FACULTY OF AGRONOMY AND FORESTRY ENGINEERING

Willingness to Pay for Tomato Insurance:
The Case Study of Moamba District, Mozambique

By

Senait Metaferia Tafese

Supervised by

Prof. João Mutondo

A Thesis

Submitted to the Department of Economics and Agricultural Development for the Requirements of Masters of Science Degree in Agricultural Economics

Maputo, January, 2016

Declaretion

I, **Senait Metaferia Tafese** declare that this thesis is a result of my original research work. The contribution of others study is clearly acknowledged with due reference to the literature. To the best of my knowledge, the finding has never been presented by previously study to the Eduardo Mondlane University or elsewhere for the honor of any academic qualification. The work was done under the supervision of Professor Dr. João Mutondo, at the Eduardo Mondlane Universirty, Mozambique.

Senait Metaferia Tafese

Signature: ________________________________

Date: ____________________________________

Dedication

This thesis is warmly dedicated to my mother (Mulu Yimenu).

Abstract

Agriculture is a risk activity because it depends heavily on biophysical conditions. This calls for existence of agricultural insurance. However, in Mozambique agricultural insurance is not well disseminated and used as mechanism to reduce risk during agricultural production. The implementation of agricultural insurance calls for the application of appropriate premium rate. However, it is not yet been estimated in Mozambique. Additionally, the estimation of premium rate is not unique mechanism towards introduction of crop insurance as it is necessary to know if producers are willing to pay for agricultural insurance. Therefore, this study estimates premium rate and farmers willingness to pay for tomato insurance in Moamba. Additionally, the study explores factors affecting farmers' willingness to adopt tomato crop insurance. Probit and bivariate probit models were used to analyze the objectives of the study. The results show that the premium rates range between 1.25 ton/h and 2.25 ton/ha per year. The results also indicate that female farmers and producers who have off-farm income are more likely to purchase tomato insurance while an increase in age of farmer reduces the probability of purchasing tomato insurance. Finally, the results indicate that farmers are more willing to purchase flood insurance and the willingness to pay for crop insurance is 1.49/ha/years which is 10% of their average tomato yield.

Keywords: *crop insurance, premium rate, WTP*

Table of Contents

List of Tables

List of Figures

Acronyms

AgDevCo	Agricultural Development Corporation
AGRA	Alliance for a Green Revolution in Africa
AYII	Area Yield Index Insurance
BAGC	Beira Agricultural Growth Corridor
CDF	Cumulative Density Function
CVM	Contingent Valuation Method
DB-DC	Double Bounded-Dichotomous Choice
FAO	Food and Agriculture Organization
IFAD	International Fund for Agricultural Development
MPCI	Multiple Peril Crop Insurance
MSE	Mean Square Error
MWTP	Mean Willingness to Pay
MZN	Mozambican Metical
OECD	Organization for Economic Co-Operation and Development
RMA	Risk Management Agency
SB-DC	Single bounded Bounded-Dichotomous Choice
SUBVP	Seemingly Unrelated Bivariate Probit
WTP	Willingness to Pay

Acknowledgement

I would like to express my deepest gratitude for my academic advisor Prof. Dr. Joao Mutondo for continuous valuable comment, encouragement and patience. His guidance helped me from the beginning idea of the research topic up to final research result, without him this thesis would have not been accomplished.

I would like to thank Intra-ACP - Sharing Capacity to Build Capacity for Quality Graduate Training in Agriculture in African Universities (SHARE) scholarship awarded me with financial support throughout the academic year. Special thanks are given to Dorcas Loga Okello for great follow up and immediate response including solving different kind of my issues**.** Furthermore, I would like to thank RUFORUM and Eduardo Mondlane University which provided me financial support for this thesis.

My gratitude also goes to Haramaya University, particularly Dr. Lisanework Nigatu for facilitating the scholarship award. I would like to thank to one and all, who directly or indirectly supported me.

Lastly but not list I would like to express my deep gratitude to my family and in particular my mother; Mulu Yimenu and my brother Addisu Metaferia and also Dr. Admasu Abebe and Dr. Yonas Hailu for your great support and encouragement.

1. Introduction

1.1 Background

Agriculture is a cornerstone for the development of Mozambique as the sector employs nearly 70% of the active population and contributed with 31.9% to the country's GDP in 2012 (Hamela and Manhicane, 2013). Among the crops produced in Mozambique, horticulture is one of the important cash crop as it is mainly produced for comercialization. Mozambique's horticulture sector has been dominated by small-scale farmers who constitute around 99% of the sector and produce about 83% of the total production area (Schelling, 2014; Hamela and Manhicane, 2013).

Most agricultural production and business activities are exposed to risk and uncertainty due to climate, pests, diseases and market situations which are beyond the capacity of smallholder farmers. For example, Mozambique is ranked third among African countries most vulnerable to weather-related hazards. According to UNISDR (2009) about 48% of the population in Mozambique has been currently affected by either drought or flood. These factors have a great impact on crop yield and price variability which alters farmers' income adversely. Due to these factors food insecurity persists in Mozambique.

Food insecurity has the potential to contribute towards instability in on-farm income due to agricultural risks such as climatic factors. Agricultural risk is a situation related to negative outcomes through biological, climatic and price variability (World Bank, 2005). Agricultural risk not only affects farmers, but the whole agribusiness value chain. Different participants along the supply chain such as producers, processors and consumers are subject to these risks. Although the agricultural sector greatly influences the performance of agriculture business, most smallholder farmers in developing countries like Mozambique lack the resources to absorb shocks resulting from natural and manmade factors (Danso-Abbeam, 2014). In order to mitigate risk, poor farmers commonly adopt self-insurance and informal measures and avoid investing in potentially profitable activities (Kwadzo, Kuwornu and Amadu, 2013).

Although agricultural production risk cannot be avoided, it can be minimized through different production management methods. Agricultural risk management mostly relies on a combination of technical and financial tools which enable producers to deal with the multiple sources of agricultural risk. One way of minimizing risk in agriculture is transferring some or all of the risks to a third party through an insurance contract (Rahman, 2012). Crop insurance can serve as either a social or financial device in risk management (Akyoo, Temu, and Hella 2013). In addition, Hess (2003) mentioned that crop insurance can be an essential alternative management tool for agricultural producers to handle production risk.

According to Arias and Reis (2013), agricultural insurance is a tool to manage farming production risk and improve the allocation of production resources. The most well-known types of agricultural insurance are: single-risk insurance; combined insurance (MPCI); yield insurance; price insurance; revenue insurance; whole farm insurance; income insurance and index insurance (Rahman, 2012). Currently, researchers and practitioners have developed a demand for alternative agricultural insurance approaches based on indices (Makaudze and Miranda, 2009).
The area yield index insurance (AYII) is a sub branch of index insurance where the indemnity payout is based on the actual average yield of an insured unit at district level, not on actual yield of an individual farm.

Indemnity is paid for beneficiaries when the realized area average yield is less than the critical yield which is defined in the insurance contract (Carter, Galarza and Boucher, 2007). The main advantage of AYII over other types of insurance is that it promotes competition among producers; encourages beneficiaries to take measures for unsystematic risk; avoids the problems of moral hazard and adverse selection and no assessment losses are required at the individual level. Generally, the indemnity process is quick and inexpensive to administer. Moreover, the design of the product reduces the administration and operational expenses (Ali, 2013 and Deng et al., 2005). Therefore, the study explores farmers' WTP for AYII.

Currently, the contingent valuation method (CVM) is widely implemented by economists to analyze environmental goods as an alternative method through the hypothetical market. For instance, Sun and Zhong (2009) and Zeng at el. (2009) employed CVM to analyze farmers' willingness to pay (WTP) for agricultural insurance. This method has been used by many researchers to find out average WTP for some environmental policy initiatives. Since agricultural policy insurance has no market value, it shares key elements with environmental goods. This valuation method has a potential to generate precise values of nonmarket goods (Yadav et al, 2012). To remain in the spirit of previous studies, this study estimates willing to pay for tomato insurance using the contingent valuation method (CVM).

1.2 Problem Statement

Mozambique has the potential to develop globally competitive agricultural production for both smallholder and large-scale commercial farms (Hamela and Manhicane, 2013). It has around 36 million hectares of arable land, of which approximately 10% is under cultivation by smallholder farmers which accounts for 97% (FAO, 2007). However, agricultural productivity remains low in the country. For instance, crop productivity of Mozambique was between 50-80% smaller than the world average (Guanziroli, 2011).

The low productivity of the agricultural sector in Mozambique has been behind the high poverty rates faced by the country. It is necessary to note that more than 70% of the poor households live in rural areas and depend on this sector as source of food and income (IFAD, 2014). Low agricultural productivity has been attributed to a number of factors such as limited use of agricultural inputs like high yielding seed varieties, shortage of information which may be related to price and lack of agricultural insurance; low access to credit because of absence of sufficient collateral; animal disease, and natural calamities (mainly floods and drought), low on-farm income and others (Donovan and Tostão, 2010; OCED, 2012).

The low on-farm income of smallholder farmers is a crucial problem for agricultural productivity, as it influences the use of agricultural technology such as improved seeds, fertilizer and modern irrigation. According to IFAD (2014), the majority of the rural population in Mozambique is living under US$1.25 per day. In turn, Mozambique remains a food insecure country. In rural areas of Mozambique, mainly poorer smallholder farmers are facing unavailability of staple foods (Trefinal, 2010).

Access to credit for developing countries, particularly Mozambique, could speed up the adoption of new technology, which would motivate agricultural production through increased farm output and improved rural income distribution (Klein et al., 1999; Lapenu, 2000). However, in rural areas of Mozambique both savings and credit facilities are largely absent, especially for smallholder farmers. Only 2.9% of rural households have an access to credit (Coughlin, 2006). This indicates that the majority of farmers in this sector face limitations in terms of access to credit (Trefinal, 2010). For instance, among key constraints for access to credit, shortage of collateral assets and lack of informational in credit markets are the main ones (Baliamoune-Lutz, Brixiová and Ndikumana, 2011).

Beside on-farm income and credit, agricultural insurance can be an important technique to mitigate agricultural risk related to natural calamities by acting as collateral and facilitating technology transfer, which increases productivity of the agricultural sector. According to Poulton, Kydd, Wiggins and Dorward (2006), provision of insurance schemes to smallholder farmers helps to cover risk in case of drought or flood and other factors. Due to the importance of agricultural insurance in production risk mitigation, Beira Agricultural Growth Corridor (BAGC) launched in Mozambique the first index-based weather micro-insurance product for farmers to protect farmers against drought in 2012. However, weather index insurance has been criticized suggesting area yield index insurance as an alternative method. This is because the country only has 113 stations in 69 districts, while 73 districts are lacking weather stations (Mortgat, 2012; GFDRR, 2012).

Introducing AYII for tomato and other agricultural products helps to improve production and stabilize on-farm income of farmers which leads to improved food security. The sustainability of the launched index-based weather micro-insurance depends on the existence of agricultural insurance providers as well as farmers' willingness to pay for insurance. Moreover, insurance providers need to know what the amount of premium rate to be paid by the farmers would be sustainable for their business. This calls for the calculation of the premium rate to be applied to agricultural insurance. However, since agricultural insurance is new in Mozambique, there is no study that has calculated premium rates to be applied in agricultural insurance.

Additionally, as indicated above the existence of an appropriate premium rate does not guarantee the sustainability of the agricultural insurance since it is not known if the producers will be willing to pay for the proposed premium rate. This raises a need of estimating producer's WTP for agricultural insurance. The willingness to pay for agricultural insurance may vary among producers due to different household and individual characteristics such as age, educational level and gender of household head; access to extension service and on-farm income (Falola, Eyitayo and Olasunkanmi, 2013). However, this information is not readily available in Mozambique. Therefore, this study is motivated to analyze factors affecting farmers' decision to take agricultural insurance for the case of tomato using a double bounded dichotomies format.

In the double bounded dichotomies choice method, there are two bid responses to be answered by the respondents. In the first bid, the farmers are asked whether they are willing to pay for tomato insurance costing a certain amount (bid 1). Farmers whose response is yes for initial bid were asked their willingness to pay for follow up bid (bid2), which is higher than initial bid amount (bid1). While for those farmers who refuse to pay for initial bid also were asked the follow up bid (bid2) which is smaller than the initial bid amount (bid1). The probability of accepting the first bid amount is analyzed using probit model. However, the follow up bid which is dependent on the initial bid cannot be analyzed using probit model if there is correlation between the initial and follow up bid. Therefore, bivariate probit model is used to analyze the two probability of response since they have some relation. This approach has not yet been applied in Mozambique in tomato insurance context. If the farmer states yes, he/she will be asked if he/she is willing to pay for insurance costing a certain amount which is higher than the first bid (bid 2).

Similarly, farmers who are not willing to pay for tomato insurance costing the value of bid 1 will be asked their willingness to pay for insurance costing an amount which is less than bid 1 (bid 2). Modeling the first bid is straight forward as it is dichotomous choice, which can be modeled using probit model. However, dichotomous choice model cannot be used to model jointly the first and the second bid. Therefore, the study uses the bivariate probit model, which is an improvement of probit model, which has not yet been applied in Mozambican agricultural insurance context. In general the double bound dichotomies choice in CVM is asymptotically more efficient than the single bound model (Hanemann et al., 1991). Finally, using the two models the study attempts to answer the following four key questions

- Which types of agricultural insurance are most preferred by farmers?
- What type of risk behavior do tomato farmers have in the study area?
- How much are producers willing to pay for tomato insurance?
- What are the factors influencing tomato farmers' willingness to take insurance?

1.3 Objective of the Study

Taking into account the above key research questions the general objective of the study is to evaluate the willingness of tomato farmers to pay for tomato insurance. The specific objectives are:

- Assess farmers' preference to different types of crop insurance
- To estimate the premium rate for tomato insurance
- To examine factors influencing the tomato farmers' willingness to take insurance
- To estimate producers' willingness to pay for tomato insurance

1.4 Significance of the study

This study generates new empirical evidencesby estimatingthe appropriate premium rate and the willingness to pay for tomato insurance for tomato farmers in Moamba district, Mozambique. Therefore, it provides an input for insurance providers, policy makers, government and non-government organization and also researchers. Moreover, the study also helps to improve the farmers' understanding of the different types of agricultural insurance and reveal the factors affecting the decision of taking tomato insurance.

1.5 Scope and limitations of the study

The concept of horticultural insurance is a broad idea and should consider all types of crops, for instance potato, onion, green bean. However the study is focused on only on tomato production because there is potential production of tomatoes in the study area. In addition, the study is conducted only in Moamba. However, including other districts would provide wider data. Moreover, the premium rate estimated using tomato yield of Moamba district might not be representative as the yield of tomato may vary for different localities which are based on biophysical conditions such as types of soil; farming practice; climate; and socio-economic behavior and among others. Therefore, if premium rates are estimated for each localities rather than district level would more reflect the premium cost for farmers in the localities.

In this study, due to absence of data, premium rate is estimated using annual data on tomato yield. However, it would be better to use seasonal tomato yield since agricultural productions and costs and mainly for tomato vary drastically for different season.The sample size is also constrained by study location, time and financial concerns, which would state the true population if the sample size were increased.

1.6 Organization of the study

The study has been divided in five main chapters. Introduction is presented in chapter one that includes the background of the study, statements of the problem, objectives of the study, scope and limitations of the study. The next chapter presents the literature review section which includes theoretical and empirical studies and other important concepts and ideas. Following that, the methodology section discusses the area of study, type and sources of data collection and also data analysis. Then, the results and discussion are also presented in chapter 4. Lastly the conclusion and policy implications section are presented in chapter 5.

2. Literature review

2.1 General Background of Agricultural Insurance in Mozambique

Although the agricultural insurance market is at emerging stage of development, it is has been initiated in Mozambique. In 2011, only one domestic insurer was offered the service although other domestic insurers showed their interest in entering to this market (GFDRR, 2012). The depressing thing is that the agricultural insurance is designed for commercial-scale operations though majority of agricultural producers are smallholder farmers.

Beira Agricultural Growth Corridor (BAGC) launched on December 2012 the first index-based weather micro-insurance product for farmers in the Chimoio region of Manica Province, Mozambique from AgDevCo (Agricultural Development Corporation) fund. The weather index insurance connected to the farmer's input financing and intended to provide protection against "midseason" drought. Under the program, farmers have been received inputs and access to mechanization services and land among other resources. Moreover, the farmers obtained technical support from local commercial farmers and also guaranteed market for their production of maize, soya, beans and sesame. However, when the cost of weather index was challenged, the implementers minimized it as the farmers could afford the insurance premium because they are free from charge of interest on the finance, inputs and other services (Chris, 2012).

The Government of Mozambique has taken a few steps in assisting agricultural insurance to be provided by private organizations. For instance, both government and AGRA (Alliance for a Green Revolution in Africa) facilitated agricultural loans for small-scale farmers by facilitating credit from Standard Bank (AGRA, 2012). In conclusion, agricultural insurance in Mozambique is at initial stage covering few farmers though it has a promising market.

2.2 Concepts of Horticulture and Risk Mitigation

The term horticulture is derived from Latin word hortus mean "garden" and coletre meaning "to cultivate" that refers to the culture of a garden plant. It is an intensive practice of cultivating fruits, vegetables, ornamentals, herbs and other high value of perishable crops (Pittenger, 2002).

Horticulture is a branch of agriculture that involves only plant cultivation. Agriculture by nature is vulnerable for different type of risk. Many scholars identified different classifications of production risk management strategies to mitigate agricultural risk, for instance Eidman (1990); Miller (2004); Bielza (2009) and Crane (2013) are among well-known researchers.

Eidman (1990) identified four methods of risk management. These methods are production responses including diversification, using of low risk input, more information and regular management; marketing responses consisting in applying goods and services with low price risk; forward contracting, hedging and market information; financial response including holding assets, insurance and maintaining liquidity, investments and withdrawals; as well as public methods related to government program and services. Similarly, Miller (2004) classified agricultural risk management in four groups. These are financial strategies, marketing strategies, production strategies and insurance. The only difference from the above classification is that insurance is categorized independently while in Eidman classification public method is added as separately and insurance is merged with financial strategies.

Crane (2013) discussed three effective agricultural production risk management strategies. These are controlling risk; reduce production variability and transferring production risk. Controlling risk is implemented through applying preventive techniques such as irrigation and on time operations. Next, production variability is reduced through practicing crop diversification, integration and new technology. Lastly, transferring production risk to the third party is also a risk management strategy which is implemented through contracting and purchasing insurance. Bielza (2009) classified agricultural risk management tools in two categories as on-farm strategy and risk sharing strategy. On-farm strategies include diversification, vertical integration while risk sharing strategies include insurance and production and hedging contracts. As discussed above, almost all classifications witnessed that agricultural insurance is one of the most important production risk mitigation techniques.

2.3 Concepts of Agricultural Insurance

Insurance is an arrangement by which an institution undertakes to provide a guarantee for an unfavorable event in return for payment of specific premium. Agricultural insurance is a special property type of insurance applied in agricultural production as a financial tool to transfer production risk related to farming through third party (Rahman, 2012). It is an essential tool for agricultural risk management from antagonistic natural events. The most well- known types of agricultural insurance are identified by different scholars. For instance Iturrioz (2009) categorized agricultural insurance as being indemnity based, index-based and crop revenue insurance. Rahman, (2012) divided agricultural insurance in single-risk insurance, combined (Peril) insurance, yield insurance, price insurance, revenue insurance, whole farm insurance, income insurance and index insurance. Goo (2007) classified agricultural insurance in revenue insurance, price insurance, whole insurance and index based insurance. World Bank (2011) classified indemnity-based insurance and index insurance and Yusuf (2010) classified agricultural insurance into multiple peril crop insurance (MPCI), named peril, rainfall index, livestock and aquaculture insurance, index-based insurance products and input-based insurance products.

Indemnity based insurance evaluate claim payment based on the actual loss incurred by the insurance holder. This type of insurance has two sub classes which are named peril and multiple peril agricultural insurance. The single peril (damage based) provides indemnity against adverse events based on the crop damage explicitly listed in the insurance policy. The multiple peril crops insurance (MPCI) is applied against all perils that affect production. Similarly, Goo (2007) categorized single peril insurance and multi-peril insurance as traditional yield insurance products. The traditional yield insurance products have many problems such as correlation of crop insurance, asymmetric information, adverse selection and moral hazard. Reducing the chance of these problems through risk inspections, enforcing sales deadlines and overall monitoring of the insured producers makes it unattractive to the small producers (Carter, Galarzaand Boucher, 2007; Goo, 2007; Iturrioz, 2009).

Index-based insurance is a tool to manage agricultural risk related to adverse climatic events (Bryla and Syrok,   2007 and World Bank, 2009). The indemnity payment is calculated based on pre-specified patterns of the index using the district average yield, not on actual yields of the farmer (Bryla and Syrok, 2007). Among different sub branch of Index insurances, the area yield index insurance and weather index are the most recognized (Goo, 2007; Iturrioz, 2009). Area yield index insurance provides payout when average area yield in a pre-specified hectare falls below a certain level (Goo, 2007). The insurance contract defines an area "insured unit". The insurer makes an index using the guaranteed yield for the insured unit (Iturrioz, 2009).

Since the AYII contract is based on yield in a specified area, it fosters the competition among producers and encourages farmers to take actions. As the area becomes similar in terms of types of soil texture, altitudes, production practice and other socio-economic characteristics, the area yield index insurance is enable to mitigate individual' farming risks. One of the shortcomings of AYII is differences on biophysical conditions within the districts as it might affect differently crop yield. For example, farmers who farm in marginal land will tend to have lower yield compared to those farming in fertile land; however the low producing farmers do not receive compensation for their lose as the insurance is based on district level yield.

Weather index insurance is an agricultural insurance that is designed for climate variation experiences, such as rainfall or temperature (Iturrioz, 2009). The indemnity is based on the realizations of a specific weather parameter measured over a pre specified period of time at a particular weather station (World Bank, 2011). Similar to AYII, this type of insurance avoids the problems of moral hazard and adverse selection, it does not require an assessment of losses at the individual level and is also characterized by quick indemnity process and inexpensive to administer. However, due to some constrains both sides of insurers and insured parties, weather index insurance is not largely implemented and it can be expensive and onerous in terms of collecting data and construct the appropriate indexes.

In conclusion, many scholars classified different types of agricultural insurance but indemnity based and index insurance is the main umbrella for different sub division of insurance. Indemnity based insurance payment is based on the actual yield of policy holder while index insurance payment is on county / district yield. Indemnity based insurance has numerous weakness for both sides (insurance providers and policy holders) such as moral hazards, adverse selection, asymmetric information and high administration costs. Since index insurance payments is based on county yield, there is no need to verify and conduct the actual individual farmer's yield for the beneficiaries at the farm level and avoids moral hazard and adverse selection. However, failures in implementing correctly the index insurance mostly comes from basis risk. To minimize these problems the index insurance should be applied for situations which have homogeneous agricultural production level and soil type. Table 1 below summarizes the main features of the indemnity based and index based insurance.

Table 1: Comparison of indemnity and index based insurance

Indemnity based insurance	Index based insurance
Losses assessment calculated based on individual farmer	Losses assessment calculated using measure of an index
Crop Insurance Product examples: Damage-based products includes named-peril insurance and hail insurance Yield-based products – includes MCPI yield and crop revenue insurance	Crop Insurance Product examples: Area yield-based index insurance Weather index-based insurance Rainfall index insurance Vegetation indices

2.3.1 Advantages of the index based insurance

Implementing index insurance as an alternative loss determination is not a new idea. Indian scholars were writing about the advantages of the index insurance in the early 1900s (Chakravarti, 1920). The theory of area yield insurance was first proposed by Harold Halcrow in 1948 (Miranda, 1991). Following this, Barnaby and Skees (1990) described how an area yield contract might exercise and the potential advantages over the existing crop insurance contracts

(Miranda, 1991; Skees, Black and Barnett, 1997). After forty years, the feasibility of an area yield insurance contract was tested in the United States as a pilot crop insurance program which referred as Group Risk Plan (GRP) based on the county level yield data rather than individual yield data (Skees, Black and Barnett, 1997).

In recent years, discussions about index-based insurance products have been increasing (Deng *et al*., 2006). It also allows very timely automatic settlements, which is crucial for effective improvements of farmer's welfare beside encouraging adaptation to climate (Antón, 2012). The effectiveness of index based insurance depends on the homogeneity in farm production, cropping practice and technology and husbandry (Bielza, 2009; World Bank, 2009; Antón, 2012). For instance, South Georgia studies evaluated risk reduction performance of cotton products using index insurance, however the result showed that none of the index insurance products provided risk protection comparable to the MPCI policy (Deng *et al*., 2006), as the regions were characterized by heterogeneity in production factors such as soil quality and drainage.

Area yield index insurance (AYII) is an example of an index-based insurance product which is less susceptible to various problems than traditional MPCI (Deng *et al*., 2006; World Bank, 2009). Area yield index insurance pays indemnities using the area yield of county. For instance, it minimizes moral hazard, anti-selection and asymmetric information problem which is common for other types of crop insurance (Deng *et al*., 2006; Bryla and Syrok, 2007; World Bank, 2009). Furthermore, it eliminates the need to visit farmers and reduce the costs of administration and transactions that enables the market to provide it at lower premium cost to the small farmers (Bryla and Syrok, 2007 ; World Bank, 2009). In general, the cost of AYII is much smaller than individual yield insurance and speed up the claim settlement.

Index insurance is more attractive in developing countries because it reduces the cost of supervision (World Bank, 2005). The pilot programs conducted in several developing countries have proven the feasibility and affordability of index insurance (Bryla and Syrok, 2007). For instance, index crop insurance in Senegal is promoting access to agricultural inputs for smallholder farmers (World Bank, 2009). Area-based yield insurance has the potential to crowd-in both demand for and supply of credit.

The World Bank, developing countries and donor communities fail to provide an effective safety net for the poor smallholder farmers either due to unbalanced and untimed or created dependency (World Bank, 2005). Similarly, in Mozambique the current system of funding for ex-ante disaster has been improved, however, there is a problem related to delays in mobilization of donor funds and redistribution of budget (GFDRR, 2012). Index insurance products effectively address the challenges of ex-ante financing of highly correlated loss and high transaction costs (World Bank, 2005).

Weather index-based insurance needs densely spaced weather stations for implementation. However, Mozambique has only 113 stations in 69 districts, while 73 districts are lacking weather stations (Mortgat, 2012). In the case of many developing countries, particularly Mozambique faces similar challenges on weather time serious data for each district. Due to this challenge, it is difficult to implement weather index based insurance. On the other hand, data for agricultural yields are available through four main sources: TIA (Trabalho do Inquérito Agricola); the CAP (Agricultural and Livestock Census); AP (Aviso Prévio, early warning system); and data produced by commodity institutes (GFDRR, 2012). However, currently AYII is not under consideration by Mozambique government.

In contrast, a few scholars have made the argument that area yield index insurance is not effective in managing agricultural risk compared to weather index based insurance though their suggestions are mostly based on the failed pilot area-yield crop insurance scheme in India. On reflection, the area-yield crop insurance scheme in India had many weaknesses such as; the product attempted to cover the whole range of risks related to crops, the product was tied to the crop loan given by the rural public sector banking system; the extent of sum insured was linked to the loan size; claims assessment for loss adjustment was required which costs a huge expenditure; costly administration; claim settlement process took a long time up to two years;

the financial performance was unrealistic, and the program's benefit was not distributed equitably (Pomme, 2007).

Moreover,the failure of area yield index insurance markets may be costs related to the novelty of the product; shortage of reliable, long-term data on area yields for insurance provider and costs of marketing the product, especially to the smallholder sector (Carter, Galarza and Boucher, 2007). The failures of index based insurance might result from heterogeneity between county yield and individual farm yield farm production (Bielza, 2009; World Bank, 2009; Antón, 2012).

In conclusion, area yield index insurance is a very new product which was known as group risk plan in the United State insurance pilot program previously. AYII is an example of index insurance. Currently, AYII is practiced by many developing countries due to many advantages such as low administration costs, avoidance of moral hazards and adverse selection. Moreover, it supports government and smallholders effectively in addressing disaster response. However the success of this type of insurance is based on the homogeneity nature in production, soil, technology and farming practice. AYII is relatively less vulnerable for different kind of problem than other types of insurance like the traditional insurance.

2.4 Empirical Studies

Danso-Abbeam, Nyarko and Ehiakpor (2014) used independent double-hurdle model to determine willingness to pay for farm insurance to smallholder cocoa farmers in Ghana. The study found that marital status, educational attainment, farm land ownership, farmer's awareness of insurance scheme and income of cocoa farm were factors significantly influencing farmers willing to pay for premium insurance. Olila (2014) employed a binomial logit model to assess factors affecting awareness about crop insurance product in Kenya. The study found that gender, education and income of the farmer were significantly factors affecting farmer's awareness. Likewise, Myyrä (2014) used a choice experiment to evaluate the willingness of farmers to buy crop insurance in Finland. The result revealed that the median WTP for crop insurance was €3.8 per hectare per year.

Ali (2013) used propensity score matching to examine farmers' willingness to pay for Index Based Crop Insurance in the rain-fed areas of Pakistan. The empirical result indicated that farmers' economic status, household assets and membership of community organizations are the important determinants for willingness to pay for higher insurance premium. Santeramo (2013) used the probit model to investigate the Italian crop insurance market. The study showed that irrigation and crop diversification are substitutes for crop insurance. High premium and loss ratios tend to inhibit entry and exit from the insurance market.

Moreover, Falola, Eyitayo and Olasunkanmi (2013) used probit regression model to examine willingness to take agricultural insurance for cocoa farmers in Nigeria. The study revealed that age of household head, educational level, access to extension service and farm income were significant variable in influencing willingness to take agricultural insurance by the farmers. Regarding insurance awareness, Kumar *et al.* (2011) used Probit and Tobit models to analyze farmers' willingness to adopt crop insurance. The result revealed that cropped area, off farm-income, occurrence of agriculture risk, number of family members working in the farm, premium rate and affordability of the insurance premium amount influenced farmers' willingness to adopt crop insurance as well as the premium rate paid by farmers.

Velandia (2009) used multivariate and multinomial probit approaches to analyze factors affecting the adoption of crop insurance. The study found that farm size, off-farm income, education, age, and level of business risk are significant factors affecting the adoption of the risk management tools. Furthermore, Vandeveer (2000) showed that litchi producers in northern Vietnam preferred coverage which has higher yield guarantee levels and lower indemnity prices. Farmers who perceived greater yield risk were more likely to insure their crops. However, farmers who perceived relatively higher expected yields or prices were less likely to insure (Goodwin and Kastens, 1993; Fraser, 1992).

3. Methodology

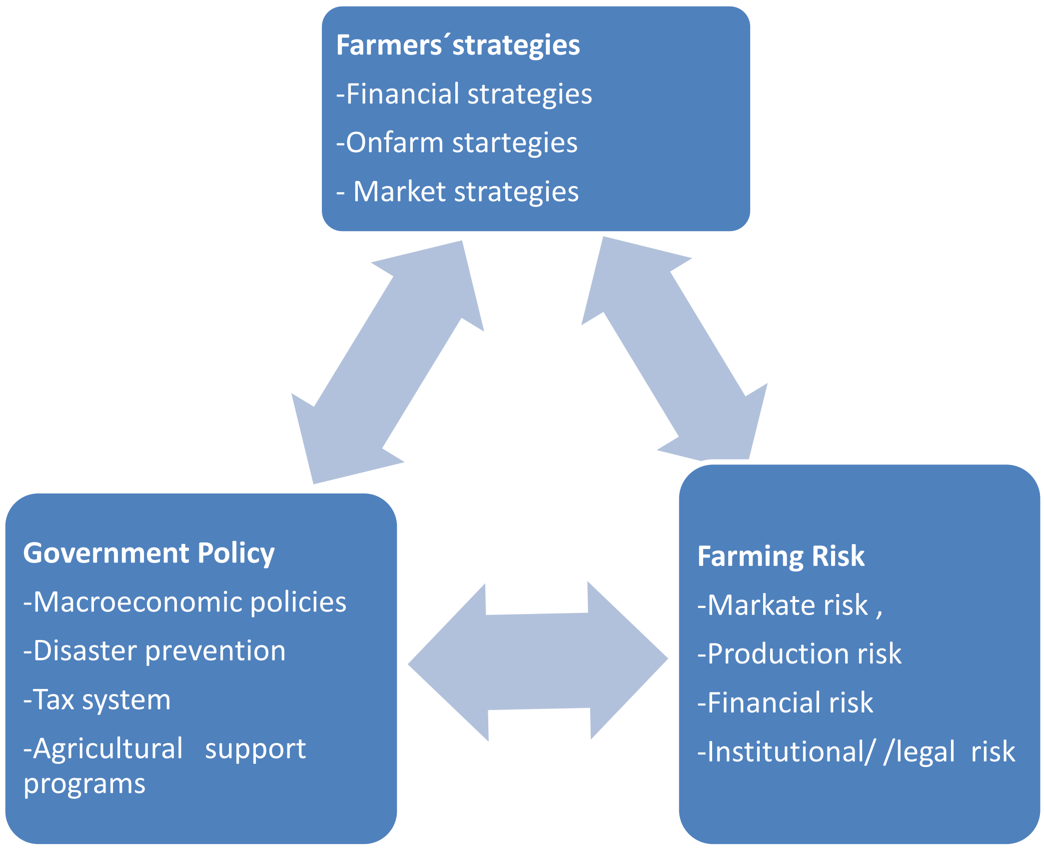
3.1 Conceptual framework

Agricultural production is subjected to risk and uncertainty. Almost all farm production decision is usually associated with multiple outcomes with different known and unknown probabilities. Many events in agricultural production have been taking place either under systematic or unsystematic risk. The unsystematic risk is a negative event, which occurs on only an individual farm and it can be controlled by the producer if the farmer practices technical farm management for instance controlling pest and disease. Systematic risk is an event which is unknown and affects the whole agricultural production. It is beyond the control of the agricultural producer for instance weather and market condition. In this circumstance, the agricultural producer has to manage the agricultural risk as part of whole management of the agricultural production and business.

Agricultural risk does not only affect the farmers but also the whole agribusiness activities. It is an interrelated "system" among markets, government and farmers actions in their risk mitigation strategies. Therefore, agricultural risk management strategies are all interdependent rather than implementing strategies by individual actors like government, market and farmers decision.

Agricultural risk management can be analyzed using two approaches: (i) linear approach and (ii) holistic approach. The linear approach assumes that there is a linear relationship between the elements such that farming risk has direct relationship with farmers' strategies and farmers' strategies have direct relationship with government policies. However, in reality, these three linkages do not have always uniform direction since agriculture depends on nature.

In the holistic approach, it accounts the whole set of the elements in risk management of agriculture rather than single direction. This study applied the conceptual framework of agricultural risk management system from (OECD, 2001; Antón, 2008) which is the holistic approach. A risk management system encompasses different sources of risk, management strategies and tools that are accessible by the farmers and government actions. Figure 2 presents the summary of holistic approach for studying risk



Source: Adapted from (OECD, 2001 and Antón, 2008)

Figure 1: The holistic approach

Farmers' strategies

Agricultural producers take actions to manage farm risk in order to improve their production and welfare. Farmers apply financial strategies to ensure appropriate liquidity in case of a hazardous event that may negatively affect their farming production and welfare. Farmers also implement on-farm strategies that include crop diversification, off-farm income vertical integration and others. Different types of risk may generate different types of market and production solutions. For instance, production risk mainly resulted from adverse weather such as flood, drought tends to be managed through crop insurance, while price risk resulted from market can be managed through price insurance and future contract.

Source of risk

Agriculture activities are vulnerable to different source of risk. According to Harwood et al. (1999) there are five main sources of agricultural risk. (1) Production risks are related with all undesirable events during production such as floods, droughts, pests and diseases, and any other hazardous events which affect crop yields. (2) Market risk, which refers to uncertainties linked with prices of inputs and outputs. (3) Financial risk, which is related to variability of interest rates or of the value of financial assets, and presence of credit. (4) Institutional risk, which is related to government action for instance change in policy and regulations that tend to affect farming production. Finally, environmental risks linked to legal responsibility of agricultural producers.

Government Policy

Government action is important to facilitate agricultural risk management through economic policy. A good government policy in business and economic environment plays a great role for the agricultural development through market such as risk pooling and risk sharing and financial management. Some agricultural support instruments are directly intended to affect the availability of risk management tools for instance insurance subsidies and safety net programs. Farmers can be benefited from insurance subsidy which increases farmers' participation in insurance programs by reducing the premium cost. Many of these measures interact with other measures, particularly on-farm strategies and market tools. For instance farmers may substitute crop diversification with agricultural insurance. Finally, government is responsible for making laws and regulations which directly affect farming activities such as food-safety, land and others.

In conclusion, under the holistic approach agricultural risk management considers different source of risk and strategies in the system taken by farmers and government for systematic risk since it's beyond the control of the producers. Systematic risk mainly managed by sharing and pooling the risk to the third party through crop insurance. Therefore, this study also tries to use agricultural insurance using area yield index insurance for Moamba District since the area is one of the vulnerable to natural disasters for instance flood.

3.2 Theoretical Framework

The theoretical framework of this study is based on utility maximization theory. The decision on whether or not to pay for agricultural insurance depends on the utility that a farmer is expecting to gain (Norris and Batie, 1987; Pryanishnikov and Katarina, 2003). Therefore, farmers' decision whether or not to obtain insurance can be considered as a binary choice. For this case, farmers as economic agents will make decision regarding the expected utility obtained from having agricultural insurance. It is important to note that farmers' utility cannot be directly observed, but the actions of economic agents (farmers) will be observed through their decision made towards obtaining tomato insurance which depends on other factors such as income, age, gender, education level and other factors.

Let us consider an individual who will have an income W under risk free circumstances. If we consider r as the level of risk, the individual's income in time of risk will be W – r. An individual can insure himself/ herself against this risk by paying to an insurance provider a premium α_1. If a loss occurs he/she will be paid $\widehat{\alpha}_2$. Without insurance contract an individual income has two states, ''risk free and risk'' i.e (W, W-r) and by having insurance the income is expressed as W-α_1 in case of not having losses and W- r+ α_2 in case of having losses, where α_2= $\widehat{\alpha}_2$– α_1. The vector $\alpha = (\alpha_1, \alpha_2)$ describes the insurance contract.

Based on expected utility theorem and an approach proposed by Rothschildand and Stiglitz (1976) in analyzing demand for insurance contracts, farmer's preferences for insurance in two states of nature are possible to be described. An individual demand for insurance is expressed by purchasing a contract during a change of pattern of income across states of nature. Let W_1 denote individual income in absence of risk, and W_2 an individual income in occurrence of risk. The utility of individuals under the two states of nature can be described as

$$V(p, W_1, W_2) = (1 - p)\, U(W_1) + pU(W_2) \quad (1)$$

where U( ) represents the utility of income and p the probability of occurrence of loss due to risk. The individual will choose the contracts that maximizes utilities V (p, α). Since he always has an option of buying or not buying insurance, an individual will purchase a contract, α only if V(p, α) ≥ V(p, 0) = V(p, W, W - r). The study assumes that individuals have the same probability of experiencing loss due to risk events.

Considering a random utility theory, the farmers' characteristics ($\boldsymbol{X_i}$) and farmers' income (Y_i,), the utility of a farmer i not willing to pay for agricultural insurance as represented by V_{i0}, can be written as

$$\boldsymbol{V_i}0 = a_{i0} + b\boldsymbol{X_i} + c\boldsymbol{Y_i} + e_i \quad (2)$$

Where a_{i0} is a constant; b and c are unknown coefficients; and e_i is the stochastic portion of the utility. On the other hand, the utility of farmer i willing to pay for agricultural insurance can be given as

$$\boldsymbol{V_{i1}} = a_{i1} + b\boldsymbol{X_i} + c\ (\boldsymbol{Y_i} - WTP_i) + e_i \quad (3)$$

where WTP_i is the amount that farmer i is willing to pay for having insurance.

Following Haab and McConnell (1997), the coefficient c is maintained the same in these two states to ensure no "money illusion". An individual farmer i would be willing to pay for agricultural insurance if the satisfaction that he /she drives from paying agricultural insurance or not paying is equal, $V_{i0} = V_{i1}$. Therefore, the expression for $WTPi$ is given as:

$$WTPi = \beta Z_i + ei \quad (4)$$

where βZ is the difference between equation (2) and (3). Assume that a latent variable $WTP*$ indicates the actual WTP by individual farmer I, equation 4 can be written as.

$$WTPi* = \beta Zi' + \varepsilon_i\ and\ WTP*|Z \sim Normal\ (\beta Z', \sigma^2) \quad (5)$$

where$\sigma^2 = Var(WTP*|Z)$ is assumed independent on Z, and ε_i is a mean zero constant variance error term.

Equation (5) can be estimated using different statistical model such as probit, tobit, bivariate probit and others limited dependent models.

This study used probit and bivariate probit model because probit model can estimate the probability of dependent variable while the bivariate probit is an extension of probit model allowing the estimation of two equation. Moreover, the bivariate probit model assumes correlation between the probabilities of two dependent variables. Further, the results from bivariate model can be compared with the results of the probit model to check the efficiency of the models, since the bivariate probit model is an extension of probit. It is important to note that other probability models such as Heckman selection and double hurdle model can allow the estimation of two equations by relaxing correlation between the probabilities of the two dependent variables at the same time. Due to this limitation as well as by requiring that the dependent variable of one of the two equations should be continuous variable, the two models were not used in this study.

The probit model is a statistical probability model having a binary dependent variable in categorical forms (Liao, 1994). The binary dependent variable *Y* takes the values of zero and one representing success (1) or failure (0). The analysis of probit model is based on the cumulative normal probability distribution. The observations *Y* must be statistically independent in order to rule out the serial correlation (Morgan, 2004). The probit model assumes y_i variable as an observable value for 0 and 1 that is determined from the latent variable y_i* which is unobseravabe variable. According to Nagler (1994) the latent variable from equation (5) y_i* is expressed as:

$$y_i *= \beta_i \grave{X}_\iota + \varepsilon_i$$

$$y_i = \begin{cases} 1\ if\ y_i *> 0 \\ 0\ \ if\ \ *< 0 \end{cases} , \qquad (6)$$

where $y_i *$ is unobservable latent variable, $\beta_i$is a vector of the estimated parameters, $\grave{X}_\iota$is the vector of explanatory variables and ε_i is the random distribution of error term and y_i is the observed dependent variable that takes value 1 if the respondent answers yes and 0 otherwise. The latent variable is unobservable by the researcher and linearly depends on explanatory variable $\grave{X}_\iota$. The outcomes of y_i is mutually exclusive and collectively exhaustive variable. The probability for accepting the binary choice using equation (5) and (6) can be written as follow:

$$Pr(y_i = 1|\mathrm{X}_i) = \Pr\left(\beta_i \grave{X}_\iota + \varepsilon_i > 0\right) \qquad (7)$$

$$= 1 - \Pr(\varepsilon_i < -\beta_i \grave{X}_\iota)$$
$$= 1 - F(-\beta_i \grave{X}_\iota)$$

where F represents the cumulative density function of the error term and Pr represents probabilities. The probit model assumes the error tem is normally distributed within mean zero and variance. Following the assumption, the probit model is defined as follow:

$$P(y_i = 1|X_I) = 1 - \Phi\left(\frac{\beta_i \grave{X}_\iota}{\sigma}\right) \quad (8)$$

where Φ represents the standard cumulative density function of normal distribution function.

Also the bivariate probit model can be used to estimate the equation (5). The bivariate probit model is a statistical model that can be used to analyze categorical binary data (Ratnasari, 2010). Now a days, this model has been implemented by many statisticians such as Rahman (2014) and Jiang (2013) due to the flexibility in statistical correlation between the error terms. The bivariate model estimation has two equations for the two binary dependent variables (Greene, 2003). From the extension of probit model in equation (5) and (6) bivariate probit model defined as follow:

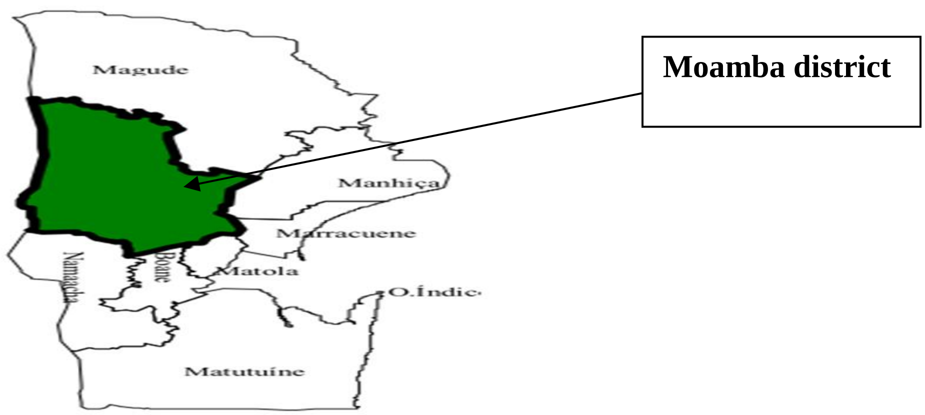
$$y_{1i}^* = \beta_1 x_{1i} + \varepsilon_{1i}$$
$$y_{1i} = \begin{cases} 1\ y_{1i} * > 0 \\ 0, y_{1i} * < 0 \end{cases}$$
$$y_{2i}^* = \beta_2 x_{2i} + \varepsilon_{2i} \quad (9)$$
$$y_{2i} = \begin{cases} 1\ y_{2i} * > 0 \\ 0, y_{2i} * < 0 \end{cases}$$

where x_{1i} and x_{2i} are a vector explanatory variables; β_1 and β_2 are a vector parameters to be estimated and ε_{1i} and ε_{2i} are the error terms that assume normal distribution with mean and non-zero variance and covariance matrix.

3.3 Analytical framework

3.3.1 Descriptions of the Study area

The study was conducted in Moamba district in Maputo province. Moamba district is located in the Northern part of Maputo Province and southern region of Mozambique, 75 km from the capital city of Maputo and it is positioned between parallels 24° 27' and 25°50' South and meridians 31°59' and 32°37' East. In the North, Moamba district is separated by the Incomati River, in the South by Boane, Namaacha, Manhica and Marracuene districts and the Western part by South Africa. The district has a triangle configuration with the North-South direction, a stretch of 150 km between Panjane next to the Creek and Massintonto Movene, and East-West direction, a length of 61 km^2 from Sabie. The surface of the district is 4,628 km^2 and the estimated population is 62,392 inhabitants at the date of 1/1/2005. Figure 1 below show the geographical localization of Moamba district in Maputo province.



Source: República de Moçambique Ministério da Administração Estatal (2005)

Figure 2: Location of the study area

3.3.2 Sampling Method

The target population of this study are horticultural farmers particularly those producing tomatoes in Moamba District. There are seventy five (75) tomato farmers producing tomatoes which are registered by the Moamba District Economic Activities Services. This study interviewed all farmers registered at Moamba District Economic Activities Services.

3.3.3 Data collection

The study collected primary and secondary sources of data. The primary data was collected from tomato farmers. Secondary data were collected from the Ministry of Agriculture, the Moamba District Economic Activities Services along with other relevant published and unpublished documents. The survey was carried out from July 15 up to August 10 2015. A pre-tested questionnaire was administered through face-to-face interviews. The face to face interview was given priority over other survey methods such as mail and telephone interviews among others because of inconsistent use of mobile phones and internet among farmers in the region.

Moreover, a face-to face interview has the merit of enabling further clarification of the questions by the interviewers (Bateman et al., 2002). The data collection concerned only tomato farmers. The study used three main parts of the survey questionnaire (Appendix 1) to collect primary data. The first part of the questionnaire includes socio-economic characteristics of tomato farmers, for example, gender, age and income. The second part of the questionnaire captured information on risk management strategies used by tomato farmers, willingness to pay (WTP) for tomato insurance, preference for different type of agricultural insurance and farmer's risk behavior. This information was used to estimate willingness to pay for tomato insurance. The last part of the questionnaire gathered information on factors affecting tomato farmers to take tomato insurance.

3.3.4 Empirical models

3.3.4.1Premium rate estimation

Currently, index insurance has been widely proposed and implemented by many developing countries for several reasons such as it overcome moral hazards and adverse selection, low administration and transaction costs; low assessment cost and easy administration (Smith, 2009). Therefore, this study implements area yield index insurance method to estimate premium rate.

Various authors have been using different methodologies to estimate agricultural insurance premium rate. For example, Miranda (1991) and Smith, Chouinard, and Baquet (1994) calculated indemnity payments to obtain premium rate by calculating the difference between critical yield and actual county yield and multiply with different percentage level of scale. Scale is a variable that allows the beneficiary to increase or decrease the amount of yield protection per hectare (Barrent, 2005).This procedure implies that all insurance holders have the same level of choice with regard to the amount of yield protection per hectare. On the other hand, Skees et al. (1997) takes into account that different beneficiaries have different choices about the amount of protection of yield coverage during the calculation of premium rates. Therefore, this study follows the methodology proposed by Skees *et al.* (1997) to calculate the tomato insurance premium rate. It starts by calculating the critical yield as shown in equation (10) below:

$$Y_c = F_{t+1} * \text{ Cov} \quad (10)$$

where Y_c is the critical yield which is a product of county yield by percentage of coverage, F_{t+1} isthe forecasted yield per hectare determined by insurance provider and Cov is a percentage of yield protection covered by the insurance provider. According to Greene (2000), Deng (2006) and Miranda and Fackler (2002) the optimal percentage scale and coverage were determined using Broyden-Fletcher- Goldfarb-Shanno algorithm for the index insurance products within the following intervals: (i) 70% ≤ *coverage* ≤ 90% and (ii) 90% ≤ *scale* ≤ 150%. Following past studies, this study established five different coverage rates: 70%, 75%, 80%, 85% and 90% with scales 90% and 100%. Forecasted yield was calculated using 7 years' time series tomato production which was collected at Moamba District Economic Activities Service. It is important to note that yield may increase or decrease over time for different reasons such as natural and human factors. Therefore, exponential smoothing is used to address the yield variation for the data. The forecasted tomato yield is calculated as follows:

$$F_{t+1} = \alpha Y_t + (1 - \alpha) F_t \quad (11)$$

where, F_{t+1} and F_t are forecasted yields per hectare for years t+1 and t, respectively, Y_t is actual yield for year t and **α** is the smoothing constant, which lies between 0 and 1.

The smoothing constant is calculated using Excel Solver by minimizing mean square error (MSE) through changing α until it acquires a minimum squire error. After the determination of critical yield, the insured will receives an indemnity payment (*indem*) whenever the actual county yield is below the critical yield. The indemnity is calculated as the percentage of shortfall yield per hectare as follows:

$$indem = max\left[\left(\frac{Y_c - Y_t}{Y_c}\right)(F_{t+1})(\text{scale}), 0\right] \quad (12)$$

All variables are defined and calculated as described above. Finally, the expected premium rate (EPR) is calculated by dividing total indemnity payments (*Indem)* by the total numbers of examined years as given below:

$$\text{EPR} = indem/n \quad (13)$$

3.3.4.2 Probit model

The binary dependent variable WTP_i takes the values zero and one for no and yes, respectively for single bounded dichotomies choice (SBDC). In other word the $WTP$for tomato insurance using SBDC is intended to an individual to answers yes if the WTP is greater than the initial Bid_1 and no if the WTP is less than the initial Bid_1 . By plugging WTP_i to the dependent variable of y_i, from equation (5) and (6) is expressed as follows :

$$WTP_i = \begin{cases} 1\ WTP *> Bid_1 \\ 0, WTP *< Bid_1 \end{cases} \tag{14}$$

where $WTP *$ is a latent variable which is unobservable willingness to pay for tomato insurance by the researcher and linearly depends on explanatory variable $\acute{X_\iota}$. The amount of tomato insurance would be willing to pay by the farmers is unknown in the side of the researcher which may depend on off-farm income, access to extension and others variables. The probability for accepting the premium bid amount using equation (7) written as follow:

$$P(WTP_i = 1|\mathrm{X}_I) = \Pr\left(\beta_i \acute{X_\iota} + \varepsilon_i > Bid_1\ \right) \tag{15}$$

By rearranging equation (12)

$$P(WTP_i = 1|\mathrm{X}_I) = \Pr\left(\varepsilon_i > -\beta_i \acute{X_\iota} + Bid_1\ \right)$$

$$1 - \Pr\left(\varepsilon_i < -\beta_i \acute{X_\iota} + Bid_i\right) = 1 - \Phi\left(-\frac{\beta_i \grave{X_\iota}}{\sigma} + \frac{Bid_1}{\sigma}\right) \tag{16}$$

Due to the reason of symmetry in the normal probability distribution, the equation defined as:

$$P(y_i = 1|\mathrm{X}_I) = \Phi\left(\frac{\beta_i \grave{X_\iota}}{\sigma} - \frac{Bid_1}{\sigma}\right) \tag{17}$$

$\boldsymbol{\beta_i X_i}$

The β is the vector of the estimated parameter and X is the vector of explanatory variables which are discussed in the section 4.3 (Variable Definition and Working Hypothesis)

3.3.4.3 Bivariate probit model

In bivariate probit model, an individual is asked a follow up bid question after the first bid response that s/he might respond different answer from the initial bid using DBDC. The bivariate model allows capturing the initial and following up bid response which may have some relation between these two responses. Therefore, bivariate probit model simultaneously models two WTP equations by considering that they have correlation with jointly distributed normal error terms (Asim and Lohano, 2014). The bivariate probit equation is defined using equation (9)

$$wtp_{1i} = \beta_i x_i + \varepsilon_{1i}, y_{1i} = \begin{cases} 1 \text{ if } wtp *> Bid_1 \\ 0 \text{ if } wtp *< Bid_1 \end{cases}$$

$$wtp_{2i} = \beta_j x_j + \varepsilon_{2i}, y_{2j} = \begin{cases} 1 \text{ if } wtp *> Bid_2 \\ 0 \text{ if } wtp_{2j} *< Bid_2 \end{cases} \quad (18)$$

Wherewtp_{1i} and $wtp_{2i}$are the observed dependent variable for obtaining initial bid and follow up bid respectively;x_i and x_j are vectors of explanatory variables;β_i and β_j are the vectors of parameters tobe estimated, *i=1, 2…n* and *j=1, 2 …n* and ε_i and ε_j are the error terms that assume normal distribution.Following the above assumption, the general bivariate probit model is presented as;

$$pr(y_{1i} = 1, y_{2i} = 1) = \int_{-\infty}^{\varepsilon_{1i}} \int_{-\infty}^{\varepsilon_{2i}} (\beta_1 x_{1i}, \beta_2 x_{2i}, \rho)\, d\varepsilon_{1i}\varepsilon_{2i} \quad (19)$$

$$= \Phi_2(\beta_1 x_{1i}, \beta_2 x_{2i}, \rho) d\varepsilon_{1i}\varepsilon_{2i}$$

where $\Phi_2$represents a bivariate normal distribution.

The estimation of the coefficient for the above equation can be done using maximum likelihood estimation method.

The study denotes the initial bid amount ($Bid_{1)}$ and the follow up bid amount ($Bid_{2)}$. For instance, if the respondent answers ‘’yes’’ for Bid_1, and s/he answers “yes” for the follow up bid then s/he will receives an upper follow-up bid (bid_2). If s/he answers ‘’no’’ for the initial bid, and answer “yes” for the follow up bid then s/he will receives a lower bid and vice versa. In general, for the initial and follow up bid, the respondent have four possible outcomes; yes-yes, no-no, yes-no and no-yes. The probability of individual response is expressed as;

$$pr(no, no) = P_{nn} = (wtp_{1i} < bid1, wtp_{2i} < bid2) \quad (20)$$

$$pr(yes, no) = P_{yn} = (wtp_{1i} > bid1, wtp_{2i} < bid2) \quad (21)$$

$$pr(no, yes) = P_{ny} = (wtp_{1i} < bid1, wtp_{2i} > bid2) \quad (22)$$

$$pr(yes, yes) = P_{yy} = (wtp_{1i} > bid1, wtp_{2i} > bid2) \quad (23)$$

where P_{nn} denotes the probability of “no” for the first and the second bid, P_{yn} denotes the probability of “yes” for the first and “no” for the second bid, P_{ny} denotes the probability of no for the first bid and "yes" for the second bid and P_{yy} denotes the probability of "yes" for the first and the second bid.

Following Haab and McConnell (2002), the general econometric model for the above formulated double bounded contingent valuation method is given as:

$$wtp_{ij} = \mu_i + \varepsilon_{ij} \tag{24}$$

where wtp_{ij}denotes the j^{th}respondent's willingness to pay, and $i = 1,2$ represents the first and second answers. The symbol of$\mu_1$and$\mu_2$represents mean for the first and second responses. The probability of observing each of the two bid response are "yes-yes", "yes-no", "no-yes" and "no-no".

To build the likelihood function, we first derive the probability of observing each of the possible two bid response sequences (yes-yes, yes-no, no-yes, no-no). For example, the probability that the respondent j^{th}answers yes to the first and the second bid is given by

$$P_{11} = pr\left(\mu_1 + \varepsilon_{1j} > bid_1, \mu_2 + \varepsilon_{2j} \geq bid_2\right)^{yy}$$

Simultaneously to for equation (22), the remaining three responses can be built in the same way, (23), (24) with equation (25). The i^{th} contribution to the likelihood function is written as

$$\mathrm{L_i}(\mu/\mathrm{bid}) = \mathrm{pr}\left(\mu_1 + \varepsilon_{1j} < \mathrm{bid}_1, \mu_2 + \varepsilon_{2j} < \mathrm{bid}_2\right)^{\mathrm{nn}} * \mathrm{pr}\left(\mu_1 + \varepsilon_{1j} < \mathrm{bid}_1, \mu_2 + \varepsilon_{2j} > \mathrm{bid}_2\right)^{\mathrm{ny}} * \mathrm{pr}\left(\mu_1 + \varepsilon_{1j} \geq \mathrm{bid}_1, \mu_2 + \varepsilon_{2j} < \mathrm{bid}_2\right)^{\mathrm{yn}} * \mathrm{pr}\left(\mu_1 + \varepsilon_{1j} > \mathrm{bid}_1, \mu_2 + \varepsilon_{2j} \geq \mathrm{bid}_2\right)^{\mathrm{yy}} \tag{25}$$

where yy =1 for a yes-yes answer, 0 otherwise, ny =1 for a no-yes answer, 0 otherwise, yn =1 for a yes-no answer, 0 otherwise and nn =1 for a no-no answer, 0 otherwise. The above formulation is referred to as the bivariate discrete choice model. Assuming the error terms are normally distributed with means 0 and variances ($\delta_1^2$and δ_2^2) and correlation coefficient ρ. The likelihood function for the bivariate probit model is derived as below.

$$pr\left(\mu_1 + \varepsilon_{1j} < bid_1, \mu_2 + \varepsilon_{2j} < bid_2\right)^{nn} = \Phi_{\varepsilon_1\varepsilon_2}\left(\frac{bid_1 - \mu_1}{\sigma_1}, \frac{bid_2 - \mu_2}{\sigma_2}, \rho\right)^{nn} \tag{26}$$

$$pr\left(\mu_1 + \varepsilon_{1j} < bid_1, \mu_2 + \varepsilon_{2j} > bid_2\right)^{ny} = \Phi_{\varepsilon_1\varepsilon_2}\left(-\frac{bid_1 - \mu_1}{\sigma_1}, \frac{bid_2 - \mu_2}{\sigma_2}, -\rho\right)^{ny} \tag{27}$$

$$pr\left(\mu_1 + \varepsilon_{1j} > bid_1, \mu_2 + \varepsilon_{2j} < bid_2\right)^{yn} = \Phi_{\varepsilon_1\varepsilon_2}\left(\frac{bid_1 - \mu_1}{\sigma_1}, -\frac{bid_2 - \mu_2}{\sigma_2}, -\rho\right)^{yn} \tag{28}$$

$$pr(\mu_1 + \varepsilon_{1j} > bid_1, \mu_2 + \varepsilon_{2j} > bid_2)^{yy} = \Phi_{\varepsilon_1\varepsilon_2}\left(\frac{bid_1 - \mu_1}{\sigma_1}, \frac{bid_2 - \mu_2}{\sigma_2}, \rho\right)^{yy} \quad (29)$$

Where$\Phi_{\varepsilon_1\varepsilon_2}$is the standardized bivariate normal cumulative distribution function with zero means, one variances and correlation coefficient ρ. The correlation coefficient of error terms is estimated using Seemingly Unrelated Bivariate Probit (SUBVP) model (Cameron and Quiggin, 1994). Therefore, SUBVP estimates the mean WTP of the respondents for tomato insurance from the double bounded format.

The general model for the standard bivariate probit model can be written as

$$\Phi_{\varepsilon_1\varepsilon_2}\left(d_{1i}\left(\frac{bid_1 - \mu_1}{\sigma_1}\right), d_{1i}\left(\frac{bid_2 - \mu_2}{\sigma_2}\right), d_{1i}d_{2i}\rho\right) \quad (30)$$

where $d_{1i} = 2y_{1i} - 1$, and $d_{2i} = 2y_{2i} - 1$, $y_{1i} = 1$ if the response to the first question is yes,

Finally, the biding structure is presented in table 2. Different level of percentage coverage (70, 75 80, 85 and 90) together with percentage of scale (90 and 100) is presented. The notations of A, B, C, D..., I are the amount of premium rate calculated taking into account the percentage of coverage and the scale. The calculation of the premium rate is explained above from equation 1 to 4. For instance, the symbol “A” denotes the premium rate calculated using a combination of 70 % and 90% coverage and scale, respectively. The respondents were presented with the calculated premium rate amount to access their willingness to take crop insurance. The first premium rate corresponding to the first bid was randomly selected from the calculated premium rates. If the respondent answer yes to the first bid, a follow up bid (hire bid) was then presented and if the respondent answer no to the first bid, a lower bid (bid 2) was also then presented to the respondent. Both the first and the second bid were randomly selected from the calculated premium rates.

Table 2: Bidding structure

Bid notation	% coverage					% Scale
	70	75	80	85	90	
Initial bid (Bid_1) in ton/hectare	A	B	C	D	E	90
Follow up bid (Bid_2) ton/hectare	F	G	H	I	J	100

Variable definition and working hypothesis

The choices of variable to be included in the estimated models are based on the theory and previous studies. The theoretical framework explained above revealed WTP for insurance depends on farmers' income and socio-economic characteristics. Specifically, Kwadzo, Korwunor and Amadu (2013) found that farm size, credit and diversification are one of the main important variables which determine farmers' willingness to participate in crop insurance. Mohammed and Ortmann (2005) revealed that on-farm income and diversification are among the important variables that influence adoption of livestock insurance by commercial dairy farmers. Also, Kouame and Komenan (2012) and Abdullah, Auwal, Darham, and Radam(2014) showed on their study that age and farm size are among the important variable in influencing farmers willingness to pay for crop insurance. Furthermore, Sherrick, Barry, Ellinger and Schnitkey (2004) showed that farmers' preferences for different types of insurance affects their choice to purchase crop insurance. Therefore, for my study I included explanatory variables, which are described in table 3 below based on theory and previous literature.

In this study, the dependent variable is willingness to pay for tomato insurance and the explanatory variables are gender and age of the respondents; types of insurance; off-farm income; farm size; access to extension service; risk preference and diversification. According to the previous literature (Kouame and Komenan, 2012), both bid1 and bid2 is negatively associated with the probability of farmer's willingness to pay for price insurance contract.

In this study, the bids (bid1 and bid 2) were modeled as categorical variables in the probit and bivariate probit models. The first bid (bid1) had the following values in ton/ha: 1.26, 1.32, 1.40, 1.43 and 1.50. The respondents were asked if they were willing to pay for insurance for certain amount of bid as indicated above which was selected randomly. The responses were categorized as less or equal to 1.30, between 1.31 and 1.40 and between 1.41 and 1.50. Two dummy variables (B2 corresponding bid amounts between 1.31 and 1.40 and B3 corresponding bid amounts between 1.41 and 1.50) were modeled in the probit and bivariate probit models. The category of bid amount less or equal to 1.30 (B1) served as the reference.

Similar to bid 1, a follow up bid (bid 2) was asked to the respondents. This bid had the following values in ton/ha: 1.35, 1.47, 2.22, 2.23 and 2.25. Respondents that were willing to pay for tomato insurance at certain amount in bid 1, were asked if they were still willing to pay for tomato insurance in bid two at certain amount which was higher than the first bid. The respondents that were not willing to pay for tomato insurance at certain amount in bid1 were asked if they were willing to pay for tomato insurance at certain amount which was lower than the first bid[1]. Two dummy variables (D2 corresponding bid amounts between 1.36 and 2.22 and D3 corresponding bid amounts between 2.23 and 2.25) were modeled in the probit and bivariate probit models. The category of bid amount less or equal to 1.35 (D1) served as the reference. Based on previous literatures the study hypothesized that variables related to bids 1 and 2 to have a negative relationship with WTP for tomato insurance.

[1]Respondents who were not willing to pay for tomato insurance at 1.26 ton/ha and 1.32 ton/ha in bid 1 were also assumed that they will not be willing to pay for tomato insurance in bid 2 as the bid 1 values are less than the values of the bid 2.

Age of farmers negatively affect willingness to pay for farm insurance (Falola, Eyitayo and Olasunkanmi, 2013; Danso-Abbeam and Ehiakpor, 2014). On the other hand, Kouame and Komenan (2012) and Ali (2013) found that age of farmers positively affects willingness to pay for price insurance contract, and that there is no unidirectional relationship between age of the respondent and farmers willingness to pay for agricultural insurance. Some studies show positive relationship between gender of a farmer and willingness to pay for agricultural insurance (Ali, 2013; Teshome and Bogale, 2014; Danso-Abbeam and Ehiakpor, 2014). Given that men are mostly the decision makers and have higher financial potential compared to females, the probability of paying for tomato insurance increases for men compared to women. On the other hand, Adhikari and O'Leary (2011) found that females have risk aversion behavior by nature (less tolerance) and since agriculture is a high risky activity, females are more willing to pay for tomato insurance. Therefore, this study hypothesized gender of farmer may have either positive or negative relation with farmers WTP for tomato insurance.

Teshome and Bogale (2014) found that the size of cultivated land to be positively related with farmers' WTP for rainfall based insurance. The study expects that farm size would have positive effect on farmers' WTP for tomato insurance because the larger the area cultivated for tomato production, the more likely exposed to production risk. Therefore, farmers would tend to need agricultural insurance in case of crop lost. Similarly, Kouame and Komenan (2012), Falola, Eyitayo and Olasunkanmi (2013) and Danso-Abbeam and Ehiakpor (2014) found farm size to have positive effect on farmers' WTP for agricultural insurance.

According to Teshome (2014), marital status of the household head (being married) was positively related to farmers' willingness to pay for agricultural insurance. Based on the findings of Teshome (2014), the study expects that farmers' marital status (being married) would have a positive relation to farmers' WTP for agricultural insurance. The study expects having extension service would have a positive relation to farmers' decision for willingness to pay for tomato insurance because access to extension service would widen the farmer knowledge on the advantage of using agricultural insurance. Similarly, Ali (2013); Teshome (2014) and Falola, Eyitayo and Olasunkanmi (2013) found that access to extension service have a positive relations to farmers' WTP for agricultural insurance.

This study expects farmers who practice diversification to have negative relation to farmers' WTP for tomato insurance because when farmers diversified into the production of other crops, they will have different source of income from these other crops. Therefore, in case one crop fails, they could substitute the income from other crops and so farmers may not see the need for having agricultural insurance. Moreover, Thanh, Hoa and Phuong (2015) found that famers who practiced diversification into their fields to have negative relation to farmers' WTP for area yield crop insurance for rice production.

Risk behavior is one of the main determinant variables for farmers' willing to pay for agricultural insurance. However there is contradiction of results from previous literatures. Other literature portray that farmers who have risk averse behavior tend more likely to purchase insurance (Cole, Tobacman and Topalova, 2008), while farmers with high risk averse behavior are less likely to purchase insurance (Kouame and Komenan, 2012). The study anticipates either positive or negative relationship between farmers' WTP for tomato insurance and risk-averse behavior of a farmer. The study captured farmers risk behavior by asking whether farmers are willing to continue with tomato production although it is vulnerable to pest and diseases and have volatile prices. Farmers who were willing to continue with tomato production were considered as risk takers while those not ready to continue with production or shifting in producing other crops were considered as risk averse[2].

Farmers who had off-farm income found less likely to participate in drought insurance because they are assured with enough income apart from agriculture (Teshome, 2014). Since agricultural production is environmentally and biologically dependent, having an income outside agricultural activities assures farmers income and therefore farmers are less dependent from agricultural

[2] It should be noted here that the procedure followed to measure risk behavior is incomplete since the technical procedure to access the behavior of individuals towards risk is through the estimation of risk aversion coefficients.

activities which make them purchase less agricultural insurance. Table 3 below presents the description of the included variables in probit and bivariate probit model with their expected signs.

Table 3: Variable definition and expected signs

Variable name	Description	Expected Signs
1.WTP1	dummy variable equal to 1 if farmers are willing to pay for the first bid to take tomato insurance and 0 otherwise	
2.WTP2	dummy variable equal to 1 if farmers are willing to pay for the follow up bid to take tomato insurance and 0 otherwise	
3. B2	dummy variable equal to 1 if farmers' WTP for tomato insurance fall between 1.31 to 1.40 for the first bid and 0 if it is less than 1.30 ton	-
4. B3	dummy variable equal to 1 if farmers' WTP for tomato insurance fall between 1.41 to 1.50 for the first bid and 0 if it less than or equal to 1.30 ton	-
5. D2	dummy variable equal to 1 if farmers' WTP fall between 1.36 to 2.22 for the follow up bid and 0 if it less than or equal to 1.35 ton	-
6. D3	dummy variable equal to 1 if farmers' WTP fall between 2.23 to 2.25 for the follow up bid and 0 if it less than or equal to1.35 ton	-
7. gender	A dummy variable equal to 1 if gender of the farmer is female and 0 otherwise	+/-
*8. family**	Family size in number	
9. farmsiz	Farm size in hectare	+
*10. oninc**	On-farm income in MZN	
11. offinc	Off-farm income in MZN	_
12. acext	dummy variable equal to 1 if farmers have access to extension and 0 otherwise	+

Table 3: Cont…

Variable name	Description	Expected Signs
*13. locon**	dummy variable equal to 1 if farmers easily gets loan and 0 otherwise	
*14. exp**	Experience in years in farming tomato	
15. age	Age of the respondent in year	+/-
*16. edun**	dummy variable equal to 1 if the farmers is illiterate and 0 otherwise	
17. insflood	a dummy variable equal to 1 if farmers preferred flood insurance 0 other type of insurance;	+
18. insrevenue	dummy variable equal to 1 if farmers preferred revenue insurance 0 other type of insurance	+
19. insmpci	a dummy variable equal to 1 if farmers prefer multiple peril crop insurance (MPCI), 0 other type of insurance.	+
20. marstat	is a dummy variable equal to 1 if the farmer is married and 0 if the farmer is partnered	+
21. tom	a dummy variable equal to 1 if farmers dominantly produce tomato than other crops, 0 producing tomato with diversification of other crops	+
22. risk	a dummy variable equal to 1 if the farmer is risk taker and 0 if the farmers have risk aversion behavior	+/-

Notes: * denotes variable that are not included in the model and therefore do not present expected sign.

3.3.4.4 Willingness to pay (WTP) for tomato insurance

The bivariate probit model is used for double bounded dichotomies choice while probit model is used for single bounded dichotomies choice. The mean willingness to pay (MWTP) is calculated using the formula specified by Haab and Mconnell (2002) for tomato insurance using both probit and bivariate probit models. The study only used the explanatory variables of bid for both models in estimation of MWTP for tomato insurance. Many studies determined mean WTP using the ratio of negative constant term with the biding coefficient (Gebremariam and Edriss, 2012 and Teshome, 2014). Therefore, this study also follows the spirit of previous studies. The estimation of the means WTP for both models using equation (17) and (30) can be described as follow:

$$mean\,WTP = -\beta_0/\beta_1 \qquad (31)$$

where β_0 is constant term and β_1 is the coefficient of the variable bid.

3.5 Major assumptions

In decision making, there are three types of risk behavior: risk averse, risk taker/ loving and risk neutral (Walsh and Schneider, 2002). Risk taker is a behavior applying for individuals with their expected utility of any lottery being more than the utility of getting the expected value of the gambling (Mahat, Nasir, and Ali, 2010). Risk taker farmers tend to consider agricultural insurance being not important since they are expecting greater satisfaction without being enrolled in agricultural insurance. Therefore risk takers farmers will less be willing to pay for agricultural insurance.

Risk averse is a behavior which applies for individuals with their expected utility of any gambling being less than the utility of getting the expected value of the gambling for sure (Concina, 2014; Mahat, Nasir, and Ali, 2010). Farmers who are risk averse tend to consider the need of agricultural insurance since they have less satisfaction. Therefore, farmers who are risk averse will be more willing to purchase agricultural insurance. Risk neutral applies for individuals with expected utility of any lottery being indifferent with the utility of getting the expected value of the gambling (Myerson, 2005 and Concina, 2014). Individuals with risk neutral behavior may have positive or negative relation towards obtaining agricultural insurance. Therefore, the major assumption for this study is that farmers have a risk-neutral behavior so that both cases (positive and negative) relationship towards getting agricultural insurance is possible to observe within the group of interviewed farmers.

3.6 Data analysis

Data were analyzed using both descriptive statistics and econometric models. Descriptive statistics such as mean, standard deviation, frequency, percentage, cumulative distribution, minimum and maximum, histogram and chart were employed to describe socio-economic characteristics of tomato farmers, farmers' preference for different types of agricultural insurance, yields and factors affecting tomato production in Moamba. Specifically, the first objective (farmer's preference for different types of agricultural insurance) was analyzed using descriptive statistic as described above. The area yield index insurance method was used to estimate premium rate. Finally, the third and fourth objectives, probit and bivariate probit models were estimated in STATA software.

4. Results and discussion

4.1 Socio-economic characteristics of tomato farmers

Among the 75 interviewed tomato farmers, the majorities (84%) are males and the remaining 16% are female farmers. It implies that tomato production is dominated by male farmers. The result of this study is similar to those reported by Familusi *et al*. (2014) who studied comparative advantage of tomato production between Mozambique and South Africa. Their result showed that 81.5% of the tomato producers were males. This is because of the unequal division of labor and absence of men's participation in homebased work, which makes difficult for women to join farming practice (Aroray, 2014). Additionally, men mainly dominated cash crop production such as tomato.

The family size on average is 8.3 with the range of 1 and 26 family members. According to (MPD-DNEAP, 2010) the average household size in Mozambique was 5.1 in 2008. However, Familusi *et al.* (2015) found that the mean household size to be 7 in Moamba. These results reveal that Moamba possess higher number of household members than the average of the country. As presented in table 4, for the 2013/14 crop season, the minimum on-farm income is 0 and the maximum is 1,500,000 MZN. The average on-farm income is 76,475 MZN. This income is for 2013/14 agricultural season. The minimum on-farm income indicates that some of the farmers lost their total production due to flood, drought pest and diseases. Furthermore, tomato farmers have on average off-farm income of 1,097.78 MZN per month.

The age of the respondents ranges between 19 to 80 years with the mean age of 45 years. The result of this study is similar with McNair, Lambert and Eash (2015) who conducted a study on conservation agriculture and household wellbeing in Mozambique and found that the mean age of household farmer was 45.5 years. However, in South Africa the average age of farmer was 62 year old (SSR, 2013). One of the main reasons for the difference on age of farmer between South Africa and Mozambique can be due to the lack of agricultural policy to empower youth engagement in agricultural sector and nonexistence of access to productive resources such as land for youth to participate in agricultural production.

The experience of tomato farmers on average is 16 years. Many studies indicate that getting a loan from financial institutions is difficult for smallholder farmers in Mozambique due to lack of collateral. In this study, on average 24% of tomato farmers responded that loans can be accessed easily from financial institutions. Among the respondents 82% of tomato farmers in Moamba have some level of formal education while the remaining 18% are illiterate. According to USAID (2015) the overall literacy rate in Mozambique is 47 percent. It implies that the majorities of farmers have got formal education which is better than the national average of illiteracy. Therefore, educated farmers are able to adopt modern farm inputs and production technologies and absorb faster new information.

Table 4: Socio-economic characteristics of tomato farmers

Variables	Mean	Std. Dev.	Min	Max
Gender	0.16	0.37	0.00	1.00
Family	8.37	4.59	2.00	26.00
Farmsize	31.64	62.37	1.00	359.00
Oninc	76,955.18	181,339.60	0.00	1,500,000.00
Offinc	1,097.78	6,088.38	0.00	50,000.00
Acext	0.77	0.42	0.00	1.00
Locon	0.24	0.43	0.00	1.00
Exp	15.99	11.68	2.00	51.00
Age	45.09	15.27	19.00	80.00
Edun	0.83	0.38	0.00	1.00
Risk	0.71	0.46	0.00	1.00

4.1.1 Tomato farmers' preference for different types of agricultural insurance

Farmers' willingness to pay for tomato insurance can be influenced by the type of agricultural insurance. The table 5 below, reveal that farmers have higher willingness to pay for flood insurance and lower WTP for the least preferred rainfall insurance. Hence, from the total of 70 farmers who responded, 29% preferred flood insurance while 1.4% of farmers preferred rainfall insurance. The main reason for farmers choosing flood insurance is that tomato production is vulnerable to flood in the area. The price insurance, revenue insurance, product insurance, MPCI and drought insurance are preferred by 20%, 19%, 17%, 10% and 4% of interviewed tomato farmers, respectively. Finally, the second biggest challenge faced by the tomato farmers is variability of tomato price in the market. During summer the price is higher compared to fresh season.

Table 5: Tomato farmers' agricultural insurance preference in Moamba

Agricultural insurance preference	Freq.	Percent	Cum.
flood insurance	20.00	28.57	28.57
revenue insurance	13.00	18.57	47.14
production insurance	12.00	17.14	64.29
drought insurance	3.00	4.29	68.57
price insurance	14.00	20.00	88.57
rainfall insurance	1.00	1.43	90.00
MPCI	7.00	10.00	100.00
Total	70.00	100.00	

The analysis of preference of different types of agricultural insurance by tomato farmers was disaggregated by different localities with the studied areas as shown in Figure 2. As indicated in the chart below, tomato farmers in Malengane locality preferred more flood insurance over other types of insurance. In addition, flood insurance is also preferred in Sabie-Sede locality 29% of tomato farmers. However, the most preferable insurance in Moamba-Sede locality is revenue insurance while flood insurance is the list preferred. This result might indicate that Moamba-Sede is the least flood prone relative to other localities.

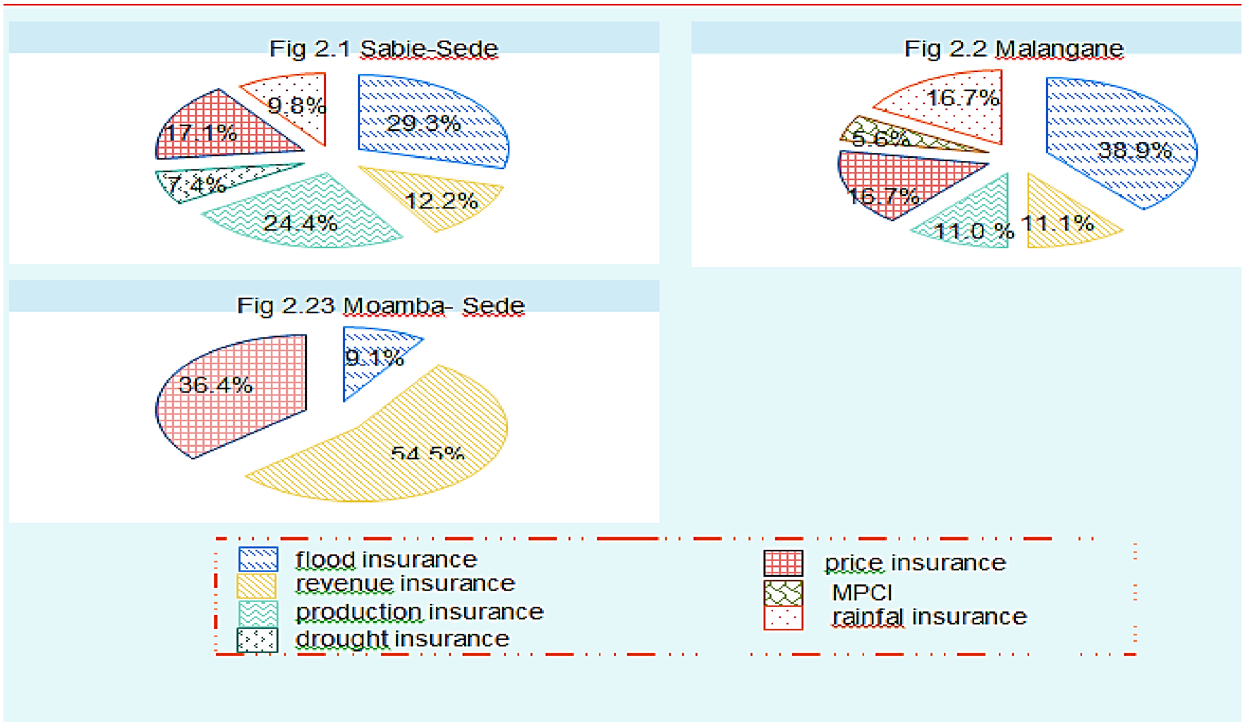


Figure 3: Distribution of farmers' preference to different types of tomato insurance

4.1.2 Tomato production in Moamba

Figure 3 presents tomato production in Moamba. Around 41% of farmers are producing tomato between 5,001-15,000 Kg per hectare. Approximately 31% of farmers are producing in the interval of 15,001-30,000 Kg of tomato per hectare. Some of the tomato farmers are producing less than 5,000Kg per hectare which accounts 16%. In contrast, 2.7 % of tomato farmers are extremely producing more than 50,001 Kg of tomato per hectare. It indicates that few farmers can use improved inputs such as high yield verities, pesticides, herbicides and apply recommended fertilizer during tomato production.

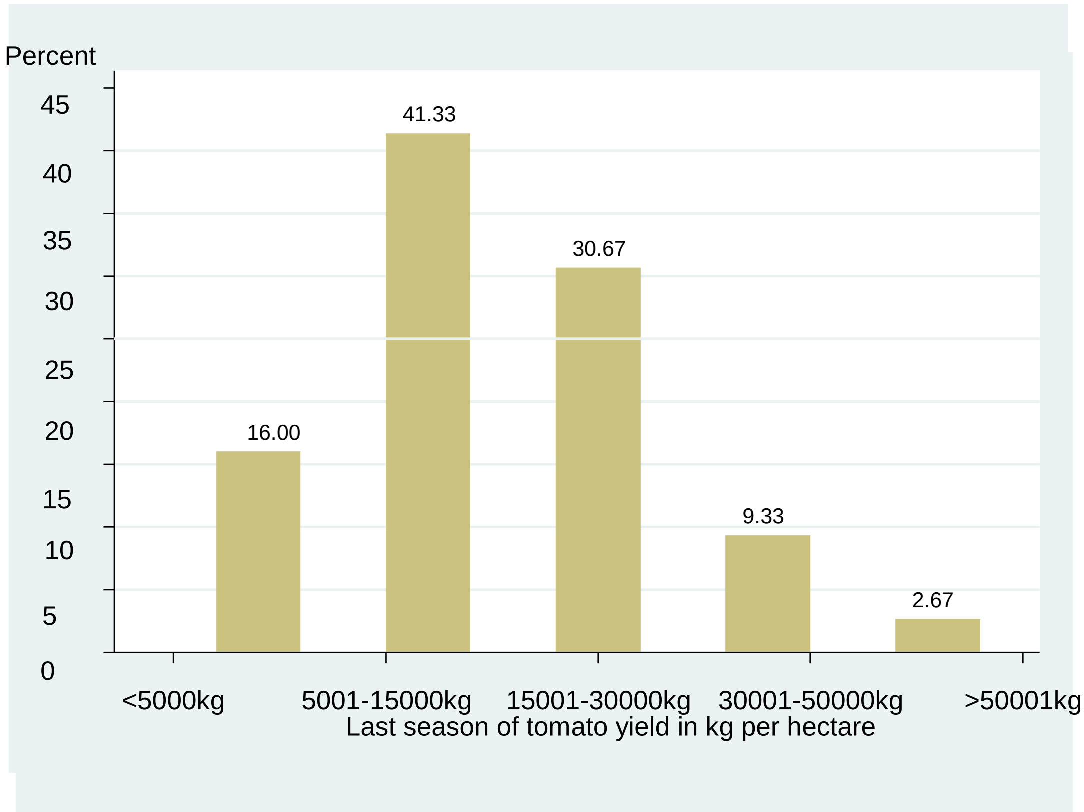


Figure 4: Production of tomatoes in Moamba

The analysis of tomato production was disaggregated by localities as presented in figure 4. The results show that about 53% of farmers are producing tomatoes between 5000-15000 kg per hectare in Malengane and 16.67% in Moamba-Sede locality. It is important to note that 21% of tomato farmers in Malengane are producing less than 5,000 Kg of tomato per hectare while in Moamba-Sede no tomato farmer is producing less than 5,000kg tomato per hectare. Productivity in Moamba-Sede is higher than the other localities due to its proximity to input markets which increases farmers' probability of using improved agricultural inputs. Moreover, around 8% of tomato farmers are producing more than 50,000 Kg of tomatoes per hectare in all visited localities.

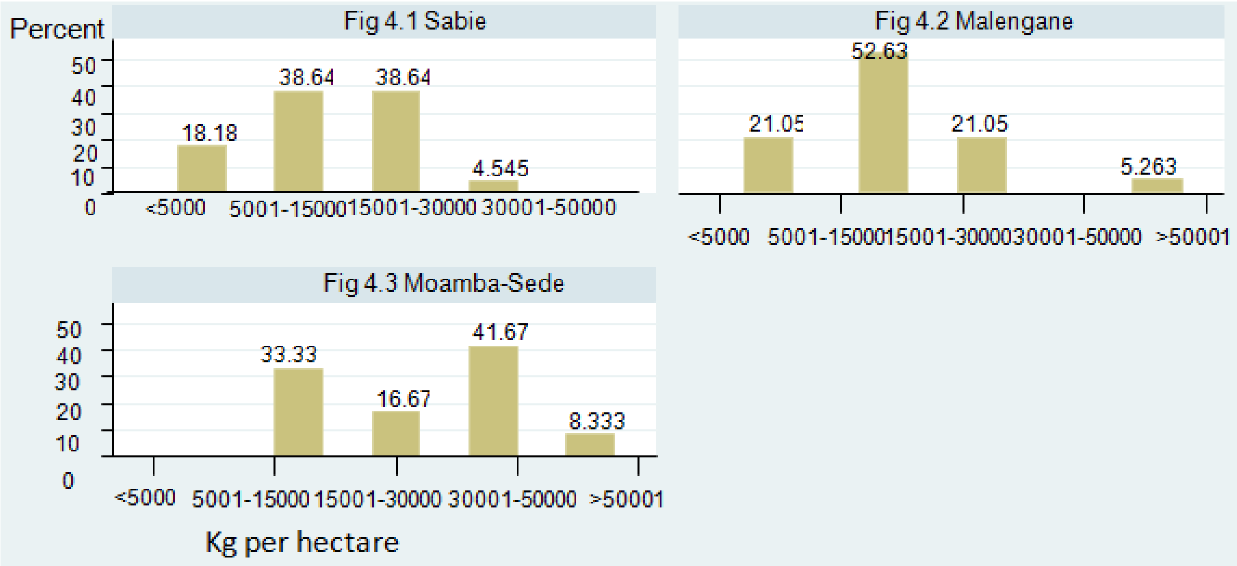


Figure 5: Production of tomatoes in different localities of Moamba district

4.1.3 Factors affecting tomato production in Moamba

Agricultural production, particularly of tomatoes, is vulnerable to different environmental and human interferences. This study tries to show which factors mainly affect tomato production in Moamba. Table 6 below shows that 91% of farmers are facing challenge in price variation of tomato production. This tells us there is a shortage of processing industries as during the time of harvest, tomato price goes down drastically. Tomato farmers do not have alternative options and they are obliged to sell their product at any market price due to the lack of storage and processing facilities. Pest is the other factor affecting tomato production in Moamba District. On average, 89% of the farmers are suffering from tomato damage or losses due to pests. American bollworm is one of the pests that are mainly affecting tomato production in the area. Flood, high temperatures and drought are other factors affecting negatively tomato production reported by 64%, 61% and 17 % of farmers, respectively.

Table 6: Factors affecting tomato production in Moamba

Variable	Mean	Std. Dev.
Pest	0.89	0.31
High temperature	0.61	0.49
Price variation	0.91	0.29
Flood	0.64	0.48
Drought	0.17	0.38

4.2 Agricultural insurance premium rate

Indemnity is a payment made by the agricultural insurance provider to the beneficiary (policy holder) whenever the average county yield is less than the critical yield. On the other hand, premium rate is a payment made by the farmers (beneficiary) to the insurance company. Indemnity payment and premium rates using scale (90% and 100%) with coverage (70%, 75%, 80%, 85% and 90%) is presented in Table 7.

Results show that the indemnity payments are higher for 100% scale compared to 90% scale regardless of the coverage rate. This result is expected because the higher scale provides the greatest protection to the beneficiaries. Additionally, the results show that the indemnity payment increases with an increase of the coverage rate. This is expected because an increase in beneficiary's desire for a percentage farm loss increases the coverage level. For all coverage rates, the indemnity payments are lower compared to critical yield. This result is expected because the maximum coverage for one hectare is 90% coverage though the protection for 90% coverage is 100% scale. Therefore, since 10% farm loss remaining to the beneficiary, the critical yield always greater than the indemnity payment.

Premium rate is determined using area yield index insurance for tomato production in Moamba District. As expected, the premium rate increases as the percentage of coverage and scale increases for a given county. This result is consistent with the earlier studies (Nelson, 1990 and Clover and Nieuwoudt, 2003). The estimated premium rates ranges from 1.25 ton/h to 2.25ton/ha using a combination of 70 % coverage with 90 % scale and 90% coverage with 100 % scale, respectively. Binici and Zulauf (2006) found that premium rate for wheat crop ranged from zero kg per dekar[3] (Beysehir and Karaty counties) to 13.3 kg per dekar (Altintekin County) using 80% coverage level. It is important to note that the range wheat crop yield in Turkey is from 1,787 to2, 835 kg per hectare with an average of 2311 kg per hectare (Kun et al., 2004). Using the ratio of premium and average wheat crop yield of Turkey, farmers are willing to for pay premium rate 2.8% from their total wheat crop yield.

The findings of this study are much higher compared to the previous studies. For instance, Akter*et al.* (2007) assessed farmers WTP for flood insurance in the wetland basin of Bangladesh. The study showed that 23% of the sampled farmers were willing to pay for flood insurance at premium cost between 2-150 kg (with average of 37 kg) of rice crops per year, for each household.

As indicated from the above studies the premium rate is different within the localities. From previous research, it can be concluded that the premium rate in Moamba is much higher compared to those estimated by previous researchers. Therefore, the government should provide subsidy to the insurance provider in order to reduce the cost of premium rate so that majority of farmers can access agricultural insurance service.

[3] The unit dekar is equivalent to 0.1 hectare (130kg/hectare).

Table 7: Indemnity and premium rate per hectare for tomatoes farmers in Moamba

COVERAGE	70%	75%	80%	85%	90%
Yc	12, 407.49	13, 293.74	14, 179.99	15, 066.24	15, 952.49
Indem using 100% scale	9,763.55	10,294.32	15,507.48	15,637.92	15,753.87
Premium rate using 100% scale	1,394.79	1,470.61	2,215.35	2,233.98	2,250.55
Indem using 90% scale	8,787.20	9,264.88	9,682.86	1,0051.66	10,379.48
Premium rate (kg)	1,255.31	1,323.55	1,383.26	1,435.95	1,482.78

4.3 Factors affecting tomato farmers' willingness to accept crop insurance

The results regarding the factors affecting willingness to accept agricultural insurance are presented in table 8. As stated in the methodology section, the probit model is employed to determine the factors affecting tomato farmer's willingness to accept crop insurance in Moamba and also estimate the mean WTP for tomato insurance. The probit model is corrected for multicollinearity problem using correlation matrix (correlation coefficient analysis). Appendix 2, the correlation matrix, shows that there is no serious multicollinearity problem among independent variables except age square. Moreover, the probit model is corrected for heteroscedasticity problem using robust standard error (applying robust command in Stata).

Results in table 7 shows that the dummy variable sex of the respondent has a positive sign and statistically significant at 5% level indicating that the probability of taking insurance increases for female tomato farmers compared to male counterpart. One of the reasons is that female farmers have a risk aversion behavior. Adhikari and O'Leary (2011) found that women exhibit less financial risk tolerance than men.

An increase in age of farmer decreases the probability of willing to pay for insurance. The variable age of farmers have a negative sign suggesting that farmers with higher age are less willing to pay for tomato insurance and also it is statistically significant at 1%. This result is in line with the finding of Falola, Eyitayo and Olasunkanmi (2013) and Danso-Abbeam and Ehiakpor (2014) who found that aged farmers are less willing to enroll in agricultural insurance programs. The results indicated also that farmers' willingness to accept tomato insurance is determined by the type of insurance. In Moamba district the probability of farmers to take insurance increases if the insurance is cover crop damage from flood (flood insurance). This result is expected since Moamba is flood prone area. The probability of taking insurance increases for farmers with off-farm income compared to their counterparts without off farm income. This result is also expected as off farm income is source of funds to finance insurance costs resulting from premium rate payments.

The marginal effects of probit model are also presented in Table 8. The results indicates that holding everything constant, if the age of the farmers increases by 1% the probability of taking insurance decreases by 1.2%. This result indicates that young farmers are more willing to take tomato insurance than aged farmers. The result is consistent with the finding of from Mezgebo *et al.* (2013) and Gebremariam and Edriss (2012) who also found that younger farmers are more willing to try new things such as technology and agricultural insurance compared to aged farmers.

The dummy variable gender shows that female farmers are more likely willingness to pay for tomato insurance by 30% compared to male counterpart and statistically significant at 1%. Finally, the results for preference of flood insurance indicates that holding everything constant, a change of preference from other type of agricultural insurance to flood insurance increases the probability of obtaining tomato insurance by 26% and statistically significant at 5%. The details of the results of the probit model including the marginal effects are presented in Appendix 3 and 4, respectively.

Table 8: Probit estimates of willingness to pay for tomato insurance

Variables	**WTP1**		**Marginal Effect (dy/dx)**	
	Coef	P>z	Coef	**P>z**
B3	-6.162	0.136	-.309	0.138
B2	-.848	0.679	-.085	0.678
Age	-.034***	0.002	-.012***	0.001
Gender	1.123*	0.066	.304***	0.005
Insflood	.851*	0.075	.265**	0.032
insrevenue	.029	0.952	.010	0.952
Insmpci	.478	0.324	.158	0.279
Marstat	-.795	0.163	-.305	0.160
Tom	.383	0.231	.135	0.230
Risk	-.236	0.581	-.082	0.568
Farmsiz	.4.4e-04	0.880	.1.0e-04	0.880
Acext	-.319	0.459	-.108	0.431
Offinc	2.1e-05	0.156	7.6e-06	0.160
_cons	2.194**	0.004	-	-

***, ** &* Statistically Significant at **1%**, **5%** and**10%,** respectively

The bivariate probit model result are reported in Table 9. In order to use the bivariate probit model approprately, correlation between the errors of the two estimated equations was checked beforeestimating the bivariate probit model. The results, which are presented in appendix 2 show that there is a correlation between the errors of the first and the follow up bid equations which allows to aply the bivariate model. It should be noted that due to the correlation of the error terms between the first and the follow up bid, the use of probit model produces biased results.

The results show that the majority of included explanatory variables in the bivariate probit model are not statistically significant except for variable age, gender, and flood insurance. The variable age has the expected negative sign indicating that older farmers are less likely to pay for tomato insurance. The same results were also reported that age of farmer negatively affect willingness to pay for farm insurance (Falola, Eyitayo and Olasunkanmi, 2013; Danso-Abbeam and Ehiakpor, 2014). For gender, the results show that female farmers are more willing to pay for tomato insurance compared to their male counterparts. This result is expected as women are reported to exibit less financial risk tolerance than men (Adhikari and O'Leary, 2011). The variable flood insurance exibits positive sign meaning that farmers who prefere flood insurance are more likely to pay for tomato insurance compared to farmers who prefered other types of crop insurance. This result is expected as Moamba district is flood prone zone.

Regarding the marginal effects of bivariate probit model, the estimated results are not statistically significant except for variable D3. Specially the results show that a farmer whose willingness to pay fall within the interval between 2.23 and 2.25 are more likely willing to pay by 54.4% for tomato insurance compared to farmers willing to pay less than 1.35. The complete output of bivariate probit model including the marginal effects is presented in appendix 5 and 6, respectively.

Table 9: Bivariate probit estimates of willingness to pay for tomato insurance

Variables					**Marginal Effect**	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	
WTP1			**WTP2**			
B3	-.7212	0.311	-	-	-.258	0.313
B2	.297	0.648	-	-	.103	0.650
D3	-	-	8.68	1.000	.544***	0.000
D2	-	-	1.969	0.000	.001	1.000
Age	-.042***	0.002	.0262	0.064	-.014	0.993
Gender	1.249**	0.026	-.356	0.632	.312	0.993
Insflood	1.115**	0.032	.470	0.353	.316	0.989
insrevenue	.036	0.941	.141	0.789	.012	0.999
Insmpci	.753	0.107	-.240	0.688	.229	0.991
Marstat	-.956	0.117	.080	0.911	-.363	0.940
Tom	.416	0.280	-.154	0.756	0.128	0.989
Risk	-.353	0.438	.090	0.878	-.117	0.985
Acext	-.329	0.457	.035	0.955	-.108	0.965
Offinc	1.0e-4	0.581	.0000	0.696	6.48e-06	0.998
_cons	2.155	0.036	-1.985	0.073	0.054	-

***, ** &* Statistically Significant at **1%**, **5%** and**10%,** respectively

4.4 Willingness to pay for tomato insurance

The result from the probit and the bivariate probit model shows that farmers are willing to pay for tomato insurance 1.52 and 1.49 ton/ha/year, respectively which is 10% of their average total production. The complete results of probit and bivariate probit are presented in appendix VII and VIII. The premium rate calculated by insurance provider ranges from 1.25 to 2.25 ton /ha per year. Both 1.52 and 1.49 fall in the range of the estimated premium. Also, farmers are willing to pay for all (70%, 75%, 80%, 85% and 90%) coverage using 90% scale. However, farmers are willing to pay for tomato insurance only for 70% and 75% coverage using 100% scale.

The findings of this study are much higher compared to the previous studies. For instance, Akter *et al*. (2007) assessed farmers WTP for flood insurance in the wetland basin of Bangladesh. The study showed that 23% of the sampled farmers were willing to pay for flood insurance at premium cost between 2-150 kg (with average of 37 kg) of rice crops per year which is 0.11% on average yearly household crop production for each household. In addition, the average WTP for agricultural insurance by cocoa farmers in Nigeria was found to be $69.5/ha (Falola, Eyitayo and Olasunkanmi, 2013). The higher rate of willingnes to pay for agricultural insurance in Moamba compared to other countries shows the desire of Moamba farmers to have crop insurance.

5. Conclusions and policy implication

This study aims to assess farmer's preference for different type of insurance; estimate the appropriate premium rate using area yield index insurance for tomato production, analyze the factors affecting tomato farmers' willingness to take tomato insurance and estimate farmers' willingness to pay for tomato insurance in Moamba District. Seventy five tomato farmers were interviewed using the farmers' list provided by the Moamba District Economic Activities Services. The primary data was collected using structured questionnaire and the secondary data were obtained from Moamba District Economic Activities Services. Descriptive statistics and econometric models were used to analyze the data.

Descriptive statistics were employed to portray farmers' preference to different types of agricultural insurance, levels of tomato production and factors affecting production of tomato farmers in Moamba. Probit and Bivariate probit models were applied to explore factors affecting tomato farmers' willingness to obtain tomato insurance and to estimate farmers' willingness to pay for tomato insurance.

The descriptive analysis revealed that out of the total farmers interviewed, 84% were males and the average family size of tomato farmers is 9. The average age of the farmer is 45 years. This show that most of the farmers who engaged in tomato production are aged farmers. Therefore, the government of Mozambique should empower youth farmers to engage in tomato production sector. The study found that on average a farmer was having an income of 76,475 MZN for 2013/14 agricultural season. Farmers are not remembering each seasonal income because of they are not registering on paper.

About 76% of farmers did not have access to loan because of to lack of collateral. Policy towards establishment of grass root microfinance institutions might improve farmers' access to loans given that they demand less collateral as requirement for having credit compared to financial institutions. Furthermore, the government should ensure property rights to land owner since it can act as a collateral in accessing loan from financial institutions. The majority of tomato farmers (around 90%) are facing price variation of tomato. This is because tomato farmers do not have contracts with buyers. Therefore, improvement in tomato value chain including production by contract is needed to mitigate the variation of tomato prices.

The study found difference in tomato productivity among the localities. The majority of tomato farmers in Moamba-Sede are producing higher (30,001-50,000kg) amounts of tomato per hectare compared to other localities. On the other hand, about 85% of tomato famers experience crop loss due to pest and diseases. Therefore, the farmers' should adopt improve crop management. The estimated premium rates ranges between 1.25 ton/h and 2.25ton/ha using combination 70 % coverage with 90 % scale and 90% coverage with 100 % scale, respectively. The estimated premium rate is much higher than these estimated in the previous studies implying that insurance companies in Mozambique have opportunity to charge more for crop insurance.

The results of the probit model showed that gender, flood insurance (insflood) and off- farm income affects positively the willingness to pay for tomato insurance. Female tomato farmers are more willing to pay for tomato insurance than men though their participation is smaller. To make the insurance program feasible the concerned body should increase awareness on the advantages of agricultural insurance for mainly male farmers. Tomato farmers in Moamba preferred flood insurance than other type of insurance. This implies that there is a serious flood problem in the area and implies that an initiative of crop insurance in Moamba should cover for crop damage due to floods.

The study concludes that, farmers would be willing to pay 1.49 ton /ha/year for tomato insurance which is 10% of their average total yield, as it estimated using bivariate probit model. The premium rate that farmers are willing to pay falls within the interval of the estimated premium rates which is from 1.25ton/ha per year to 2.25ton/ha per year. However, farmers are willing to pay for all the insurance coverage that falls under the 90% scale. This shows that the insurance cover for the100% scale seems to be expensive for the tomato farmers. Therefore, the insurance provider should focus on using all level of coverage and 90% scale because it is more affordable for the farmer compared to the 100% scale.

6. References

Abdullah, A. M., Auwal, A. G., Darham, S., & Radam, A., (2014). Farmers willingness to pay for crop insurance in North West Selangor Integrated Agricultural Development Area (IADA), Malaysia. Journal of ISSAAS (International Society for Southeast Asian Agricultural Sciences), 20(2), 19-30.

Adhikari, B. K., & O'Leary, V. E., (2011) Gender differences in risk aversion: A developing nation's case. *Journal of Personal Finance*, 10 (2), 122-147.

AGRA (Alliance for a Green Revolution in Africa), (2012) Laying the groundwork for the commercialisation of African Agriculture. South Africa: The African Centre for Biosafety.

Akter, S., R. Brouwer, S. Chowdhury and S., Aziz (2007) Testing reliability and construct validity of in-kind WTP responses in contingent valuation. http://www.prem-online.org/archive/16/doc/PREM%20WP%2007-07.pdf. [Accessed 13 September 2015]

Akyoo, A.M., Temu, A.E. and Hella, J.P. (2013) Agricultural production risks, coping mechanisms and potential for crop insurance in Tanzania. *Time Journals of Agriculture and Veterinary Sciences*, 1(1), 11-22.

Ali, A. (2013) Farmers' Willingness to Pay for Index Based Crop Insurance in Pakistan: A Case Study on Food and Cash Crops of Rain-fed Areas. *Agricultural Economics Research Review*,26 (2), 241-248.

Antón, J., (2008) Agricultural Policies and Risk Management*:* A Holistic Approach*.* Retrieved 11 2, 2015, from http://ageconsearch.umn.edu/bitstream/48103/2/Agricultural%20Policies%20and%20Risk%20Management_%20A%20Holistic%20Approach.pdf

Antón, J., Kimura, S., Lankoski, J., and Cattaneo, A., (2012) A Comparative Study of Risk Management in Agriculture under Climate Change, *OECD Food, Agriculture and Fisheries Papers*, No. 58, *OECD Publishing*, Paris.DOI: http://dx.doi.org/10.1787/5k94d6fx5bd8-en[Accessed 13 January 2015]

Arias Carballo, Diego; dos Reis, Laura., (2013) The Agricultural Insurance Market in the Caribbean. World Bank, Washington, DC http://siteresources.worldbank.org/INTLAC/Resources/257803-1269390034020/EnBreve_183_Eng_Print.pdf[Accessed 5 January 2015]

Aroray, D., (2014) Gender division of labor and farm production in subsistence households. https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=IAFFE23AC&paper_id=138 [Accessed 13 June 2015]

Asim, S and Lohano, H. (2014) Households' Willingness to Pay for Improved Tap Water Services in Karachi, Pakistan. http://www.pide.org.pk/psde/pdf/AGM30/papers/Households%20Willingness%20to%20Pay%20for%20Improved%20Tap%20Water%20Services%20in%20Karachi.pdf [Accessed 13 June 2015]

Baliamoune-Lutz, M.,Brixiová, Z., and Ndikumana, L.(2011) Credit Constraints and Productive Entrepreneurship in Africa.*IZA DP No.* 6193. http://ftp.iza.org/dp6193.pdf. [Accessed 17August 2015].

Barnaby, G. A. and J. R. Skees (1990) Public Policy for Catastrophic Yield Risk: An Alternative Crop Insurance Program. *Choices* 1990; 2(7-9).

Barnett, B.J, Black, J.R, Hu, Y. &Skees J., (2005) Is Area Yield Insurance Competitive with Farm Yield Insurance?' *Journal of Agricultural and Resource Economics*, 30(2): 285-301.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Lee, M.J., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W, Sugden, R. and Swanson,J, (2002)Economic Valuation with Stated Preference Techniques. Edward Elgar, Massachusetts.

Bielza, . C., (2009) Risk Management an Agricultural Insurance chemes in Europe . *EUR-Scientific and Technical Researchs erious*, 8-10.

Binici, T. and Zulauf, C.R., (2006) Determining Wheat Crop Insurance Premium Based on Area Yield Insurance Scheme in Konya Province, Turkey. *Journal of Applied Sciences, 6(5): 1148-1152.*

Bryla, E and, a. J., (2007)Developing Index-Based Insurance for Agriculture in Developing Countries. Sustainable Development Innovation.

https://sustainabledevelopment.un.org/content/documents/no2.pdf. [Accessed 10 August 2015]

Cameron, T. A. and Quiggin, J. (1994) Estimation Using Contingent Valuation Data from A ‘Dichotomous Choice with Follow-Up Questionnaire. *Journal of Envtal Economics and Management*, 27(3):218-34.

Carter, M.R., F, Galarzaand. S, Boucher, (2007) Underwriting Area-based Yield Insurance to Crowd-in Credit Supply and Demand. https://arefiles.ucdavis.edu/uploads/filer_public/2014/06/19/savings_and_dev.pdf[Accessed 3 January 2015]

Chakravarti, J. S. (1920) Agricultural Income: A Practical Scheme Suited to Indian Conditions. Banaglore, India: *Government Press.*

Chris, (2012) Seed Investors The who, what, where and how of African agriculture investing [Online] Available at: http://seedinvestors.blogspot.com/2012/12/beira-agricultural-growth-corridor-bagc.html[Accessed 27August 2015]

Clover, T.A. and W.L. Nieuwoudt, (2003) An economic evaluation of area yield insurance for small-scale cane growers. Dvl. Southern Afr., 20: 293-305.

Cole, S., Tobacman, J., and Topalova, P. (2008) Weather Insurance: Managing Risk through an Innovative Retail Derivative. Working paper, Harvard Business School, Cambridge, MA and The International Monetary Fund, Washington, DC.

Concina L., (2014) Risk attitude & economics. Number 2014-01 of Les Regards, Foundation for an industrial safety culture, Toulouse, France. Available at: http://www.foncsi.org/.

Coughlin, P. E. (2006) Agricultural Intensification in Mozambique Infrastructure, Policy and Institutional Framework When Do Problems Signal Opportunities? http://www.keg.lu.se/en/sites/keg.lu.se.en/files/a1.pdf. [Accessed 2 January 2015]

Crane, L. G. (2013) Introduction to Risk Management. Understanding Agriculture Risk: Production, Marketing, Financial, Legal, Human Resources. *Extension Risk Management Education and Risk Management Agency*.

Danso-Abbeam, G., K.N. and D.E. (2014) Willingness to Pay for Farm Insurance by Smallholder Cocoa Farmers in Ghana. *American Research Institute for Policy Development* , 2(1): 163-183.

Deng, X., Barnett, B.J., Hoogenboom, G., Yu, Y. & Garcia, A. (2006), Evaluating the Efficiency of Crop Index Insurance Products, Orlando, Florida. Retrieved from http://purl.umn.edu/35333 [Accessed1 2 December 2015]

Deng, X., Barnett,J., Yingzhuo Y., and Hoogenboom, G. (2005) Managing Crop Production Risk with Crop Index Insurance Products. http://ageconsearch.umn.edu/bitstream/35607/1/sp05de01.pdf. [Accessed 2 December 2014]

Donovan, C. and Tostão, E. (2010) Staple Food Prices in Mozambique. Prepared for the COMESA policy seminar on "Variation in staple food prices: causes, consequences and policy options. Maputo, Mozambique, 25-26 January, 2010.

Eidman, V.T. (1990) Quantifying and Managing Risk in Agriculture. *Agrekon*, 29(1):11-23.

Falola, A. and Ayinde, O. E. (2013) Willingness to Take Agricultural Insurance by Cocoa Farmers in Nigeria. *International Journal of Food and Agricultural Economics*, 1(1): 97-107.

Familusi, L. D.,Diriba, S., Aniambossou, I., Comé, E., Masika, V., Niyomwungere, Z., Maluwa, K., Metaferia, S., & Ndaro, Z (2015) Comparative Advantage of Tomato Production Between Mozambique And South Africa: An Application of Domestic Resource Cost (DRC) Analysis. *VEF Journal of Agriculture, Rural and Community Development*, 2(1): 1-9.

FAO(Food and Agriculture Organization), (2007) Promoting Integrated and Diversified Horticultur Production in Maputo Green Zones towards a stable Food Security System. Rua de Mukumbura, Maputo, Mozambique.

Fraser, R., (1992) An analysis of willingness-to-pay for crop insurance. *Australian Journal of Agricultural Economics*, 36(1): 83-95.

Gebremariam, G. G. & Edriss, A. K., (2012) Valuation of Soil Conservation Practices in Adwa Woreda, Ethiopia: A Contingent Valuation Study. *Journal of Economics and Sustainable Development*, 3(12): 97-107.

GFDRR (Global Facility for Disaster Reduction and Recovery), (2012) Mozambique: Disaster Risk Financing and Insurance Country Note.

http://www.gfdrr.org/sites/gfdrr.org/files/DRFICountryNote_Mozambique_Jan072013_Final.pdf. [Accessed 5 February 2014]

Goo, K.M. (2007) Innovative agricultural insurance products and schemes. Agricultural Management, Marketing and Finance Occasional Paper 12. http://www.microfinancegateway.org/sites/default/files/mfg-en-paper-innovative-agricultural-insurance-products-and-schemes-2007.pdf. [Accessed 15 October 2014]

Goodwin, B.K., (1993) An Empirical Analysis of the Demand for Multiple Peril Crop Insurance. American Journal of Agricultural Economics, 75, 425-434.

Greene W.H., (2000) Econometric Analysis, 4th ed. Upper Saddle River, N.J.: Prentice Hall, Inc.

Greene, W.H. (2003) Econometric Analysis.5th Edition. New York: *Macmillan Publishing*.

Guanziroli, C. E., (2011)Increasing Agricultural Production and Productivity in Mozambique.http://www.theigc.org/wp-content/uploads/2015/02/Guanziroli-2011-Working-Paper.pdf. [Accessed 22 June 2014]

Haab, T. and McConnell,K. (2002)Valuing Environmental and Natural Resources: The Econometrics of Non Market Valuation. *Edward Elger Publishing Limited*, Glensada House, Cheltenham.

Haab, T.C, and K.E. McConnel (1997) Referendum model and Negative Willingness to Pay: Alternative Solutions. *Journal of Environmental Economics and Management*, 32 (251-270).

Hamela, H. and Manhicane, T.(2013) Non-Fiscal Barriers to the Agriculture Development in Mozambique. http://www.speed-program.com/wp-content/uploads/2014/01/2013-SPEED-Report-006-Non-Fiscal-Barriers-to-Agriculture-in-Mozambique-EN.pdf. [Accessed 2 February 2015]

Hanemann, M., Loomis, J. and Kanninen, B., (1991) Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics*, 73, 1255-1263.

Harwood, J., R. Heifner, K. Coble, J. Perry and A. Somwaru, (1999) Managing Risk in Farming: Concepts Research and Analysis. Agricultural Economic Report No. 774. Economic Research Service, USDA.

Hess, U., (2003) Innovative financial services for rural India: Monsoon-indexed lending and insurance for small holders. Agriculture and Rural Development Working paper 9 http://www.ruralfinance.org/fileadmin/templates/rflc/documents/Innovative_Financial_Services_for_Rural_India.pdf [Accessed 23 January 2015]

IFAD,(International Fund for Agricultural Development), (2014) *Investing in rural people Rural poverty in Mozambique.* Rome, Italy.http://www.ifad.org/operations/projects/regions/pf/factsheets/angola.pdf. [Accessed 28 January 2015]

Iturrioz, R. (2009) Agricultural Insurance. Washington, DC 20433: The World Bank. http://siteresources.worldbank.org/FINANCIALSECTOR/Resources/Primer12_Agricultural_Insurance.pdf. [Accessed 28 October 2014]

Jiang, F. (2013) Application of a Bivariat Probit Model to Investigate the Intended Evacuation fromHurricane. *FIU Electronic Theses and Dissertations. Paper 883*. http://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1999&context=etd. [Accessed 23 November 2014]

Klein, B., R. Meyer, A. Hannig, J. Burnett and M. Fiebig (1999) Better Practices in Agricultural Lending, Agricultural Finance Revisited Report No. 3, FAO, Rome, Italy.

Kouame, E. B. H., and Komenan, A. (2012) 'Risk preferences and demand for insurance underprice uncertainty: An experimental approach for cocoa farmers in Cote D'Ivoire', ILO Microinsurance Innovation Facility Research Paper No. 26, Geneva: International Labour Organization.

Kumar, S., Barah, B.C., Ranganathan, C.R., Venkatram, R., Gurunathan,S. & Thirumoorthy, S. (2011) An Analysis of Farmers' Perception and Awareness towards Crop Insurance as a Tool for Risk Management in Tamil Nadu *Agricultural Economics and Policy Research Review*, 24: (38-43).

Kun, E., Y.C. Cifci, M. Birsin, A.C. Ulger, S. Karahan, N. Zencirci, A. Oktem, M. Guler, N. Yilmaz, M. Atak (2004) Tahılveyemeklikdanebaklagillerüretimi. TürkiyeZiraat Mühendisliği Odas IV. TeknikKongresi, 367-407, Ankara

Kwadzo, G. T.M., Korwunor, J.K.M. & Amadu, I. S. B. (2013) Food crop Farmer's Willingness to participate in Market-based Crop insurance scheme: Evidence from Ghana. *Research in Applied Economics*, 5 (1):1-17.

Lapenu, C. (2000) The Role of the State in Promoting Microfinance Institutions. FCND Discussion Paper N° 8: Food Consumption and Nutrition Division. Washington: International Food Policy Research Institute.

Liao, T.F., 1994, Interpreting Probability Models (Logit, Probit and Other Generalized Linear Models), Sage Publications, Thousand Oaks, London.

Mahat, F., Nasir, A. M., & Ali, N. A. (2010) The Mediating Effects of Risk Tolerance on Fund Performance. International Journal of Business and Social Science, 1(2), 89-102.

Makaudze, E., M. and Miranda, M., J., (2009) Catastrophic Drought Insurance Based on the Remotely Sensed Normalized Difference Vegetation Index for Smallholder Farmers in Zimbabwe. AAAE Third Conference/AEASA 48th Conference. https://agriskmanagementforum.org/sites/agriskmanagementforum.org/files/Documents/142.%20Catastrophic%20drought%20insurance%20in%20Zimbabwe.pdf. [Accessed 15 July 2015]

McNair, W. E. (2015) Conservation Agriculture and Household Wellbeing: A Non-Causal Comparison among Smallholder Farmers in Mozambique . *Journal of Agricultural Science, 7(1-14)*

Mezgebo, A., Tessema, W. and Asfaw, Z., (2013) Economic Values of Irrigation Water in Wondo Genet District, Ethiopia: An Application of Contingent Valuation method. *Journal of Economics and Sustainable Development*, 4 (2); 23-36.

Miller, Alan C. D. (2004) *Risk Management For Farmers.*Department of Agricultural Economics, West Lafayette, Indiana.http://core.ac.uk/download/pdf/7089262.pdf. [Accessed 26 November 2014].

Miranda, M.J. (1991) Area-Yield crop insurance reconsidered. *American Journal of Agricultural Economics*, 73(2): 233-242.

Miranda, M.J. and P.L. Fackler, (2002) Applied Computational Economics and Finance. Cambridge: The MIT Press.

Mitchell, R. and R. Carson (1989) Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future. Washington, DC: 484.

Mohammed, M. A., & Ortmann, G. F. (2005) Factors influencing adoption of livestock insurance by commercial dairy farmers in three Zobatat of Eritrea. *Agrekon*, 44(2), 172-186.

Morgan, K.L, A. C. (2004) A Probit Model Analysis of Factors Affect Consumption of Fresh Sweet Corn in Major U.S. Marketshttp://ageconsearch.umn.edu/bitstream/34692/1/sp04mo01.pdf. [Accessed 7 November 2014]

Mortgat, C. P. (2012) Agricultural Risk Micro Insurance Product for Mozambique

MPD-DNEAP (Ministry of Planning and Development- National Directorate of Studies and Policy Analysis), (2010) Poverty and Well-being in Mozambique: The Third National Assessment.

Myerson, R. B. (2005) Probability models for economic decisions. Thomson/Brooke/Cole.

Myyrä, S., Liesivaara, P. and Väre, M., (2014) Willingness to Pay for Agricultural Crop Insurance. http://ageconsearch.umn.edu/bitstream/182855/2/ID_176_Poster_paper.pdf. [Accessed 28 December 2014]

Nagler, J., (1994) Interpreting Probit Analysishttp://www.nyu.edu/classes/nagler/quant2/notes/probit1.pdf. [Accessed 8 September 2014]

Nelson, C.H., (1990) The influence of distributional assumptions on the calculation of crop insurance premia. *North Central Journal of Agricultural Economics,* 12(1): 71-78.

Norris, E. and Batie, S. (1987) Virginia Farmers' Soil Conservation Decisions: An Application of Tobit Analysis. Southern Journal of Agricultural Economics, 19:89-97.

OECD (Organization for Economic Co-Operation and Development), (2012) *Estimating The Constraints To Agricultural Trade Of Developing Countries.* COM/DCD/TAD(2012)16/REV2

OECD (Organization for Economic Co-Operation and Development), (2001) Decoupling: A conceptual overview, Paris

Olila, D. O. (2014) Determinants of Farmers' Awareness about Crop Insurance: http://ageconsearch.umn.edu/bitstream/165997/2/8th%20EgertonOlila.pdf. [Accessed 22 January 2015]

Pittenger, D. R. (2002) Introduction to horticulture: what plants are, how they grow, how they function. Oakland, University of California Division of Agriculture and Natural Resources Publication 3382: 5-28.

Pomme, O. M. (2007)Scaling Up Microinsurance: The Case of Weather Insurance for Smallholders in India.Agriculture and Rural Development Discussion Paper 36. http://siteresources.worldbank.org/INTARD/Resources/ScalingUpMicroinsurance.pdf. [Accessed 12 December 2015]

Poulton, C., J. Kydd, S. Wiggins and A. Dorward (2006) State Intervention for Food Price Stabilization in Africa: Can It Work? Food Policy, 31(4): 342–356.

Pryanishnikov, I. and Katarina, Z. (2003) Multinomial Logit Model for Australian Labour Market. *Australian Journal of Statistics*, 4:267-282.

Rahman, I. (2012). Agricultural insurance schemes for the development. *The 3rd International Symposium "Agrarian Economy and Rural Development - realities.* Romania: econstor.

Rahman, S. (2014). Determinants of crop choice by Bangladishi Farmers: A Bivariate Probit Analysis. *Asian Jornal of Agriculture and development, 5(1*): 30-32.

Ratnasari, V. p. (2010) Estimation and Test Stataistic in Bivariate Probit Model. *Journal of Basic and Applied Scientific Resarch*, 1(3): 178-178.

República de Moçambique Ministério da Administração Estatal (2005) Perfil do Distrito de Moamba, Provincia de Maputo. Maputo: Ministério da Administração Estatal.

Rothschild, M. and Stiglitz, J., (1976) Equilibrium in Competitive Insurance Markets Quarterly. *Journal of Economics* 93: 541-562.

Santeramo, Fabio G. & Goodwin, Barry K. & Adinolfi, Felice & Capitanio, Fabian, (2013) Revisiting the Demand for Crop Insurance: Evidences from the Italian Market. http://ageconsearch.umn.edu/bitstream/150184/2/AAEA_Poster.pdf. [Accessed 2 December 2015]

Schelling, N. (2014)*Horticulture and Potato Market Study in Mozambique.* http://agriprofocus.com/upload/HorticultureandPotatoMarketStudyinMozambique1417448632.pdf. [Accessed 15 December 2015]

Sherrick, B. J., Barry, P. J., Ellinger, P. N., & Schnitkey, G. D. (2004). Factors influencing farmers' crop insurance decisions. American Journal of Agricultural Economics, 86(1), 103-114.

Skees, R.J., J.R. Black and B.J. Barnett, (1997) Designing and rating an area yield crop insurance contract. Am. J. Agric. Econ., 79: 430-438

Smith, V. H. (2009) Index Based Agricultural Insurance In Developing countries Scalability and sustainability. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.476.4002&rep=rep1&type=pdf. [Accessed 19 March 2015]

Smith, V.H., H.H. Chouinard, and A.E. Baquet (1994) Almost Ideal Area Yield Crop Insurance Contracts. *Agricultural and Resource Economics Review*, 23.75-83.

SSA/Statistics South Africa Census (2011) Pretoria: Statistics South Africa; 2012: Ref. URL http://www.statssa.gov.za/#sthash.I4aEImsM.dpuf. [Accessed 10 May 2015]

Sun, X. and F. Zhong (2009) Analysis of Influencing Factors to the Efficiency of Agricultural Insurance Subsidy-A Data Research of Willingness-To-Pay in Xinjiang, Heilongjiang and Jiangsu Province. *Journal of Guangdong University of Finance* 24(4):112-119.

Teshome, H. A. (2014) Willingness to pay for Rainfall based Insurance by Smallholder Farmers in Central Rift Valley of Ethiopia: The Case of Dugda and Mieso Woredas. *Asia Pacific Journal of Energy and Environment*, 1(2): 121-153.

Thanh, T. C., Hoa , T. P., & Phuong, N. T. (2015, 10 26). Area yield crop insurance in Vietnam An Analysis from the Demand Side. Vietnam. Retrieved 10 25, 2015, from http://mernetwork.org/wp-content/uploads/2015/05/Area-yield-crop-insurance-Final.pdf

Trefina, M. A. (2010) Improving access to credit for smallholder farmers in Mozambique: Lessons from government efforts in developing countries of Africa and Asia. http://repository.up.ac.za/bitstream/handle/2263/27157/dissertation.pdf?sequence=1&isAllowed=y. [Accessed 7 January 2015].

UNISDR (United Nations International Strategy for Disaster Reduction), (2009) Global Assessment Report on Disaster Risk Reduction, Geneva.

USAID (United State Agency for International Development), (2015) Education. https://www.usaid.gov/mozambique/education. [Acceesed 10 October 2015]

Vandeveer, M. L., (2000) Demand for area crop insurance among litchi producers in northern Vietnam. *Agricultural Economics*, 26, 173-184.

Velandia, M. R. (2009) Factors Affecting Farmers' Utilization of Agricultural Risk Management Tools: The Case of Crop Insurance, Forward Contracting, and Spreading Sales. *Journal of Agricultural and Applied Economics*, 41(1): 107–123.

Walsh, K.R., & Schneider, H. (2002) The role of motivation and risk behavior in software development success. Information Research, 7 (3) [Available at http://InformationR.net/ir/7-3/paper129.html

World Bank. (2005) Managing Agricultural Production Risk: Innovations in Developing Countries. *International Bank for Reconstruction and Developmen*, 130-144.

World Bank. (2009) Index-based Crop Insurance in Senegal: Promoting Access to Agricultural Insurance for Small Farmers . 57-64.

World Bank. (2011) Weather Index Insurance for Agriculture: Guidance for Development Practitioners. Agricultural and rural discussion paper 50; Washington, DC: World Bank.

Yadav, L., van Rensburg, T., Kelley, H. (2012) A comparison between the conventional stated preference technique and an inferred valuation approach. *Journal of Agricultural Economics*, 64(2): 405-422.

Yusuf, K., K. (2010) Insurance Options in Risk Management in Agriculture Finance. Being the full text of paper presented on the occasion of the AFRACA Conference in Abuja.

Zeng, X., F. Xiu and J. Jia, (2009) Empirical Analysis of Purchase Intention for Cow Farmers in Shaanxi Province. Insurance Studies, 8: 77-83.

Appendix I: Questionnaire

I. Socio-economic Characteristics of the Respondents

Questioners	**Answer**
1.Gender (0= male, 1=female)	
2. Marital status ; 1= Married, 0 = Partnered)	
3. Educational status (0=illiterate, 1=grade1-6, 2=grade 7-12, 3=college and Bsc degree and 4= Msc and above)	
4. Family size(No)	
5. Farm size (Ha)	
6. On-farm Income (MZN)	
7. Access to extension services; 1= if farmers have an extension service , 0 otherwise	
8. Off farm-income (MZN)	
9. Loan condition (1= if farmers had access to loanfrom financial institution , 0 =otherwise)	

10. How long have you been producing tomato ?(experience)__________
11. How many hectares of tomato did you cultivate in last season?

a. 0-0.50 ha
b. 0.50-1 ha,
c. 1-2 ha
d. 2-3 ha
e. 3-5 ha;
f. 5 ha and above

12. How many kg of tomatoes per hectare did you get in last season?

a. <5000 kg
b. 50001-15,000 kg
c. 15,001-30,000 kg
d. 30,001-50,000 kg
e. 50,000kg and above

13. Which horticulture crop had the greatest area coverage in the last season?

a. Tomato b. Potato c. Cabbage d. Other

II. Estimating willingness to pay for tomato insurance

14. Are you willing to pay for tomato insurance

a. A. Yes b. No

If No, thank the respondent for his time and participation, finish the interview

15. If yes, would you be willing to pay {1.5 ton/ha, 1.43 ton/ha, 1.4ton/ha, 1.32 ton/haand 1.26 ton/ha} ________?

a. Yes b. No

16. If your answer to questionnaire 15 is “ yes” select higher bid and for the farmer who respond “no”, select the smaller bid for the follow up question, by asking what about if it increased /reduced to {2.25 ton/ha, 2.23 ton/ha, 2.22 ton/ha, 1.47 ton/ha and 1.35 ton/ha}, ____________amount, will you be willing to pay?

a. Yes b. No

17. Based on your main problem in crop production, what type of agricultural insurance do you want for your crop production? (after explaining well-known agricultural insurance)_________

a. flood insurance
b. revenue insurance
c. production insurance
d. MPCI
e. price insurance
f. drought insurance
g. rainfall insurance

III. Factors affecting tomato production

Category	pest	Disease	High Temperature	Variation in yield	Flood	Drought
Yes =1						
No=0						

18. Are you producing tomato even though its price is highly volatile in the market and it is attacked by pest and disease and easily perishable and vulnerable to adverse conditions? (A farmer who continues producing tomato is considered as risk taker, farmer who shift to others crop is considered risk averse and a farmer who is in between to continue and shift to other crop is considered as a risk neutral behavior)

a. Risk averse b. Risk neutral c. Risk taker

Appendix II: Correlation Matrix

(obs=75)

	WTP1	WTP2	bid1	bid2	ag	gd	insflood	insrev~e	insmpci	marstat	tom	risk	farmsiz
WTP1	1.0000												
WTP2	0.3904	1.0000											
bid1	-0.1561	-0.0267	1.0000										
bid2	0.8190	0.8115	-0.0237	1.0000									
ag	-0.2939	0.0609	-0.1249	-0.1139	1.0000								
gd	0.1758	0.0077	-0.0164	0.0940	-0.0075	1.0000							
insflood	0.1382	0.1965	0.1445	0.2333	0.0937	-0.0164	1.0000						
insrevenue	-0.0969	-0.1625	-0.0110	-0.2046	0.0367	0.0884	-0.2761	1.0000					
insmpci	0.0536	0.0238	-0.1241	0.0653	-0.0319	0.0803	-0.3513	-0.2667	1.0000				
marstat	-0.1008	-0.0700	-0.0240	-0.1073	0.1915	0.2026	0.0847	0.0700	-0.0026	1.0000			
tom	0.1090	0.0169	-0.0239	0.0725	-0.0147	-0.0553	0.1448	0.0536	-0.0687	0.0138	1.0000		
risk	0.0049	0.0918	0.0704	0.0552	0.0040	0.1214	-0.0088	0.0629	0.2406	-0.0620	0.2087	1.0000	
farmsiz	-0.0747	-0.0140	0.1018	-0.0554	0.0428	-0.1457	-0.0698	0.2454	-0.1456	0.1864	-0.0385	-0.0004	1.0000
acext	-0.0080	-0.0796	0.0066	-0.0287	-0.0156	0.1494	0.1824	-0.0045	-0.0508	0.1871	-0.0535	-0.1390	0.0018
offinc	0.0930	0.0535	-0.0438	0.0886	0.1414	-0.0030	0.1735	-0.0665	-0.0570	0.3398	0.0915	-0.2053	0.2905
ageeee	-0.3008	0.0624	-0.1213	-0.1186	0.9877	-0.0505	0.1140	0.0254	-0.0294	0.1783	-0.0047	0.0126	0.0479

	acext	offinc	ageeee
acext	1.0000		
offinc	0.0721	1.0000	
ageeee	-0.0503	0.1295	1.0000

Appendix III: Probit Model Results

Probit regression		Number of obs	=	75
		Wald chi2(13)	=	21.29
		Prob > chi2	=	0.0673
Log pseudolikelihood = -39.109167		Pseudo R2	=	0.2020

answer1	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
b3	-.8482769	.5692525	-1.49	0.136	-1.963991	.2674376
b2	-.2428096	.5866363	-0.41	0.679	-1.392596	.9069764
ag	-.0342862	.0108433	-3.16	0.002	-.0555387	-.0130336
gd	1.123265	.6106394	1.84	0.066	-.073566	2.320096
insflood	.8507898	.4776395	1.78	0.075	-.0853665	1.786946
insrevenue	.0285489	.4770007	0.06	0.952	-.9063552	.9634531
insmpci	.4781801	.4849356	0.99	0.324	-.4722762	1.428636
marstat	-.7952147	.5694901	-1.40	0.163	-1.911395	.3209653
tom	.3831721	.3196221	1.20	0.231	-.2432757	1.00962
risk	-.2363484	.4278478	-0.55	0.581	-1.074915	.602218
farmsiz	.0004487	.0029662	0.15	0.880	-.0053649	.0062622
acext	-.3192853	.4315304	-0.74	0.459	-1.165069	.5264987
offinc	.0000215	.0000152	1.42	0.156	-8.20e-06	.0000513
_cons	2.194296	.7542369	2.91	0.004	.7160186	3.672573

Appendix IV: Marginal effect of Probit Model

```
Marginal effects after probit
      y  = Pr(answer1) (predict)
         =  .68468965
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
b3*	-.3088706	.20818	-1.48	0.138	-.716895	.099154	.36
b2*	-.0853844	.20535	-0.42	0.678	-.487859	.31709	.573333
ag	-.0121849	.00381	-3.20	0.001	-.019657	-.004713	45.0933
gd*	.3044914	.10772	2.83	0.005	.093371	.515612	.16
insflood*	.2651265	.12328	2.15	0.032	.023499	.506754	.266667
insrev~e*	.0100998	.16799	0.06	0.952	-.319149	.339348	.173333
insmpci*	.1584854	.14643	1.08	0.279	-.128519	.44549	.253333
marstat*	-.3049678	.21704	-1.41	0.160	-.730357	.120421	.106667
tom*	.13504	.1126	1.20	0.230	-.085646	.355726	.48
risk*	-.0818104	.14344	-0.57	0.568	-.362947	.199326	.706667
farmsiz	.0001595	.00105	0.15	0.880	-.001906	.002225	31.6467
acext*	-.1080819	.13727	-0.79	0.431	-.37712	.160956	.773333
offinc	7.65e-06	.00001	1.40	0.160	-3.0e-06	.000018	2097.78

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

Appendix V: Bivariate probit model results

```
Seemingly unrelated bivariate probit              Number of obs   =         75
                                                  Wald chi2(24)   =      43.48
Log likelihood = -55.748335                       Prob > chi2     =     0.0088
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
answer1						
b3	-.721816	.7126355	-1.01	0.311	-2.118556	.674924
b2	.2956693	.6485834	0.46	0.648	-.9755309	1.566869
ag	-.0411976	.0131549	-3.13	0.002	-.0669809	-.0154144
gd	1.248952	.5603173	2.23	0.026	.1507504	2.347154
insflood	1.114862	.5187494	2.15	0.032	.0981322	2.131593
insrevenue	.0359296	.487754	0.07	0.941	-.9200506	.9919099
insmpci	.7534301	.4672605	1.61	0.107	-.1623836	1.669244
marstat	-.956075	.6103322	-1.57	0.117	-2.152304	.240154
tom	.4161554	.3850131	1.08	0.280	-.3384565	1.170767
risk	-.3534653	.4558872	-0.78	0.438	-1.246988	.5400572
acext	-.3289079	.4426551	-0.74	0.457	-1.196496	.5386801
offinc	.0000186	.0000338	0.55	0.581	-.0000476	.0000849
_cons	2.154589	1.029035	2.09	0.036	.137717	4.171461
answer2						
d3	8.680636	69454.9	0.00	1.000	-136120.4	136137.8
d2	1.969146	.5488036	3.59	0.000	.893511	3.044782
ag	.0261518	.0141287	1.85	0.064	-.0015398	.0538435
gd	-.3564846	.7453897	-0.48	0.632	-1.817422	1.104452
insflood	.4700583	.5062272	0.93	0.353	-.5221287	1.462245
insrevenue	.1409384	.5271216	0.27	0.789	-.892201	1.174078
insmpci	-.2397692	.5972125	-0.40	0.688	-1.410284	.9307457
marstat	.0795286	.7083281	0.11	0.911	-1.308769	1.467826
tom	-.1539639	.4957027	-0.31	0.756	-1.125523	.8175955
risk	.0899675	.5845374	0.15	0.878	-1.055705	1.23564
acext	.035141	.6212988	0.06	0.955	-1.182582	1.252864
offinc	.0000415	.0001061	0.39	0.696	-.0001665	.0002494
_cons	-1.985373	1.10723	-1.79	0.073	-4.155504	.1847582
/athrho	-19.90716	980.1348	-0.02	0.984	-1940.936	1901.122
rho	-1	0			-1	1

```
Likelihood-ratio test of rho=0:     chi2(1) =  9.50681    Prob > chi2 = 0.0020
```

Appendix VI: Marginal effects of bivariate probit model

```
Marginal effects after biprobit
      y  = Pr(answer1=1,answer2=1) (predict)
         =  .70298908
```

variable	dy/dx	Std. Err.	z	P>|z|	[95%	C.I.]	X
b3*	-.2577002	.25556	-1.01	0.313	-.758585	.243185	.36
b2*	.1031974	.22758	0.45	0.650	-.342858	.549252	.573333
ag	-.014239	1.74563	-0.01	0.993	-3.43561	3.40713	45.0933
gd*	.3122009	36.984	0.01	0.993	-72.1748	72.7992	.16
insflood*	.318524	23.845	0.01	0.989	-46.4161	47.0531	.266667
insrev~e*	.0124292	8.13675	0.00	0.999	-15.9353	15.9602	.173333
insmpci*	.2292231	19.878	0.01	0.991	-38.7301	39.1885	.253333
marstat*	-.3631395	4.80271	-0.08	0.940	-9.77629	9.05001	.106667
tom*	.1425307	10.485	0.01	0.989	-20.4069	20.6919	.48
risk*	-.116874	6.40841	-0.02	0.985	-12.6771	12.4434	.706667
acext*	-.1077232	2.42672	-0.04	0.965	-4.864	4.64856	.773333
offinc	6.48e-06	.00277	0.00	0.998	-.005417	.00543	2097.78
d3*	.5439697	.09637	5.64	0.000	.355082	.732858	.426667
d2*	.001175	115.66	0.00	1.000	-226.696	226.699	.28

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

Appendix VII: Estimation of MWTP using probit model

```
Iteration 0:   log likelihood = -49.006365
Iteration 1:   log likelihood = -48.072603
Iteration 2:   log likelihood = -48.071458
Iteration 3:   log likelihood = -48.071458

Probit regression                                 Number of obs   =         75
                                                  LR chi2(1)      =       1.87
                                                  Prob > chi2     =     0.1715
Log likelihood = -48.071458                       Pseudo R2       =     0.0191
```

WTP1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
bid1	-3.161016	2.34062	-1.35	0.177	-7.748547	1.426515
_cons	4.825917	3.314354	1.46	0.145	-1.670098	11.32193

Appendix VIII: Estimation of MWTP using bivariate probit model

```
Iteration 10:   log likelihood = -50.722527

Seemingly unrelated bivariate probit              Number of obs   =         75
                                                  LR chi2(2)      =      54.61
Log likelihood = -50.722527                       Prob > chi2     =     0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
WTP1						
bid1	-3.63082	2.190117	-1.66	0.097	-7.92337	.6617311
_cons	5.484925	3.10144	1.77	0.077	-.5937848	11.56364
WTP2						
bid2	3.868702	1.498623	2.58	0.010	.9314545	6.805949
_cons	-5.399576	2.013344	-2.68	0.007	-9.345658	-1.453495
/athrho	-11.32574	564.2	-0.02	0.984	-1117.137	1094.486
rho	-1	3.28e-07			-1	1

```
Likelihood-ratio test of rho=0:     chi2(1) =  14.8202    Prob > chi2 = 0.0001
```