							
Dependency	0.0294	-0.0399	-0.0075	1.0000						
HHsize	0.1076	0.2697	0.0269	0.4200	1.0000					
Prop_NoSch~l	-0.0363	0.1741	0.0484	0.1449	0.2151	1.0000				
Prop_Primary	0.0466	0.1075	0.0094	0.2492	0.2663	-0.0150	1.0000			
Prop_Secon	0.0894	-0.0009	0.0023	0.4539	0.5222	0.0710	0.0626	1.0000		
Prop_Matric	0.0137	0.1405	-0.0358	0.0932	0.6449	0.0283	-0.1112	0.0234	1.0000	
Prop_Terti~y	0.0646	0.0385	0.0159	-0.0206	0.1606	-0.1013	-0.2572	-0.1739	0.0535	1.0000
Experience	-0.1126	0.3531	0.0509	-0.2387	0.1086	0.1154	-0.2455	-0.0529	0.2485	-0.0516
Tenu_Secure	0.1591	0.1461	0.0222	0.1121	0.2488	0.1914	0.1159	0.0387	0.0961	0.0812
Crop_Diverse	0.0477	-0.0029	0.0541	-0.1440	0.0444	-0.0378	0.0819	0.0165	-0.0835	0.0255
Live_diverse	-0.0902	-0.0321	-0.0698	-0.1505	0.0251	0.0466	0.0106	-0.0385	0.0819	-0.0670
Live_size	-0.0504	-0.0191	-0.0726	-0.1513	0.0070	-0.0706	-0.1336	-0.1450	0.2178	0.0280
Lost_an	0.1014	-0.0132	0.0595	-0.0690	0.0390	-0.0189	-0.0682	-0.0416	0.0995	0.0300
Animal_sold	0.0223	-0.0428	-0.0421	0.0048	-0.0125	-0.0384	0.0176	0.0255	0.0325	-0.0611
PC1	0.0955	0.0178	-0.0530	-0.1011	-0.1420	-0.0830	-0.1885	0.0212	-0.1162	0.0905
PC2	-0.0387	0.0218	-0.0346	0.1177	0.1013	-0.1578	-0.0875	-0.0534	0.1412	0.2512
PC3	0.0642	0.1478	-0.0056	-0.0702	-0.1354	-0.1300	0.1699	-0.0566	-0.1031	-0.0968
Wealth	0.0433	-0.0291	-0.0393	-0.1482	0.0750	0.0317	-0.2054	-0.0098	0.1341	0.2147
Inc_Crop_01	-0.1997	-0.0136	-0.0027	-0.0491	-0.1078	-0.0368	0.0365	-0.0210	-0.1355	-0.0918
Inc_Livestoc	0.1048	0.0240	-0.0603	-0.0193	0.0166	0.0374	-0.1320	-0.0300	0.0922	0.0123
Inc_Salary	0.0814	-0.0020	-0.0347	0.0841	0.0669	0.0431	-0.0332	0.0867	-0.0261	0.0939
Inc_Off	0.0572	-0.0403	-0.0092	0.0206	-0.0103	-0.0185	-0.0011	-0.0569	0.0307	-0.0050
Inc_NonF	-0.0106	0.0845	-0.0366	-0.0827	0.0450	0.0206	0.0552	0.0190	0.0295	-0.0456
Inc_NonL	-0.0994	-0.0473	0.1265	0.0295	-0.0493	-0.0640	0.0798	-0.0190	-0.0320	0.0091

	Experi~e	Tenu_S~e	Crop_D~e	Live_d~e	Live_s~e	Lost_an	Animal~d	PC1	PC2	PC3
Experience	1.0000									
Tenu_Secure	0.1134	1.0000								
Crop_Diverse	-0.0793	-0.0756	1.0000							
Live_diverse	0.2633	0.0178	0.1376	1.0000						
Live_size	0.2860	0.0378	0.1318	0.4241	1.0000					
Lost_an	0.0403	-0.0166	0.0886	0.0390	0.0134	1.0000				
Animal_sold	-0.0871	-0.0673	-0.0237	0.0094	0.0029	0.0831	1.0000			
PC1	0.1980	-0.2841	0.0506	0.0181	0.1602	-0.0542	-0.0264	1.0000		
PC2	-0.0807	-0.0717	-0.1549	-0.0516	-0.0029	0.0147	0.0254	-0.0000	1.0000	
PC3	0.0880	0.0996	-0.0490	0.0480	-0.2258	0.0080	-0.0055	-0.0000	0.0000	1.0000
Wealth	0.2068	-0.0038	0.2297	0.0745	0.4017	0.0257	-0.0441	0.1835	0.1398	-0.1757
Inc_Crop_01	0.0288	-0.0119	-0.0917	0.0082	-0.0390	-0.0177	-0.0892	-0.1079	0.0262	-0.0126
Inc_Livestoc	0.0217	-0.0787	0.0294	0.0462	-0.0180	0.0299	-0.0083	0.1576	-0.0125	-0.0363
Inc_Salary	0.0435	0.0219	0.0578	-0.0758	-0.0798	0.1105	-0.1190	-0.0275	0.0061	0.0433
Inc_Off	-0.0612	0.0496	0.0036	0.0341	0.0813	-0.1028	-0.0199	0.0108	0.0173	-0.0249
Inc_NonF	0.0127	0.0110	-0.0177	-0.0329	0.0217	-0.0096	0.1896	-0.0833	-0.0108	0.0091
Inc_NonL	-0.0433	0.0086	-0.0211	0.0238	0.0298	-0.0410	0.0224	0.0321	-0.0225	0.0022

	Wealth	Inc_C~01	Inc_Li~c	Inc_Sa~y	Inc_Off	Inc_NonF	Inc_NonL
Wealth	1.0000						
Inc_Crop_01	-0.0825	1.0000					
Inc_Livestoc	-0.0863	-0.1148	1.0000				
Inc_Salary	0.0947	-0.1378	-0.2452	1.0000			
Inc_Off	0.0600	-0.1009	-0.1796	-0.2155	1.0000		
Inc_NonF	0.0726	-0.1185	-0.2109	-0.2530	-0.1854	1.0000	
Inc_NonL	-0.0893	-0.1389	-0.2473	-0.2795	-0.2174	-0.2552	1.0000

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