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Smallholder Farmers' Willingness to Pay for Weather Index based Crop Insurance in Mieso, West Hararghe, Oromia National State

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Gonfa Ejeta

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Smallholder Farmers' Willingness to Pay for Weather Index based Crop Insurance in Mieso, West Hararghe, Oromia National State

A Thesis Submitted to College of Agriculture and Environmental sciences
Department of Agricultural Economics

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In Partial Fulfillment of the Requirements for the Degree of
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I hereby certify that I have read and evaluated this Thesis Smallholder Farmers' Willingness to Pay for Weather Index based Crop Insurance in Mieso, West Hararghe , Oromia National State, by Gonfa Ejeta. I recommend that it be submitted as fulfilling the thesis requirement.

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DEDICATION

I dedicate this thesis manuscript to my role model and my mother Warki Iticha Gelashe.

STATEMENT OF THE AUTHOR

This is a M.Sc. thesis submitted to the Haramaya University and expected to be reserved in the University Library for reference. I would like to then declare that this thesis should not be submitted to third parties for the purpose of academic award. This thesis is my work and all sources of materials used have been duly acknowledged.

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BIOGRAPHY

The author was born in 12th November 1972 in Ilu Woreda, South West Showa Zone of Oromiya Region. He attended his elementary and secondary school education at Fitewurari Habtegiorgis Abamechal and Hibret Fire secondary school in Tullu Bollo Town respectively. Upon his successful completion of his high school education he joined Asella Teachers Training College In 1996. He joined Western Hararghe Education Office and he had served in different sectors there and he joined Haramaya University for his BSc degree in 2008. He had graduated in Economics at the end of 2011. He attended his post graduate study in Rural Development and Agricultural Economics at Haramaya University during 2013. Currently the author is working in Awash Insurance Company S.C as a Manager, Dire Dawa Branch. The author is married and the father of a son and four daughters.

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ABBREVATION AND ACRONYMS

AWS	Automated Weather Stations
CVM	Contingent Valuation method
EADI	Ethiopian Agricultural Drought Index
ECI	Ethiopian Insurance Cooperation
FAO	Food and Agricultural Organization of the united Nations
FSD	Financial Sector Deepening
HARITA	Horn of Africa Risk Transfer and Adoption project
IFAD	International Fund for Agricultural Development
IFW	Insurance for Work
ICRI	International Climate Research Institute
LPM	Linear probability Model
NISCo	Nyala Insurance Share Company
OA	Oxfam America
PA	Peasant Association
PASDEP	Plan for Accelerated and sustainable Development to End Poverty
PSNP	Productive Safety Net Programme
SDPRP	Sustainable Development and Poverty Reduction Programme
SFSA	Syngenta Foundation for Sustainable Agriculture
SSA	Sub Saharan Africa
VIF	Variance Inflation Factor
WFP	World Food Programme

WTP	Willingness to Pay

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Smallholder Farmers' Willingness to Pay for Weather Index Based Crop Insurance in Mieso, West Hararghe Oromia National State

ABSTRACT

Weather index based insurance has been one of the recommended risk transfer mechanisms to support smallholders in coping with production risks. The objectives of this study were to identify the factors affecting farm households' WTP for crop insurance and estimate the mean amount of farmers' willingness to pay for the proposed insurance scheme in the study area. To do this, a multi stage simple random sampling techniques was used to select 153 sample households from three sample kebeles in the district, which were selected out of 29 agro-pastoral kebekes; and semi structured questionnaire with face to face interviews was used to collect the data. Descriptive statistics, Double Bounded Contingent Valuation Method and Bivarate Probit Model were used for the analysis of the survey data. Sample farm households were categorized based on their joint responses to the offered bids (Bid one and follow bid).The response of households in the double bounded contingent valuation method reveals that the first response is shared by 79.08% of Yes and 20.92 % of No responses; whereas the sample households' response to the second bid is shared by 69.93% of Yes and 30.06% of No responses. The bivariat probit model estimate result revealed that among fourteen explanatory variables included in the model, six variables TLU, bid one, annual income , access to media, age of household head and Household size have significant effect on WTP at bid one level and seven variables age, TLU, annual income, household size, extension visit, availability of private and public aid, and follow bid have significant effect on farmers' WTP at follow bid level in study area . The mean WTP for bid one is 191.68ETB per hector, where as the mean WTP by farm households for follow bid is 2942.5ETB per hector. Finally the study recommends that policy makers need to aware and act on different socioeconomic and institutional characteristics of households' that influence their WTP for crop insurance. Besides, the study result showed there is a big difference in the mean WTP at bid one and follow bid levels and needs the government and stockholders to finance and support the scheme.

Key wards: Weather index Based Crop Insurance, WTP, Double Bounded CVM and Bivarate Probit Model.

1. INTRODCUTION

1.1. Background of the Study

Weather shocks in agriculture present adverse conditions for billions of poor farmers in the developing world (Wheeler and von Braun, 2013; Brown and Kshirsagar, 2015).These Weather shocks will affect agricultural production through higher mean temperatures and more frequent weather extremes, *(*Kenneth *et al*., 2017). The smallholder farmers are particularly vulnerable to these weather shocks, and the vulnerability of rain-fed agriculture to extreme weather conditions results in substantial income loss to farm households, and these households have little support from the government in the form of insurance cover to face the failure (Khant *et al*., 2004; Akheter, 2013).

As the adverse effect of climate change on agriculture, smallholder's farmers in Africa are desperately poor; they usually face extraordinary production risk challenges which increase the frequency of crop failure and livestock mortality. These frequent weather extremes are associated with risk-avoidance strategies, such as low uptakes of productivity-enhancing inputs and technologies (Dercon and Christiansen, 2011). A number of African countries are taking adaptation not as an option but as a necessity to improve the resilience of smallholder agricultural system to uncertain future impact of climate change. Thus, over the year's different risk management strategies that are either on-farm measures or risk sharing with others which include farm financing, share-cropping, price pooling arrangements, forward contracting of farm products, and hedging on future markets. Agricultural insurance as potential tool of transferring risk were used by these farm households (Hiwot and Ayalneh, 2014).

The farm households have limited capability to manage risks; informal risk-management strategies appear to be typically used in the absence of well-developed insurance markets. However, formal insurance market access is limited and though their functioning is not accurately understood by rural farmers (Smith, 2014).Therefore, weather index based insurance product for smallholder farmers has distinct advantages over traditional crop insurance since claims could paid by using the same index and premium rate for each policy holder in an area and avoid adverse selection and moral hazard problems. On the other hand, smallholder farmers have barrier to the uptake of new methods and insurance products in particular because they have been the lack of understanding and trust or i.e. clients' knowledge of the insurance products (Dercon*et al*., 2008). There is a clear correlation between the desires to purchase insurance products and level of product understanding, as insurance is a shock absorber for farmers, actors in the agricultural value chain, enables access to credit, and protects investments in better inputs and technologies which increase their productivity; and reduce the government's budget exposures to agricultural risks (Patt*et al*., 2010).

In Ethiopia, the capacity of small holder farmers to contract weather index based crop insurance is inadequate due to the extension of land plots, imperfect and inefficient financial markets; and the traditional insurance is damaged by information asymmetries, high administrative costs, and no diversifiable risks insurance By considering this issue the government was set to introduce weather index based crop insurance aiming to rescue smallholder farmers from unpredictable weather that damages their crops at macro and micro levels (IBLI, 2016).

On a macro level, the government of Ethiopia with the support of World food program (WFP) and the World Bank implemented the first index-based national drought insurance program of its kind in 2006 by using historical rainfall data from national metrological agency and crop-water balance model to develop Ethiopian Agricultural Drought Index (EADI). It targeted an estimated five million transiently food-insecure people, who face food insecurity risk when drought strikes; they are usually able to sustain themselves under normal weather conditions. Thus, the drought index insurance that releases adequate funds on time was great

importance on those households. The scheme was scaled up in 2007 to Livelihood Early Assessment Protection LEAPS (Niels and Ulrich, 2010).

In 2008 Ethiopia Insurance and Corporation (EIC) along with the World Bank in Alaba area (Southern region) and in 2009 Nyala Insurance S.C. (NISCO) in collaboration with World Food Program in Bofa area of Oromia regional state have piloted Weather Index Agricultural Insurance (Araya, 2011). The NISCO believes that, in spite of all challenges related with data, infrastructure, etc., it can play a critical market-based role to sustainable agricultural growth in the rural areas in particular in drought prone area of the country. However, poor literacy levels among farmers, the complexity of WII schemes and the need to convince intermediaries such as farmers' cooperatives has discouraged other insurance companies from offering crop insurance coverage (Elias, 2015).

According to all Africa Report (2017) tens of thousands of smallholder farmers in Ethiopia have benefited from the country's first weather index insurance payment to cover the loss for the previous year's crop failure due to El Nino. The weather index insurance payouts of 2.6 million birr were part of the pilot insurance initiative supported by UNDP, the Global Environment Facility, the country's Ministry of Environment, Forest and Climate Change. Therefore, for Ethiopian farmers dealing with the worsening impacts of climate change, small-scale crop insurance can be a lifesaver; but the insurance needs to expand and undergo some tweaks to effectively help and recover from extreme weather risks.

In Miseo West Hararghe rainfalls during the main rainy seasons are erratic, and crops fail in most years due to lack or irregular distribution of annual rain. Crop failures are much more regular since most of the rainfall is received in only few months, where most of the months are dry. As a result, recurrent drought is a major problem, and is making them rely on relief food aid in almost all kebeles of Mieso Woreda. In view of this issue, this study tries to examine farmers' WTP for the proposed WII service which is the up-to-date risk management strategies to cope up with the frequently incurring drought risk in the study area.

1.2. Statement of the Problem

Weather shocks can trap farm households in poverty, and the risk of shocks limits the willingness to invest in measures that might increase their productivity and improve their economic situation (WFP, 2011). Besides, they lack of access to weather based agricultural insurance which can reduce some of the problems associated with traditional, indemnity-based insurance programs, because of weather index based insurance contracts are not yet sufficiently tailored to the needs and preferences of them (Kenneth *et al*., 2016).

Ethiopia is one of the countries in SSA with poorly diversified production systems focusing on rain-fed staple crop production and rearing of livestock; and these activities are inherently risky investment and production decisions by farm households are made within environments that are affected by risk. Because of poorly developed or absent credit and insurance markets it is difficult to pass any of these risks to a third party. The index-based crop insurance which was introduced at macro level at different places enable poor households to better deal with weather-related shocks, which had frequently challenged those who depended on farming for livelihoods under natural conditions. The initiative was expected to improve their welfare in the short run and improve their opportunities for income growth in the long run (Yesuf and Bluffstone, 2007; Mebrahtu, 2014).

In spite of their better size of landholding and soil fertility, farmers in West Hararghe zone of Mieso Woreda are vulnerable to risk of recurrent drought and other weather related risks which are negatively affecting their livelihoods. Those farm households' are food insecure even in normal rainfall years due to abnormal rain distribution this is still a major issue (Hiwot and Ayalneh, 2014).

The limits of existing risk management strategies of agro-pastoral households of the study area to smooth income and consumption create a need for alternative or complementary strategies, such as weather index based crop insurance against a specific natural disaster. The decision made by these farm households to invest in agricultural production depends on the vagaries of weather has returns characterized by substantial uninsurable risk; markets for weather contingent securities to insure against this risk are limited and inaccessible to the majority of these farmers (Hiwot and Ayalneh)

A study has done on farmers' willingness to pay for weather index based crop insurance in Miseo Woreda, ten years ago. However, now days due to change in perception, market price, knowledge and attitude of farm households', introduction of new insurance markets, and extreme weather shock could result in substantial income loss of the farm households. A study which considers such specific problem of agro-pastoral households should be in place in the study area. Therefore, this study attempts to fill this gap by examining those factors affecting the farm households' willingness to pay and mean amount of premium that farmers' are willing to pay for crop insurance service in the study area.

This study therefore, is tried to assess the willingness of farmers' to pay for weather index based crop insurance by addressing the following research questions:

1. What are the major factors affecting farmers' willingness to pay for the weather index based crop insurance in the study area?

2. What is the mean amount of premium that farmers are willing to pay for weather index based insurance to get covers for their crop loss in Mieso Woreda?

1.3. Objectives of the Study

The main objective of the study is to assess the willingness of farmers' to pay for weather index based crop insurance in Mieso, West Hararge of Oromia National State.

The specific objectives of the study are:-

1. To identify factors that affect farmers' willingness to pay for weather index based crop insurance in the study area.
2. To estimate the mean premium amount that farmers' are willing to pay for weather index based crop insurance in the study area

1.4. Significance of the Study

The study aims to identify factors affecting and the mean premium amount farmers' WTP for weather index based crop insurance in the study area. Therefore, identifying smallholder farmer's willing to pay for weather index based crop insurance is likely helpful for policy makers in providing tangible information to propose informed decisions on when and how to intervene. Likewise, funding agencies and insurance companies, governmental or NGOs, engaged in development activities, those insuring rural resilience and food security programs will utilize the findings of the study. Besides, micro finance institutions, insurance service providers could utilize the result of the findings to properly intervene in the development process. Finally this study can be used as in put for further studies.

1.5. Scope and Limitations of the Study

The study was conducted to identify demographic, socio-economic and institutional factors these affecting farmers' willingness to pay, and to estimate mean amount of money smallholder farmers' willing to pay for weather index based crop insurance. Limitation of the study is farmers' interest in weather index insurance may be limited due to basis risk; and some farmers may not sufficiently understand weather index insurance and so may not purchase it, and a considerable portion of farmers may also require a subsidy if they are to purchase weather

index based crop insurance. Other limitation of the study was the absence of well documented weather related risk events data at all levels that is the absence of secondary data at grass root or kebele level. The proposed research is also limited to data collected from West Hararghe Agricultural Office and Miseo Woreda, Government Sectors. Thus; the study was focus on limited number of representatives and bounded by time due to the exiting resource and time constraints.

1.6. Organization of the Study

The thesis is organized into five sections. The first section presents an introduction part which includes background, statement of the problem, objective of the study, and the second section presents theoretical and empirical literature reviews and the third section presents the research methodology that describes the data and the methods used for analysis. The fourth and fifth section presents the results, findings and the summary, conclusion, and recommendations of the study respectively.

2. LITERATURE REVIEW

This section presents the concept of weather index based crop insurance service, risks in agriculture and risk management strategies by farm households; traditional crop insurance versus whether Index based insurance and empirical studies on willingness to pay for weather index based crop insurance.

2.1. Definition and Concepts

Willingness to pay: Willingness to pay is the amount of money an individual is willing to use in purchasing the product given a number of characteristics such as income, risk perception and level of risk aversion; whereas, Willingness to accept (WTA), is the maximum amount an individual is willing to receive in order to give up a good (Ali, 2013).

Risk and uncertainty: Uncertainty is a state where the probability of possible event is not known whereas; Risk can be defined as an incomplete knowledge where the probability of loss or possible outcome or consequence to a specific action is known (Hiwot and Ayalenh, 2014).

Premium: It is the monetary sum paid by the insured to the insurers for a period of insurance provided by the policy. The policy is a formal document expressing the terms and conditions of the insurance contract between the insured and the insurers (Chen, 2011).

Crop insurance: It refers to as an indemnity that provides financial compensation for production losses (Mahul and Statley, 2010). Crop insurance is a means of protecting farmers against the variations in yield resulting from uncertainty of practically all natural factors beyond their control such as rainfall, drought, excess rainfall or flood, and other weather variables. Crop insurance is a financial mechanism to minimize the impact of loss in farm income by factoring in a large number of uncertainties which affect the crop yields. As such it is a risk management alternative where production risk is transferred to another party at a cost called premium (Singh, 2010).

Moreover reducing the uncertainty faced by the insured, crop insurance evens out the burden of potential production losses, particularly those of a large-scale nature and part of the risk is transferred to an insurance company that in turn pays the farmer compensation after the loss occurs; and the insurance is constrained mainly with covering covariate losses that cover a large region as a result of droughts or flood and are usually severe. An indemnity is paid when the realized value of the predetermined weather variable exceeds a pre-specified threshold, and calculated based on a pre-agreed sum insured per unit of the index (Aidoob *et al*., 2014).

Crop insurance can be categorized into two major groups namely the indemnity based insurance and the index based insurance. The indemnity based insurance is made up of the multi-peril crop insurance, named peril and yield insurance, and Index-based crop insurance consists of two types of index products area-yield index insurance and weather-index insurance. Area-yield index insurance provides an indemnity based on the realized average yield of an area, which can be a country or a district. The amount of the insured yield is computed as a percentage of the average yield for the area, and indemnity is paid if the realized yield for the area is less than the insured yield regardless of the actual yield on a policy holder's farm, and the area-yield index insurance requires historical area yield data and it is mostly used in developing countries. The other types of crop insurance are the price, income and revenue

insurance which cover fluctuation in prices, yield, cost of production and farm revenue respectively (Khandker *et al.*, 2010).

On the other hand, weather index insurance is designed to trigger compensation against specific hazards such as droughts or floods which are predefined and 'indexed'. These insurance contracts are non-indemnity and parametric i.e. they are not linked to actual losses, rather than assessing the damage to a crop, claims are settled on the basis of a simple and transparent index, such as rainfall measured at a nearby weather station. It has been experienced that this can be a valuable tool for unlocking rural credit and hence improves rural livelihoods (Deressa *et al*., 2010).

In weather-index insurance the indemnity is based on the realizations of a specific weather parameter over a pre-specified period of time at a particular weather station, and measures a specific weather variable for a particular crop based on historical data. Furthermore, it specifies a threshold and a limit for making payouts. This type of insurance can be used to protect against either excessive rain or too little (World Bank, 2011; Khandker *et al*., 2010).

Whether index based crop insurance: It is a type of agricultural insurance that can serve smallholder agricultural development and risk management by protecting assets and encouraging productive investments. Limited availability, accessibility, quantity and poor quality of data on the ground are some of the primary technical constraints preventing scaleing-up and sustainability of index insurance. Weather index insurance provides protection for vulnerable households against specific weather shocks by using historical rainfall, yield and related agronomic and weather data (Osgood *et al*.,2007; Barnett *et al*.,2008).

A contract is signed between an insurer and a policy holder in advance, and payment is made based on the observable intensity of a weather index closely correlated to yield rather than to the non-observable specific impact on yield (Mahul,2001). The policy holder will get a payout when, for instance, rainfall is below an agreed amount (trigger point) based on automated weather station records, and the insurance thereby needs evidence of the statistical relationship

between the specific weather event being measured and volumetric risk (e.g. crop loss) at the farm level.

The challenge is how to make weather index insurance functional and attractive to both insurers and policy holders. This calls inter alia for a reliable index, appropriate compensation of the policy holders in the event of loss, and affordability to the bulk of farm households in the risky environments. Several questions however remain whether index insurance would become a game-changing innovation for managing agricultural risks in low income regions where other options have often failed due to high costs and low returns to insurance providers (Binswanger-Mkhize,2012).

In general agricultural insurance lowers risk faced by farmers by compensating them for damages, consequently allowing them to increase the level of investment and income and household which has a large potential to lose income and assets due to risk with very limited chances of recovery has the highest probability of taking insurance (Nahvi *et al*., 2014).

2.2. Risks in Agriculture

Agriculture is subject to a multitude of risks and uncertainties that affect different actors in agricultural supply chains in different ways**.** The risks encounter smallholder farmers' are production risks such as undesirable events during production such as floods, droughts, pests and diseases, and any other hazardous events which affect crop yields; market risk which are uncertainties linked with prices of inputs and outputs; financial risks such as variability of interest rates or of the value of financial assets, and presence of credit, institutional risk caused by government action for instance change in policy and regulations that tends to affect farming production and environmental risks which legal responsibility of agricultural producer (Havemann and Muccione , 2011).

On other hand, FAO (2011) categorized risks in agriculture supply chain as weather related risks, biological and environmental risks, market related risks, logistical and infrastructural risks, management and operational risks, policy and institutional risks, political risks.

2.3. The Rural Poor and Risk Coping Strategies

Risk coping mechanisms are strategies that are developed by communities to address problems related to hazards and environmental stress which are built up on historical knowledge, cultural acceptability and experiences emanating from interaction of the communities with the environment in which they live (Akyoo *et al*., 2013). These risk coping strategies has been classified as household level (risk mitigation), community level (risk sharing) and market based (risk sharing and transfer). The first two mechanisms are informal risk management and the later one is formal risk management instruments.

Farmers in developing countries tend to have little access to formal risk management solutions, and usually rely on informal coping mechanisms. These includes enterprise diversification, altered production techniques, reallocation of labor, high discount rates on new practices, maintaining reserves of non-interest-earning assets that are sold in the event of a shock, reducing household consumption and, or investment such as educating children, especially girls. Each of these strategies may provide short-term relief but in the longer term may contribute to increased household poverty and vulnerability. Buffer stocks accumulation (money, land, livestock and other assets) is also a common risk mitigation strategy. Livestock particularly represents an important component of household risk mitigation, as animal products can be sold throughout the year (IFAD, 2010a). They are also relatively easy to sell but are vulnerable to the effects of climate change (IFAD, 2010b).

Community-level savings and credit associations help farmers to mitigate risks by developing a pool of savings and a local source of borrowing. These include extended families, cooperative labor arrangements, group sharing of the costs and benefits of livestock herding, and a jointly owned storage and processing infrastructure. However, as stated in IFAD (2010) many of

these strategies fail when risks are catastrophic type and consequently affect a large number of members at once.

2.4. Formal Risk Management Instruments

This instrument is mainly market based strategy of risk transfer and sharing which includes contract marketing, insurance, contingency fund for disaster relief, saving, credit and others; and as insurance penetration in general remains very low in developing countries, for example Latin America, Asia and sub-Saharan Africa together accounted for only 21 percent of the world insurance premium total in 2008, and it still can be used as a vital risk management tool (Wenner, 2010).

2.5. Insurance Products

According to Havemann and Muccione (2011) insurance can be divided into indemnity-based insurance which is traditional insurance, index-based insurance and micro-insurance.

Traditional (indemnity-based) insurance compensates a client the estimated financial loss resulting from a shortfall, or loss in yield at the time of harvest that cover can be either multi-peril crop insurance or single peril crop insurance, and usually reinsured in that the local insurance company transfers all or part of the risk to a reinsurer. In this manner, insurer and reinsurer share premiums and risks, thereby making the premiums more affordable. Agricultural indemnity based instruments protect against livelihood and asset losses generated from catastrophic events and can concurrently improve access to finance, as risks are transferred from farmers to third parties.

However, index-based insurance pays out based on the value of an index rather than actual losses measured at field level. Examples of indexes are rainfall, temperature, humidity, and crop yield and river levels. Payouts occur when the index (such as rainfall) is below a total agreed value over a certain period for insurance against drought related crop loss, and such schemes do not require farm level assessments.

On the other hand, micro-insurance is usually targeted at low-income farmers in developing countries with limited access to traditional insurance; and aggregates multiple individual smallholders or smallholder groups into larger groups where risks can be pooled. A broad variety of risks can be covered, such as life, health and asset insurance. It is typically provided to low-income individuals in combination with microfinance loans, and these products tend to be pooled at several levels for reinsurance purposes; for example at village level, regional level and then reinsured at national level.

2.5.1. Index-based insurance

Beginning in the late 1990s, the development community got more and more interested in parametric insurance solutions, widely known as index insurance. Starting with relatively simple indices based on cumulative rainfall data obtained from automated weather stations, more complex products were soon created. Combining rainfall with temperature, multiple index periods within one crop cycle, and remotely sensed data are just a few examples (Muller *et al*., 2014).

Parametric insurance products are usually classified into two broad categories those that rely on aggregate yield or loss data for a specific area (or on a representative sample), and those relying on weather parameters as a proxy for yield, (rainfall or soil moisture). The first group is usually named area yield insurance, while the second group is commonly called weather index insurance (Collier *et al*., 2010; World Bank, 2011). Another way to classify index based

insurance products follows the level of directly targeted customers (Hazell *et al*., 2010, Dick *et al*., 2011).

Micro-level: The policyholders are farmers, households, or small business owners, who purchase insurance to protect themselves from potential losses caused by adverse weather events. By doing so, households may better manage low-to-medium-frequent covariate risks such as drought or excess rainfall. In this setting, crop insurance may facilitate access to credit, encourage investment in higher-quality inputs, and help smallholders who took out a loan to avoid default and restart production (e.g. by using the insurance pay-out to purchase new seeds) in the case of severe weather events.

Meso-level: The insurance product is sold to risk aggregators such as farmers' associations, input suppliers, MFIs or banks, for protecting their members, assets, or loan portfolio. Here, index insurance may help the targeted organizations to expand their business, opening access to a new client segment and helping to manage mass defaults caused by weather shocks. It may also create new market opportunities by developing innovative linkages along the supply chain (e.g. contract farming, packaging of credit and inputs). In most cases, direct benefits will primarily accrue to the aggregator, but can also be extended to its members. However, this requires specific contractual arrangements and great care has to be taken not to expose the aggregator to substantial risk (through covering basis risk).

Macro-level: Weather index insurance can help governments and relief agencies in development and disaster management without allocating unforeseen funds from the fiscal budget. It allows government or relief agencies to plan ahead of crises, knowing that funds will be available when they need them. In its development variant, index insurance intends to promote higher investments into agriculture, resulting in an average increase in smallholders' income, while still protecting them against severe set-backs. This may be achieved at the micro- level or meso-level. In the context of disaster risk management, index insurance would primarily operate at the meso or macro-level, allowing involved stakeholders to rely on secured and timely pay-outs for relief work.

2.6. Traditional Crop Insurance versus Weather Index Insurance

The agricultural and rural development study by World Bank (2005) which took Malawi for its case study on weather based insurance indicated that traditional multiple-peril crop insurance that indemnifies losses on individual farm basis is subject to high administrative costs in monitoring farm yields to prevent both higher losses than the initial rating and serious actuarial problems; and due to the large correlated risks multiple-peril crop insurance requires the extra cost of providing reinsurance; but weather index insurance is not subject to these problems. Its monitoring costs are less as there is no need to perform farm-level loss adjustments and the reinsurer is more likely to provide better terms when the insurance is based upon weather events and not traditional crop insurance which is based on farm-level losses.

Evkaya (2012) in his study modeled weather index based insurance as coping with the problem of moral hazard and adverse selection as the best advantages of weather index based insurance. Moral hazard which is a problem of asymmetric information in the market where the policyholder develops an attitude that directly affects the crop production such as failing to use necessary fertilizers and pesticide knowing they will be compensated, will not affect weather insurance because it is free from individual behavior and works based on the previously agreed up on index as a proxy estimate for the loss. Adverse selection which occurs when potential policyholders have private information about their risk exposure that is not available to the insurer will not be a problem because there is no asymmetric information between the insurer and insured about the weather events.

Evkaya (2012) also identified transparency and rapid pay outs as additional advantages of weather index based insurance over traditional crop insurance. This is because under the weather insurance farmers can easily reach the information about the pay outs and this property strengthens the trust of the policy holders in the insurer companies. It also enables companies to undertake payouts so fast since they do not determine the crop loss for each farmland separately. Thus, weather index insurance could be a preferred alternative to crop

insurance, as it avoids the above mentioned challenges that the traditional crop insurance cannot overcome.

2.7. Weather Index Based Insurance Practices in Ethiopia

There are different pilot projects under implementation in Ethiopia by different international organizations together with local insurance companies. A study conducted in Meskan, Silte and Anilemo Woredas to assess the uptake of rainfall insurance by farmers using informal groups called Iddir in Ethiopia by Dercon *et al*. (2012) targeted seventeen rural kebeles from three Woredas where each kebele contains two to three villages, and total of 117 iddirs with an average number of 175 members were incorporated. They conducted the experiment in such a way that together with Nyala Insurance Share Company they provided training for Iddir leaders and leader nominated members on issues of risk and insurance which raised their awareness on how to choose suitable policy; and after grouping the study sample into two groups they delivered training with two different contents for each groups independently; and the training was randomized among the groups and so as to avoid bias during selection; one of the main findings of the study was result in increase in demand among trainees, and they also found that one type of the training did not improve understanding of the products being offered.

A study by Million *et al*. (2012) on demand for drought insurance Ethiopia selected four districts from Oromia regional state and Southern National Nationalities and Peoples' Region Shashemen and Arsi and Damot Sore and Wondogenet districts selected due to their different agro ecologies, production potential and access to markets using data collected from a total of 576 randomly selected households indicated that about 87 percent of the sample household considered the possibility contributing their labor in tree planting or other development activities to receive insurance cover. The study further concluded that average participants need a subsidy to pay cash for insurance since their willingness to pay is less than the expected cost of the insurance for an insurance company.

In 2009, the Horn of Africa Risk Transfer and Adaptation project (HARITA) of Oxfam America (OA) along with local and international organizations such as the International

Climate Research Institute (IRI) at Columbia University, Swiss Re and Nyala Insurance (a private company in Ethiopia) were able to develop a more participatory weather index insurance product in Northern Ethiopia. The project integrated the Productive Safety Nets Program (PSNP) activities of the Ethiopian government with the so-called insurance-for-work (IFW) model (Brans *et al*., 2010). This pilot project initially covered 200 teff-producing farmers in the Kola Tenben districts of Northern Ethiopia and later was scaled up to 13,000 farmers in 43 villages (OA, 2010). The program was further rolled out to additional regions in Ethiopia (OA, 2013; Greatrex *et al*., 2015), for instance, in 2012 about 19, 000 farmers were insured over 76 villages in northern parts of Ethiopia (OA, 2013). However, the pilot project still faces the challenge of developing a viable and flexible index that could predict losses. Moreover more innovation and analysis was needed to see the sustainability of this model.

Other studies have also been conducted in various parts of Ethiopia. For instance using a panel of 1400 Ethiopia households that have been tracked for 15 years as part of Ethiopian Rural households survey Hill *et al*. (2011) found that educated, rich and proactive individuals are more likely to purchase weather index based insurance. They also found that some evidence on the positive role of weather index insurance on fertilizer adoption.

2.8. Empirical Studies

A study conducted in Kenya to identify determinants of crop insurance uptake where a sample of four hundred smallholder farmers participated found that awareness of farmers about agricultural insurance had significant influence on the crop insurance uptake (Njue *et al*., 2014). The study showed that farmers' decision was highly affected by their awareness about insurance, that those with awareness about its benefits were more likely to adopt and utilize the program. Similar study has found that ownership of saving accounts was also another determining factor of index based crop insurance uptake, this shows that owning bank account influenced farmers' decision in such a way that households with saving accounts were better

placed to receive the insurance scheme; and it was mainly used to capture trust towards insurance and liquidity access from formal financial institutions.

A study by Falola *et al*. (2013) in Nigeria to assess famers willingness to take agricultural insurance found that age of household head, educational status, access to extension service and farm income were significantly associated with their willingness to pay. As the farmer gets older the lower his/her likelihood to participate in the insurance scheme which could possibly be due to less receptivity of older farmers to innovation unlike young educated ones. Farmers that are well educated are more likely to adopt the insurance program than those with little educational readiness, and access to extension service was also another significant predictor and those utilizing the service are more likely to adopt crop insurance scheme because it provides them with crucial information on modern methods of managing risks including the insurance.

A study by Hill *et al*. (2011) in Ethiopia using a panel data of 1400 households found that age, sex, education, access to credit and income of household were significant predictors of farmers willingness to adopt crop insurance. Women were 12 percent less likely willing to pay for crop insurance. Additionally older individuals and less-educated individuals were less likely to adopt the insurance program. The key predictors that indicated early adopters of the crop insurance products were high income and having access to credit which measure access to financial markets.

The study is also revealed that the rich, educated, proactive and younger farmers were more likely to purchase insurance; basis risk and high priced contracts were likely to reduce the likelihood of purchase. The estimate of probit results showed that households with some degree of self-insurance and those people who were less risk averse were less likely to purchase insurance. Among many reasons for the lack of willingness to purchase insurance, the most stated response was the inability to purchase even though there is a desire to buy the product.

Another study by Hiwot and Ayalneh (2014) conducted in Central Rift Valley Dugda and Mieso Woredas of Ethiopia by using Tobit model and CVM method taking a sample of 161 smallholder farmers indicated that household income and owning of a radio affected their willingness to pay positively. In contrary off-farm income, age of household, number of livestock owned and availability of public or private gifts had negatively affected farmers' willingness to pay for crop insurance.

Alexander and Fotis (2013) conducted in Ethiopia using household survey data found that age of household head, education of household head, previous loss experience and access to credit were significant predictors of farmers' willingness to pay for the proposed crop insurance, and respondents with earlier year experience of drought were less likely to take part in the insurance scheme.

Ataklti (2014) had conducted a study on farmers' willingness to pay for weather index crop insurance, in Adiha, central Tigray, using probit model. The Bivariate probit model revealed that sex of respondents, education, plot size, access to information and access to credit positively and significantly determines farmers willing to pay for the weather index crop insurance. To the contrary, the result showed that age of the household head negatively and significantly affected the farmers WTP decision for weather index crop insurance.

Clark and Kalani (2011) conducted an experiment on WTP for index insurance and for indemnity insurance, to analyze whether these choices are rational, how to explain behaviors according to a utility theory, and whether insurance is better sold to risk-sharing groups. They used data on a sample of 378 households from the Ethiopian Rural Household Survey (ERHS), farmers were instructed, through visual aids, to make three decisions each time but were paid for only one of them and compensation was set in order to obtain an average expected daily earning higher than the daily wage. The initial endowment was 65 ETB with a potential loss of 50. Having included several explanatory variables, Clark and Kalani(2011) show a non-linear relationship between wealth (proxied by livestock ownership) and take-up of index insurance, with the highest frequency in the intermediate wealth levels. Contrary to other studies,

education and knowledge do not increase the take-up of indemnity or index-based insurance. Historical risk exposure positively influences the take-up of indemnity insurance. Participation in risk-sharing groups has the same effects on both types of insurance. A dummy representing the ability to obtain emergency cash of 100 ETB is positively associated with the take-up of index insurance, probably because it is a proxy for the higher degree of familiarity with informal risk-sharing methods and insurance.

2.9. Methods of Valuation

Literature on WTP indicates that there are various ways of estimating an individual's willingness to pay for insurance. The first approach is the revealed preference method where the production patterns and other behaviors of the farmer are examined to determine the value of the good; and the second approach is estimating the indirect market premium by combining household and market variables where the level of utility of farmers with and without insurance is compared and the amount they would be willing to pay from moving from a state without insurance to one with insurance is estimated (Chantarat *et al*., 2009).

The third approach is the contingent valuation (CVM) method which is widely utilized and this takes the form of describing the situation or product to the individual and asking them directly what he/she is willing to pay for it. This valuation method is a stated preference approach and it is mostly used in analyzing environmental goods which are not sold or bought in the marketplace. The technique is generally employed to determine the value of a hypothetical or non-existing market good (Ramasubramanian, 2012).

2.9.1. Elicitation Methods

There are different elicitation methods in using CVM technique, one of which is asking open-ended questions on WTP; and is less often used due to the possibility of having missing values as a result of the difficulty in answering the payment question or having understated or overstated values, and the take it or leave it approach, where the individual decides to accept a product presented at a predetermined price or not accepts it which is considered to be a

practical approach to gathering information on the preference of consumers. This is also called iterative bidding approach, where individuals are questioned on their willingness to pay an initial amount after which the amount is increased or decreased depending on the initial response. The maximum amount with a positive response is taken as the WTP for the product (Ramasubramanian, 2012; Abdullah *et al*., 2014).

There is the dichotomous choice approach where the individual is asked if he/she would pay a certain amount for the product. This technique can be a single or double bounded dichotomous choice where a simple one time yes or no response is required for the bid mentioned in the single bounded choice but a follow up bid is presented to the respondent after the initial response in the double dichotomous case (Abdullah *et al*., 2014). Double bounded models are quite complex because the second question depends on the first question and therefore respondents are likely to treat the responses for both questions differently (Haaband, 2002). On the other hand, it is simple for respondents to make a choice and it has the advantage of limiting the possibility of receiving calculated responses (Abebe and Bogale, 2014). Therefore, the researchers have used a Double Bounded Dichotomous Format choice elicitation technique in soliciting WTP information to reduce biases and improve efficiency.

2.9.2. Contingent Valuation Method (CVM)

The most widely used stated preference determinant of WTP is the contingent valuation method (CVM), introduced by Davis (1963). The main CVM formats which can be close-ended or bounded, and open-ended; and open-ended models allow the individual to state the price he/she is willing to pay for a product, and close-ended processes offer a product to the potential customer at one price, or a series of pre-determined prices, where the "bounds" of the method refer to the maximum number of prices an individual may be offered in the process. In a single bounded close ended format, a product is offered to the individual at a single price, and then he/she decides whether or not to accept the offer. This approach tells the researcher whether the offered price is above or below the individual's WTP, and is thought to most closely mimic actual market situations, where consumers are offered price and must decide

whether or not to purchase (Hanemann *et al*., 1999; Simpson, 2016). In the double-bounded close-ended model, the potential customer is offered an initial starting price; and if the price is accepted/ rejected, the individual is offered a second higher/lower price.

Another type of close-ended model is the iterative bidding model, where a range of prices is first predetermined, and then the potential customer is offered an initial starting price. If the price is accepted /rejected, the individual is offered a higher/lower price until the offered price is rejected /accepted or the maximum/minimum price is accepted/ rejected. These multiple-bounded models give the researcher the range within which the individual's WTP lays (usually between the highest accepted price and the highest rejected price) (Simpson, 2016).

Follows an open-ended format and is called the "interactive bidding" (IB) method helps identify a more precise estimate of WTP; it also suffers from certain limitations including starting point bias and hypothetical bias. Starting bias arises when respondents interpret the starting value in the bidding game as being indicative of market information, or as representing a typical bid. For instance, Kartman and colleagues (1996) found that individuals in the highest starting-bid group were willing to pay double that of those in the lowest (as cited in Dong *et al*., 2004).

Starting point bias can be reduced by using a range of starting point bids (i.e. different starting values for different respondents) and comparing the effect of each of those starting points on the final WTP value elicited. Hypothetical bias arises when an individual responding to a survey fails to take into account the additional information she/he possesses in terms of her/his budgetary constraints, preferences, available substitutes (Slovic, 1972 as cited in Bateman, 1993). Thus, in order to make results more accurate, it is important to explicitly introduce "mental accounting" into CVMs by asking some initial questions about the respondent's total yearly budget etc (Bateman, 1993).

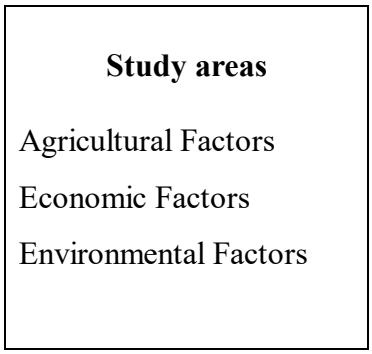
Therefore, this study uses the CVM method by applying an open-ended format and single closed ended elicitation techniques. This method is preferred because of its flexibility in valuing

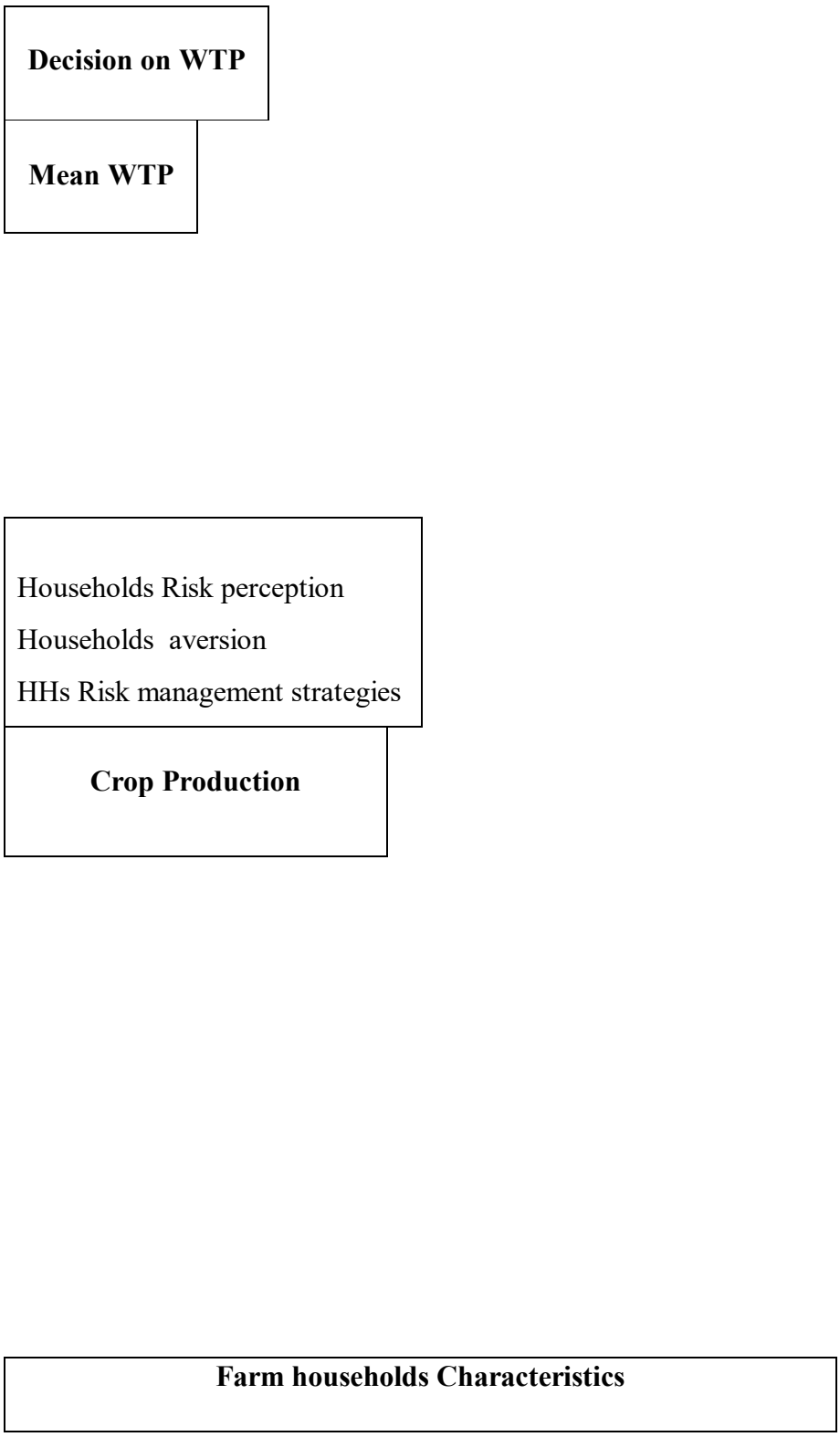
a diverse range of nonmarket goods and is very helpful in situations where no market data are available (Abebe and Bogale, 2014).

2.10. Conceptual Framework of the Study

The conceptual framework of the factors affecting smallholder willing to pay for weather index based crop insurance were drawn from empirical and theoretical literatures and theories supporting the driving forces that were expected to affect their decision on willingness to pay .

The conceptual frame work presented in figure 2 below shows the cause and effect relationship between the determined issues like, the existing environmental, agricultural and economic factors with the Policy considerations of the study area as a whole are affecting the crop production status and the production status is also determines the supply side of crop production. Based on the demand and supply theory, the decision of households' on the willingness of how much they could pay depends on the quantity and quality of crops produced. On other hand their production depends on households risk perception, their risk behavior and risk management strategies. The other factors such as demographic, resource endowments and intuitional factors were affecting on decision of farm household's willingness to pay for weather index based crop insurance (Desalegn, 2015).




Decision on WTP
Mean WTP
Households Risk perception
Households aversion
HHs Risk management strategies
Crop Production
Farm households Characteristics

Demographic	Resource Endowment	Institutional
Age sex Education Family size	Live stock holding Land holding Income Previous loss	Frequency of Extension service Credit constraint Availability of Aid Access to media

Source: Modified from Susan and Linda, (2001).

Figure 2. Conceptual Frame Work

3. RESEACH METHODOLOGY

This chapter presents description of the study area, study design, sample size and sampling technique, data source and methods of data collection, methods of data analysis, operational definitions of variables and working hypothesis.

3.1. Description of the Study Area

MiesoWoreda is located 302 km east of Addis Ababa at about 200 km east of Adama town, Eastern Shewa zone of Oromia Regional State, and located in the main road from Addis Ababa to Harar, at the boundary with west of Somali region, south west of Afar region, north of Chiro and Guba Qoricha, east of Doba, northeast of Anchar Woredas of East Hararghe Zone,

where agro- pastoral farming system is practiced. The Woreda has a total number of 44 kebeles and 4 town dwellers. Twenty nine kebeles out of the total 44 kebeles belong to agro-pastoral farming system.

The recent population report indicated that the Woreda has 167,152 total populations, while the total number of agricultural household are 25,206, while 7,160 households are urban residents, lives in four small towns including Mieso, the Woreda's town. Out of the total rural households, 19,913 are male and 5,293 are female households. The total rural population are 132,786, out of which, 68,817 are male and 63,969 (48%) are female.

The woreda is located between9"30.1' W and 56"44' E; and19"52'N and 48"12 N; attitudinally, the woreda ranges from 1107 to 3106 m above sea level. Mieso Woreda is surrounded by a chain of mountains in all directions, and Asebot Mountain which is the biggest mountain in the Woreda, located in the northeast of Mieso town. Based on the digital data, the average annual temperature is around 23^{O}C and average annual rainfall is between 600 and 900 mm. The total cultivable land (annual and perennial) in agro pastoral farming system is estimated to 21,877 ha, and the total area is about 145,864 ha, with average land holding size (cultivable land) , 1.5 ha per household. The proportion of total land to total rural households in the farming system is1.5 ha.

Population pressure forced the people to convert natural grazing lands into crop lands which substantially affecting the soil conservation practices negatively. Livestock products are generally limited and expensive during the periods of low feed availability and livestock's body conditions become good and sale of livestock earns a reasonably good income during crop harvest and crop weeding.

Annual Rainfalls in Mieso Woreda is erratic and irregular in distribution and as a result crops such as sorghum and maize which are common in the area fail in most years since most of the rainfall is received in only few months, while most of the months are dry. As a result, recurrent drought is a major problem, and almost all kebeles of MiesoWoreda are in needs of food aid.

Thus, this study tries to examine farmers' WTP for the proposed WII service which is the up-to-date risk management strategies to cope up with such frequently incurring drought risk in the study area.

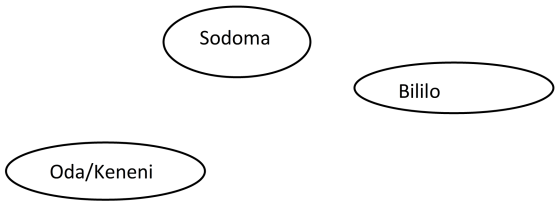


Figure1. Map of Study area

3.2. Sample Size and Sampling Technique

A two-stage sampling technique was used to select 153 sample households for an interview. In the first stage, out of the 44 kebeles 29 agro-pastoral kebeles were identified based on livelihood option and then out of 29 kebeles in the Woreda, 3 kebeles were randomly selected. In the second stage, from the three selected kebeles a total of 153 farm households were randomly selected based on probability proportion to size.

The required sample size (n) is determined using single population proportion formula considering (p) of 30.3% (Gizaw *et al*., 2014). Therefore, margin of error (W) of 5 percent and non-response rate of 10 percent was used to calculate the sample size. Accordingly, the sample size was determined by the formula below:

(1)

Where, n = sample size

($Z_{a/2}$) = confidence level; taking 95% level of confidence interval, i.e. 1.96

is variance of the amount the farmers are willing to pay i.e. 0.3

W=margin of error tolerated (0.05)

Based on the above assumption, the sample size is:

n =139

Considering an estimated non-response (incompleteness of the data) of 10% 14 households added to the calculated sample size giving a total of 153 samples. From a total of twenty-nine agro-pastoral kebeles three kebeles namely Sodoma, Odakeneni and Bililo kebeleles were randomly selected and data collection was undertaken on these kebeles. Thus, a total of 153 sample households were interviewed.

Table 1: Sampling frame of kebeles and sample size

Sample Kebeles	Total households	Sample size per kebeles

Sodoma	582	40
Odakeneni	990	67
Bililo	673	46
Total	2245	153

Source: MiesoWoreda Agriculture Office

3.3. Sources and Methods of Data Collection

3.3.1. Data on the Determinants of WTP

The study used both primary and secondary data. The primary data were collected from agro-pastoral farmers, and secondary data were obtained from different sources mainly Mieso Woreda Agriculture Office West Hararghe Agriculture Office.

Semi structured survey questionnaire was designed and pre-tested before the collection of the actual primary data. For this purpose, 10 enumerators who had experience in data collection techniques and who are fluent in speaking local language of the community were recruited; training was given to enumerators on the content of the questionnaires, interview techniques, objectives of the study and the approaches they have to make towards the respondents before the actual survey begins. The questionnaire encompass information on demographic characteristics, crop and livestock production, farming systems and productive resources, land use, access to services, risk perception, risk management, coping strategies employed by the farm households, maximum amount they are willing to pay for WII in single and double bounded elicitation methods.

The willingness data were collected through Contingent Valuation Method (CVM) which is suitable to solicit farmers' willingness to pay for a product that is not yet on the market. This method enables the researcher to create a hypothetical market in a new good and the values generated by this hypothetical market are treated as values of the new good. Based on a starting value obtained from pilot-test, different bid values was selected and distributed randomly on the hypothetical market created for the respondents. They were asked if they are

willing to pay the stated amount and if they respond yes another follow up bid is offered; if he /she say NO, a second bid which is lower than the initial bid is offered to the respondent. Once data has been collected and brought it was checked one by one to make sure that questionnaires with many missing items per sample per unit are excluded. Once data entry is over data cleaning was conducted. Finally in order to maintain the quality of data different procedures are followed.

3.4. Methods of Data Analysis

3.4.1. Descriptive Statistics

Different descriptive statistical methods like frequency, percentage, standard deviation, proportion, correlation, tabular presentation and others were used. To check association among different variables Chi-square (χ^2) test was utilized. Pearson correlation is used to check relationship among numerical variables. Statistical tests like t-test and other are applied to undertake comparative analysis across different socio-demographic and other characteristics of the respondents. Additionally the descriptive statistics is helping us undertake comparative analysis of amount of household's willingness to pay between the groups.

3.4.2. Econometric Model

3.4.2.1. Bivariate Probit Model

Review of the previous studies show that there are number of elicitation techniques and econometric models to estimate WTP. CVM is used for recovering the information about willingness to pay by direct questions. There are different types of elicitation techniques in CVM to elicit WTP information. The closed-ended dichotomous choice techniques have become credible approach in CVM studies (Haab and McConnel, 2002). With dichotomous choice closed-ended questions, most commonly used techniques are single-bound and double-bound dichotomous choice questions. In single-bound dichotomous choice, a respondent is asked only once about WTP and is expected to answer yes or no. In this case,

WTP can be estimated by probit model. In the double-bound dichotomous choice, a respondent is asked a follow bid question contingent upon the response to the bid one question.

Hanemann, Loomis and Kanninen (1991) showed that a follow-up question significantly increases the statistical efficiency of willingness to pay estimates. In this case, WTP can be estimated by interval data model. However, the literature indicates that the respondent is likely to change or adjust the value of WTP when the second question is asked. To address this issue, bivariate probit model was used to estimate WTP. However, Haab and McConnell (2002) raise the concern that the researcher has to decide whether to rely on the WTP based on initial or follow-up response. Thus, with dichotomous choice closed-ended questions, most of the previous studies have used one of the following models: probit model, interval data model and bivariate probit model, and this study uses Bivrate Probit model.

Briate probit model is method for two-response surveys with double-bound dichotomous choice questions. The bivariate probit model was initially introduced by Cameron and Quiggin (1994). It was argued that when the individuals are asked two questions, the respondents may reconsider about their WTP and the distribution of WTP may change from initial question to the follow-up question. The bivariate probit model allows for the possibility of different distributions of WTP across the initial and follow-up question while the interval data model assumes the same distribution of WTP during initial question and the follow-up question.

In the bivariate probit model, the two dichotomous choice responses are simultaneously modeled as single-bounded, i.e. two correlated WTP equations with jointly distributed normal error terms. The bivariate probit model relaxes the restrictive assumptions of the interval data model and solves the problem of potential bias caused by these assumptions. We use probit because it allows for non-zero correlation, while the logistic distribution does not.

It is assumed that the error terms are normally distributed with mean zero and respective variances and have a bivariate normal distribution with correlation coefficient. As the distributions of WTP are likely to be different across the initial question and follow-up question, the researcher has to decide which distribution to use for estimating WTP even after

estimating the both distributions in the bivariate probit model. After estimating the bivarite probit model, the expected value of WTP can be computed for individuals with given values of explanatory variables.

In this study the responses were analyzed using bivariate probit model, which was used to determine the farmers' willingness to pay for the proposed weather index based crop insurance .With the obtained responses, two binomial discrete variables are formed that have the characteristics of the dependent variable. The appropriate variant of a bivariate probit regression model is used when explaining the willingness-to-pay, with the assumption that the two decisions are interconnected and the errors of the two regressions correlated; this increases estimation efficiency despite the evaluation of an additional parameter measuring the coefficient of the correlation between random errors in both regression equations (ρ). The values of regression coefficients are estimated by applying the maximum likelihood (ML) estimator.

In the bivariate probit regression model, dependent variables represent the respondent's answers to the initial bid value one and the follow-up bid responses on willingness-to-pay value for WII. These are binary variables that take the value 1 if the respondent accepts the proposed value and 0 otherwise. The corresponding function value of willingness-to-pay is the respondents evaluate both proposed willingness-to-pay values consecutively. Their basic response is represented by the following expression:

$$WTP = \mathbf{X'\beta} + \mathbf{e}(1)$$

Where, WTP represents a vector of values of the dummy response variable, **x** is a matrix of values of explanatory variables, β is a vector of regression coefficients and e represents a vector of residuals. The follow-up willingness-to-pay value depends on the respondent's response to the first willingness-to-pay value that was proposed.

3.4. 3. Estimating the mean willingness to pay

In estimating the mean willingness to pay, a double-bounded contingent valuation format of Bivrate Probit model was used , where the respondents were asked a series of questions that progressively narrowed down to their willingness to pay. This method has been shown to generate more efficient estimates than those based on a single question or those that ask open-ended question about willingness to pay as it make clear bounds on unobservable true WTP and sharpen the true WTP. It is also very vital to collect more information about WTP of each respondent (Watson and Ryan, 2006).

The mean WTP for this study is determined depending on the normality assumption of WTP distributions (Haab and McConnell, 2002): Thus, the mean willingness to pay from the dichotomous double bounded format of Bivrate Probit model of farmers' response about their willingness to pay for initial bid one and follow up bid in the study area were calculated as:

Mean WTP =
Where
= the intercepts of the two equations.

= slope coefficients of Initial bid one and follow up bid.

3.5. Definitions of Variables and Working Hypothesis

3.5.1. Dependent Variable

WTP: It is the likelihood estimate for farm households willingness to pay for weather index based crop insurance service certain amount of money for the proposed contingent valuation scenario (Haab and McConnell2002; Siyaranamual, 2014). This is achieved by the combined binary response outcome of both the first bid and second bid levels for the premium amount that they are willing to pay per hector.

3.6.2. Explanatory Variables

Based on literature review the following variables were hypothesized to affect the willing to pay for weather index based crop insurance service per hectare.

Age of household head: This is a continuous variable measured in years. It refers to number of years of farm households up to the time of survey. Abdullah *et al*. (2014) found that age had a negative effect on WTP that older farmers are less willingness to pay for the crop insurance scheme as compared to young farmers. Aidooet *et al*. (2014) and Kiran and Umesh (2015) found similar result associating farmer's age with their willingness to pay. Thus, in this study age of household is expected to have negative influence on farmers' willingness to pay for crop insurance.

Sex of household head: Sex of the household head is a dummy variable which takes the value 1 if respondent is male and 0 otherwise. Deressa (2008) found that sex has a positive association with willingness to pay for weather index based crop insurance. Thus, in this study sex of household is expected to positive influence on farmers' willingness to pay for the crop insurance.

Household size: This is a continuous variable measured in adult equivalent. Abdullah *et al*. (2014) found that household size has negative influence on farmers' willingness to pay.
Large family size is accompanied with larger household expenditure, which consequently depletes household cash resources. Hiwot and Ayalneh (2014**)** have shown that as size of household increases, demand for insurance decrease. In this study household size is expected to have negative effect on the willingness to pay for weather index based crop insurance.

Education Level of household head: It is dummy variable taking 1 if the respondent is literate and 0 if the respondent is illiterate. Education may increase farmers' ability to use information as well as practice it. Educated farmers are in a better position to make decision on the proposed insurance scheme (Abdullah *et al*., 2014; Aidoo*et al*., 2014). In this study education expected to have positive influence on farmers' willingness to pay for weather index based crop insurance.

Availability of private and public aid: This is a dummy variable which takes a value 1 if the household is getting aid and 0 otherwise. When there is a local or international aid available households feel less or no need to undertake self-preventive measures and less likely to agree to pay for insurance scheme (Makaudze, 2005). The result from the study by Hiwot and Ayalneh, (2014**)** showed that as the availability of public and private aid is high, participation and willingness to pay for weather index based crop insurance is low. Therefore in this study availability of private and public aid is expected to have a negative influence on farmers' willingness to pay for crop insurance.

Credit constraint: It is dummy variable which takes the value 1, if the household has credit constrained and 0, otherwise. A study conducted by Gine*et al.* (2007) indicates that insurance participation is higher when households are less credit constrained. In this study credit constraint is expected to have a negative effect on the farmers' willingness to pay for weather index based crop insurance.

Extension contact: This is a variable indicating number of contacts a farmer could have with an extension agent in his/her farm. The provision of agricultural extension service helps farmers to be aware about weather related risks these could improve their productivity (Nkonya*et al,* 1997, Kansana*et al.,*1996). In this study it is expected to have positive influence on farmers' willingness to pay for weather index based crop insurance.

Initial Bid and follow up bid: It is the starting bid value one and follows up bid. As the bid amount increases, the respondents would be less willing to pay for weather index based crop insurance. For instance, Kiran and Umesh (2015) and Abdullah et al. (2014) found that initial bid values was significant and had a negative sign because farmers were sensitive to cost aspects while willing to decide for crop insurance. Thus, this study expected that both bid values have negative influences on farmers' willingness to pay.

Livestock holding: This is continuous variable which refers to total livestock owned by farm households and measured in tropical livestock unit. Ali (2013) found that livestock holding is positive influence on farmers' willingness to pay for crop insurance. In contrary to this, Ghazanfar*et al*. (2015) found that this variable negative on farmers willing to pay. Thus, in this study it is expected that total livestock holding have a negative influence on farmers' willingness to pay for weather index based crop insurance.

Cultivated land size: This is continuous variable measured in hectare. Aidoo (2014) found that owning large cultivated land size increases farmers demand for index based crop insurance. Having larger cultivated land may help households' to produce more which increase their willingness to pay for index based crop insurance. In this study, this variable is expected to have positive influence on farmers' willingness pay for crop insurance.

Total annual income: This is a continuous variable measured by the total amount of money earned by farm households during the last one year. It is expected that households' with more income will be more willing to pay for index based crop insurance due to their ability to pay

more premium for their crop cover (Ellis, 2016). Annual income is therefore expected to have a positive influence on the willingness to pay for index based crop insurance.

Previous loss: It is discrete variable which shows the frequency of loss incurred for the last 10 years on crops of farm households. Ali (2013) found that frequency of previous loss incurred by farm households' have positive effect on farmers' willingness to pay for index based crop insurance. In this study, previous loss is expected to have positive influence on farmers' willingness to pay for weather index based crop insurance.

Access to media: This is a dummy variable, which takes the value of 1 if household has access to media and 0 otherwise. Access to media such as radio is a source of information and can enhance the ability of farmers' access to different sources of information such as extension service, credit service, use of new technologies, improved seed varieties, input price, output price, crop protection, post-harvest handling techniques than those farmers' who does not have access to media. Thus, farmers who have access to media might be able to understand this information earlier than those who do not have access. In this study this variable is expected to have positive influence on farmers' willingness to pay for index based crop insurance.

Table 2: Variable type, definitions, measurement and expected sign

	Type	Definition	Measurement	Effect
Explanatory variables				
Age	Continuous	Age of household head	Years	Negative
Education level	Continuous	Education level of head	Years	Positive
Extension visit	Continuous	Extension visit	Number	positive
Sex	Dummy	Sex of the head	1 if a head is male 0 otherwise	positive
Credit constraint	Dummy	Credit constraint	1 if a HH have credit constraint 0 other wise	Positive
Availability of aid	Dummy	Availability aid	1 if HH get to aid , 0 if not	Negative
Household size	Continuous	Family size	Number	Negative
Cultivated land size	Continuous	Cultivated land size	Hectare	Positive
Annual income	Continuous,	Annual income	Birr	Positive
Initial and follow bid	Continuous	Initial bid value	Number	Negative
Previous loss	Continuous	Previous loss	Number	Positive
Livestock holding	Continuous	Livestock holding	Number	Negative
Access to media	Dummy	Access to media	1 if households access 0 other wise	Positive

4. RESULTS AND DICUSSION

In this section the major findings of this study are discussed in comparison with the results of other studies presented. First, descriptive statistics results like mean and percentage comparison of those households who are willing to pay and not willing to pay for weather index based crop insurance at bid one and follow bid levels are presented. Second, the econometric model results of the study that describes factors affecting farmer's willingness to pay and the mean premium amount they are willing to pay are discussed in detail.

4.1. Descriptive Characteristics of Sample Households

The demographic and other socio-economic characteristics of sample farm households' is summarized in relation to factors affecting farmers' WTP for weathers index based crop insurance at bid one and follow bid levels are discussed below.

4.1.1. Descriptive Statistics of WTP

4.1.1.1. Willingness to pay to weather index insurance Hypothetical market

The willingness-to-pay part began by describing the closest weather station (NME), at Miseo town, to the respondents' home as a reference for two parties, the insured and insurer and the amounts of rain observed at that station. A hypothetical insurance contract was then described in terms of well-known insurer "Ethiopian Insurance Corporation" offering a payment when rainfall at the closest weather station fell below the agreed threshold level. Sample respondents were then asked if they would be willing to pay for the insurance for a beginning premium of values (250, 300, 350 and 400) , then based on their responses to bid one, follow bid is offered to them to estimate the mean amount of premium farmers' willing to pay for crop insurance.

Consequently, sample farm households were asked their willingness to pay for the weather index based crop insurance for loss of their crop per hectare at bid one and follow bid offered to them. The results showed that out of the total sample households, 121 (79.08%) were responded yes to pay bid one; whereas 32 (20.91%) were responded No to pay bid one. On the other hand, 107(69.93%) households were willing to pay for the follow bid and 46 (30.06%) were not willing to pay the follow bid.

4.1.2. Demographic Characteristics of Sample Farm Households

Age of the household head: The mean age of the sample respondents was found to be 40.26 with the minimum age 18 and maximum of 80 years. The mean age of sample respondents who are willing to pay for weather- index based crop insurance was 38.71, while that of not willing to pay was 46.15 years for bid one, and 38.89 for willing to pay and 43.45 for not willing to pay for follow bid. The t-test showed that there was significant difference in mean ages of sample households head between the two groups at less than 1 percent probability level at bid one and 5 percent at follow bid level. Hence, it showed us that age differences in sample household heads have an influence on farmer's willingness to pay for weather index based crop insurance.

Household size: The range of the household size was found to be very large; falling between 1 and 12 persons per household. The average family size in adult equivalent of sample respondents was 3.73. The mean family sizes of the sample respondents willing to pay for weather index based crop insurance was 3.56 and not willing to pay was 4.39 bid one level, and 3.6 for willing to pay and 4.05 for not willing to pay follow bid . The t-test shows that there was a significant difference in the mean family size at less than 1 percent probability level between the two groups at bid one and follows bid level. This is in line with the priori expectation that farm households with large household size tends to be less willing to pay for weather index based crop insurance as compared to those households with small family size.

Cultivated land size: The survey result indicated that the mean cultivated land holding by sample households was 1.09 and 0.94, for willing to pay and not willing to pay for weather index based crop insurance respectively for bid one, and 1.01 for willing to pay and 0.96 for not willing to pay for follow bid. The overall mean cultivated land holding of sample households was 1.04 which shows a significant difference among the two groups at less than 10 percent probability level at follow bid level. This implies that having larger cultivated land may increase the income of households and which in turn increase the demand of households' willingness to pay for weather index based crop insurance.

Total livestock holding: Livestock has been the most important capital asset of the agro-pastoral households of the study area. Livestock owned by sample farm households' are cattle, sheep, goats, donkey, camel and chickens each provides a variety of purposes such as an indicator of wealth, source of income to purchase food and nonfood items during crop failure, sources of draft power which in turn increases crop production, and as source of food for households.

The total livestock population owned by the sample farm households were 840 in number, while oxen and cows makes higher share in proportion 37% (311); the other remaining types of livestock owned by farm households were calf (69), heifer (56) camel (22), donkey (68) sheep and goats (59) and chicken (55) in number. This shows that the remaining livestock make share 62.97% (529) in number. The mean livestock holding in TLU, of households willing to pay and not willing to pay for weather index based crop insurance was 2.86 and 3.99 in TLU, for bid one respectively, and 2.86 for willing to pay and 3.56 for not willing to pay for follow bid. The overall mean was 3.098 TLU; with the maximum number of livestock owned by sample households was 12.25 TLU. The t-test result shows that there was a statistically significant means difference in TLU between the two groups of households at 5 percent of probability level at bid one level.

Previous loss: The result of the survey showed that the maximum numbers of times sample farm households' crop loss incurred during the last ten years were about 10 times. The mean

previous crop loss incurred during the last ten years for sample households willing to pay and not willing to pay for weather index based crop insurance were 5.07 and 4.75 respectively for bid one; and 5.48 for willing to pay and 3.91 for not willing to pay for follow bid. The t -test shows that there is significance mean difference among the two groups at less than 5percent probability at follow bid level. This implies that frequency of previous loss may increase the demand for households' willingness to pay for the proposed weather index based crop insurance.

Annual income of the household head: The survey result indicated that the mean annual income earned by sample households willing to pay for weather index crop insurance was birr 16,880.79 and not willing to pay was birr 12,167.19 for bid one, and 17,463.61 for willing to pay and 12,246.69 for not willing to pay for follow bid. The survey result depicted a significant mean difference in annual income of sample farm households at less than 10 percent and 5 percent probability levels between the two groups at bid one and follow bid level respectively. This suggests that having better annual income increases demand of households to willingness to pay for weather index based crop insurance.

Frequency of extension visit: The survey revealed that mean frequency of extension visit of households willing to pay 4.89 and non willing to pay was 3.81 for bid one and 4.78 for willing to pay and 4.32 for non willing to pay for weather index crop insurance for the follow bid . The t -test shows that there is significance mean difference among the two groups at less than 10 percent probability at bid one level. This implies that frequency of extension visit may increase the demand of households' willingness to pay for weather index based crop insurance.

Table.3. Descriptive Characteristics of Sample households for Continuous Variables

	Initial bid one					Follow bid				
Variable					t-value					t- value
	WTP		Non-WTP			WTP		Non-WTP		
	Mean	Std	Mean	Std		Mean	Std	Mean	Std	
Age	38.71	11.89	46.15	11.18	3.187**	38.89	11.94	43.45	11.9	2.162**

					*				7	
Fam.siz	3.56	0.98	4.39	0.87	4.37***	3.6	0.96	4.05	1.07	2.59***
Farm	1.09	0.46	0.94	0.57	1.547	1.01	0.47	0.96	0.52	1.702*
		1460		1191		17,46		1224		
Income	16,880	9	12167	4	1.681	3	15472	6	9802	2.110**
Loss	5.07	3.18	4.75	5.52	0.431	5.48	4.09	3.91	2.65	2.387**
TLU	2.86	2.28	3.99	3.48	2.204	2.89	2.31	3.58	3.16	1.59
Exten	4.89	3.53	3.81	2.2	1.65*	4.78	3.47	4.32	2.86	1.62

Source: Own survey result. ***,** and * means significant at 1%,5% and 10% significance of probability level

Sex of the household head: The survey result indicated that out of total sample respondents 73.2 percent and 64.7 percent of households' are willing to pay for bid one and follow bid respectively are males; where as 5.9 percent and 5.2 percent are females.

On the other hand 19.6 percent and 28.1 percent of male and 1.3 percent and 2 percent of female households are not willing to pay for bid one and follow bid respectively. The chi-square test indicated that there is no significance percentage difference between the two groups of households.

Credit constraint: The survey result indicated 59.5 percent and 51.6 percent of sample households willing to pay for bid one and follow bid have credit constraint where as 19.6 percent and 18.3 percent of sample household have no credit constraint respectively. On the other hand 16.3 percent and 24.2 percent of households not willing to pay for bid one and follow bid has credit constraint where as 4.6 percent and 5.9 percent of households have no credit constraint respectively.The chi-square test indicated that there is significant percentage difference between two groups of with respect to this variable at initial bid one and second bid level 5 percent probability level.

Availability of private and public aid : The survey result showed out of total sample respondents 58.8 percent and 51.6 percent of sample households are willing to pay for bid one and follow bid respectively have gotten public and private aid, where as 20.2 percent and 17.6 percent of households have not got aid from private and public sources. On the other

hand, 16.3 percent and 24.2 percent of households not willing to pay for bid one and follow bid have gotten aids where as 4.6 percent and 6.5 percent of households not willing to pay have not get aids. The chi-square test indicated that there is significant percentage difference among two groups of households' at less than 10 percent probability level. Hence, it showed that availability of aid have an influence household's willingness to pay for crop insurance.

Access to media: The survey result revealed that about 67.3 percent and 62.7 percent of households willing to pay for bid one and follow bid have access to media such as radio where as 11.8 percent and 7.2 percent of households have no access to media. On the other hand 16.3 percent and 20.3 percent of households were not willing to pay for bid one and follow bid have access to media where as 4.6 percent and 9.8 percent of households have no access to media respectively. The chi-square test indicated that there is significant percentage difference between the two groups of households at less than 10 percent probability level at bid one and follow bid levels.

Education level of the household head: The survey result showed that about 30.7 percent and 22.9 percent sample households willing to pay for bid one and follow bid respectively, were literate, where as 48.4 percent and 47.1 percent of households were illiterate. On the other hand 4.6 percent and 13.1 percent sample households not willing to pay were literate where as 16.3 percent and 16.9 percent of households not willing were illiterate. The chi-square test showed that there is no significant percentage difference between the two groups of households.

Table.4. Distribution of sample households by categorical variables

	Initial Bid one					Follow bid				
Variables	WTP		Not- WTP		χ 2 - value	WTP		Not- WTP		
	Freq	Per	Fre	Per		Freq.	Per	Freq	per	χ2–valu
Sex of head				1.92						2.12
Male	112	73.2	30	19.6		99	64.7	43	28.1	
Female	9	5.9	2	1.3		8	5.2	3	2	
Credit con					1.97					3.52**

Yes	91	59.5	25	16.3		79	51.6	37	24.2	
No	30	19.6	7	4.6		28	18.3	9	5.9	
Edu.Level										
Literate	47	30.7	7	4.6		35	22.9	20	13.1	
Illiterate	74	48.4	25	16.3		72	47.1	26	16.9	
Ava. Aid					3.95*					2.11*
Yes	90	58.8	25	16.3		79	51.6	37	24.2	
No	31	20.2	7	4.6		27	17.6	10	6.5	
Media access					4.78*					3.42*
Yes	103	67.3	25	16.3		96	62.7	31	20.3	
No	18	11.8	7	4.6		11	7.2	15	9.8	

Source: Own survey result, ** ,* means significant at less than 5% and 10% probability level respectively.

4.1.3. Farm Households Risk Perception

Households in the study area perceive that they are exposed to a variety of extensive risks from different sources which are significantly affecting their crop yields during the last ten years. These risks are production risks, drought or shortage of rainfall, flood, diseases and pests which lead to increases their livestock mortality and reduce their yield in crop production during the last ten years. They are also recognized that frequent food aid by NGOs as risk mitigating options not only during bad weather events but also for their income deficits.

4.1.4. Households Risk Management Strategies

In order to reduce the negative consequence of risks that they met households of the study area have employed various risk management strategies such as sales of livestock, during failure of their crops, engaged in off farm activities, like daily worker, receive food aid and cash for six months during sever food shortage, use intercropping and growing short maturing crops during shortage of rain.

4.2. Determinants of Farmers' Willingness to Pay in the Study Area

Households were categorized based on their joint responses to the offered bids (bid one and follow bid).The response of sample farm households' in the double bounded contingent valuation format reveals that the first response is shared by 79.08% of Yes and 20.92 % of No responses for bid one; whereas the follow bid is shared by 69.93% of Yes and 30.06% of No responses.

The model used is checked weather it fits the data correctly or not. As presented in Table 5, the bivariate probit model result showed that for all explanatory variables included in the model the hypothesis that the explanatory variables included are equal to zero is rejected at less than 1% level of significance which indicates the variables included have effects on the dependent variable.

In addition to that bivariate probit model is fitted and have evidence to consider the effect of both bids together. The Wald test of Rho (ρ) =0 is rejected, indicating that the chi-square at 1 degree of freedom is different from zero and it is positive significant at 95% confidence level. The correlation coefficient (ρ) is less than one, indicating the random component of WTP for the first bid is not perfectly correlated with the random component of the follow bid and being greater than zero give us clue for considering to run both bids together to derive efficient result than considering separately, which make the bivariate probit model used fits the data.

In determining the estimate of the bivariat probit model for the WTP the maximum likelihood is employed as the method of estimation. Out of fourteen explanatory variables included in the bivrate probit model six variables have significant influence on farmers' willingness to pay at bid one level, and seven variables have significant influence on farmers' willingness to pay for weather index based crop insurance at follow bid level in the study area.

Thus, variables livestock holding, bid one, annual income, access to media, age of the household head and family size are significantly affecting farmers' WTP at bid one level and seven variables namely, age of household heads, total livestock holding, annual income,

household size, frequency of extension visit, availability of private and public aid, and follow bid are found significantly affecting farmers' WTP at follow bid level in the study area .

The age of the households head has a negative significant effect on farmers' willingness to pay for weather index based crop insurance at less than 10% probability level at bid one and follow bid levels. The possible justification for this is that older farmers may more experienced in traditional risk management strategies and younger farmers might have more awareness to modern risk management practices. The marginal effect is also 0.0084 which shows that for each additional years in the age of household heads, the individuals become 0.84% less likely to pay for weather index based crop insurance , keeping other factor constant which implies that, aged people are less likely willing to pay for weather index based crop insurance than younger people.

Household size has negative and significant effect on farmers' willingness to pay at less than 5% probability level at follow bid level. The possible justification for this is that having large family size exerts greater expenditure on households' consumption which reduces their willingness to pay for crop insurance cover. The marginal effect is also 0.0412 shows that when the number of family size in adult equivalent increases by one the probability of farm households willingness to pay for weather index based crop insurance decreased by 4.12% keeping other factor constant. The result is in conformity with the findings of Hiwot and Ayalneh(2015).

Total livestock holding of the farm households negatively influence farmers' WTP for weather index based crop insurance at bid one and follow bid levels, and significant at less than 5 % and 1% probability level respectively, which was in line with a prior expectation. This shows that farm households which owns more livestock are probably less vulnerable to crop production risks and consequently he/she has a less likely willing to pay for weather index based crop insurance. The marginal effect was 0.0616 indicating that for each additional unit of TLU their WTP for weather index based crop insurance decrease by 6.16% holding other factors constant.

Annual income of the households is another significant factor, and positively affecting farmer's willingness to pay for weather index based crop insurance at less than 10 % probability level at bid one and follow bid levels. This positive effect indicated that respondents with higher annual income were more likely to say yes to the first bid and follow bid than households with lower income. This indicated that households with higher income have a greater ability to pay for their crop insurance cover than the households with lower income. A study by Tefera (2006) recognizes significant association between households' income and their WTP. The marginal effect also shows that keeping the influences of other factors constant at their mean value, a one birr increase in income of the respondent increase the probability of WTP for bid one by 0.001 %.

Access to media has positive and significant effect on farmers' willingness to pay for bid one at less than 10% probability level. The possible justification for this is that media which is major sources of information, enables to use such better risk management strategies like crop insurance. This implies that farm households who have access to media depicted more likely willing to pay for weather index based crop insurance. The marginal effect has also indicated that the farmers who have access to media were 19.87% more likely willing to pay for weather index based crop insurance as compared to those who have no access to media, keeping other factors constant.

Frequency of extension visit has positive significant effect on farmers' willingness to pay at follow bid level at less than 5 % probability level. The possible explanation for this is that farmers who have more contact with extension agents have got more awareness and information on weather related risks, farm management practices, use of farm inputs and improved seeds than those who have less contact with extension agents. The marginal effect is 0.0199 indicates that as frequency of extension visit increases by one the probability of farm households' willingness to pay for weather index based crop insurance increases by 1.99% holding other factor constant.

Availability of private and Public Aid has negative significant effect on farmers' willingness to pay for weather index based crop insurance at follow bid level at less than 10% probability level. The possible explanation for this is that availability of public and private aid makes households feel less or no need to undertake self –preventative measures and hence less likely to pay for crop insurance. The marginal effect is also 0.2616 indicates that probability of those households have got aid from private and public aid is 26.16% less likely willing to pay for weather index based crop insurance as compared to those who have not got aid from private and public sources keeping other factors constant.

Bid one and follow bid levels were hypothesized to bring negative effect on farmers' willingness to pay for the weather index based crop insurance, and the bivariate probit model result also estimated similar result. That is bid one and follow bid have negative and significant effect at less than 1 % probability level. The marginal effect is also reveals that additional 1 ETB on bid one and follow bid levels on farmers' it reduces farmers' WTP for weather index based crop insurance for by 0.0134 % and 0.0067% respectively holding other factor constant.

Table.5. Bivariate probit Estimates of WTP for weather Index Based crop Insurance

Exp.variables	WTP bid one		WTP follow bid		Marginal effect	
	Coefficient	RobStd.Err.	Coeff	Rob.Std.Err.		Rob.Std.Er r.
Sex of HHs	0.0653	0.5283	0.4303	0.5412	0.1130558	0.1734
Cult. Land	0.0783	0.4213	-0.5066	0.26313	-0.08385	0.1528
credit con	0.4286	0.2995	-0.0414	0.3171	0.04646	0.1766
Media access	0.5124*	0.308	0.3832	0.317	0.1987**	0.9749
Exten.visit	0.024	0.02509	0.0682**	0.0311	0.0199**	0.0093
Access to aid	-0.5659	0.3841	-0.7324*	0.4341	-0.2616**	0.1077
Previous loss	-0.0591	0.0693	-0.0188	0.0691	-0.0108	0.2374
Household size	-0.0168*	0.0739	-0.1814**	0.0837	0.0412*	0.0265
TLU	-0.1230**	0.0549	_0.1520***	0.05474	-0.06165***	0.0188
Age HHs	-0.0192*	0.0116	-0.01806**	0.0122	-0.0084***	0.0041
Bid one	0.0028**	0.0825	0.0030	0.0012	0.00134***	0.00044

Follow bid	0.0002	0.00006	0.00008**	0.00006	0.000067***	0.00002
Income	0.00003**	0.00001	0.3288**	0.1598	0.00001*	0.00001
Edu. Level	0.0548	0.2674	0.362	0.276	-0.0369	0.093
_cons	0.9277	0.9352	0.099	0.321		
/athrho			1.4565	0.2714		
Rho			0.8969			

Source: Own survey result**.** , ***, ** ,* means significant at less than 1% ,5% and 10% probability level respectively.

4.3. The Mean WTP for Sample farm households in the Study Area

In the survey, there were specific questions designed to estimate the premium amount that farmers' would be willing to pay for the weather index based crop insurance scheme using the double bounded contingent valuation format of bivirate probit model. Pilot test was done and four initial premium amounts was offered to farmers' as the initial bid after which a follow bid is higher or lower than the initial bid depending on their response to the initial bid. Consecutive bids were therefore offered to the frames depending on weather a negative or positive response was obtained from the previous bid and the one with the last response was chosen as maximum amount farmers' WTP for weather index based insurance.

The double bounded dichotomous choice format was used to estimate the mean WTP from bid one and follow bids offered to the respondents, and analysis was conducted using bivirate probit model. In estimating the mean WTP of farmers for weather index based crop insurance for bid one and follow bids offered to the respondents, while, bid one and follow bids have used as dependent dummy variables in the model. The mean WTP was calculated by dividing bid one and follow bid constant terms by their respective estimator coefficients.

The result showed that bid one and follow bid have negative signs and statistically significant at 5% probability level. This implies that the higher the bid one and follow bids lead to lower the probability of farmers' WTP the bid offered.

The sample farm households WTP for bid one from the estimate of bivirate probit model is

WTP IB_1= Where: = - 0.47=0.0025

= =191.68 Birr per hector

Whereas the mean willingness to pay for weather index based crop insurance by farm households form follow bid of bivariate probit model is:

WTP IB_2== 2942.5 Birr per hector

The mean willing to pay for bid is 191.68 birr per hector , where as the mean willingness to pay by farm households for follow up bid is birr 2,942.5 per hector. The result indicated the farm households of the study area were willing to pay between 191. 68ETB and 2942.5ETB per hector for the proposed weather index based crop insurance.

Table.6. Estimation of the mean from Double Bounded Dichotomous choice Format

Variable	Coef.	Std. Err	Z- value
Follow Bid	-0.00011**	0.00005	2.01
Initial bId	-0.0025**	0.0009	2.60
Constant	-0.4792	0.2763	0.083
Constant	0.1177	0.2644	0.45
Athrho	1.2803	0.2090	6.13
	0.8565	0.5565	
Number of observation	153		
Loglielihood	-147.417		
Wald chi(4)	15.06		
Prob chi 2	0.0046		
Likelihood-ratio test of rho=			

Source. Own Survey Result.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The objective of the study was to assess farmers' WTP for weather index based crop insurance in Mieso Woreda with specific objectives were to identify factors that influence farmers' willingness to pay and mean premium amount that farmers' willing to pay for weather index based crop insurance in the study area. To do this, a cross - sectional survey data were collected from three agro- pastoral kebeles which have chosen out of 29 agro-pastoral kebeles of the woreda. A multi stage sampling technique was used to select 153 agro-pastoral households, and primary data were collected through semi-structured questionnaire with face

to face interview and secondary data was from published and unpublished sources necessary for the study.

Descriptive statistics have been employed to portray demographic and socio-economic characteristics of sample households and Contingent Valuation Method (CVM) of the double bounded dichotomous choice format of a Bivariate Probit Econometric models were applied to explore the factors that influence farmers willingness to pay for weather index based crop insurance and to estimate mean premium amount of birr that farmers' willing to pay for weather index based crop insurance per hector.

The descriptive statics result of double bounded dichotomous choice format of sample households WTP for bid one and follow bid offered to them showed that out total sample households 121 (79.08%) were responded 'Yes' to bid one; whereas 32 (20.92%) of the households were responded 'No' to pay bid one. On other hand, 107(69.93%) of sample households are WTP for follow bid and 46(30.06%) were not WTP for follow bid.
The descriptive statistics result showed that variables; age of the households head, households annual income, cultivated land size, access to media, availability of private and public aid , previous loss, frequency of extension visit, total livestock owned, household size, credit constraint showed significant variations among the WTP and non-WTP households.

The Contingent Valuation Method (CVM) of double bounded dichotomous choice format of bivariat probit model estimate result showed that the mean WTP for weather index based crop insurance calculated for bid one is 191.68 ETB per hector, whereas the mean WTP by sample households for follow bid is 2,942.05 ETB per hector. Thus, the respondents were WTP between 191.68 and 2,942.05 ETB for the proposed weather index based crop insurance per hector in the study area.

5.2. Conclusion and Recommendations

Based on the findings of the study, both short term and long term actions to be undertaken by government bodies, donors, insurance companies and households themselves to reduce the negative consequence of weather related risk have been recommended.

Age of the household head: The finding of the study showed that age of the sample household head had negative significant effect on farmers willingness to pay for weather index based crop insurance at bid one and follow bid levels. Hence giving awareness for

older farmers about consequences of weather related risk and how to use contemporary risk minimizing techniques with usual coping practice in the Woreda can help the farm households to reduce the negative impact of weather related risks.

Household size: finding of the study showed that household family size has negative significant effect on farmers' willingness to pay at follow bid level for weather index based crop insurance. Therefore; policy measures directed towards the provision of better family planning should give adequate attention and priority by the woreda, at zonal and federal government levels, that could help households' willingness to pay for crop insurance.

Annual income of household: The findings of the study showed that annual income has a positive influence on farm households' willingness to pay at bid one and follow bid levels for proposed weather index based crop insurance. Therefore, improving farm households' income through promotion of better livestock management practices, short matures crop, small scale irrigation schemes, and diversification of farm products (value addition and strengthening market linkages) could assist households of the study area to reduce the negative consequences of weather related risks.

Total live stock owned by households had negative significant on farmers willing to pay at bid one and follow bid levels for weather index based crop insurance. Hence creating awareness for farm households to join such type of insurances not only for their crops but also for their livestock might help them to reduce the risk encounters them during their live.

Access to media: The finding of the study showed that access to media had positive significant effect on farmers willing to pay for weather index based crop insurance. Hence, creating access to information on weather related risks through different community conversation programmers, to improve their use of improved technologies and risk management strategies.

Access to private and public Aid: The findings of the study showed that availability of private and public aid had negative significant effect on farm households' willingness to pay at

follow bid level for weather index based crop insurance. Therefore, creating awareness for households who have access to aid from private and public sources will help them to join such a modern risk managing and financial service providing tool to get not only cover for their crops loss but also access to credit for their farm inputs, loan services, etc.

Frequency of extension visit: finding of the study showed that extension visit had positive significant influence on farmers willing to pay at follow bid level for weather index based crop insurance. Hence, improving frequency of contact by improving the number and quality of agricultural expertise with will help farm households to join such type of insurance cover for their crop losses.

The Contingent Valuation Method of the double bounded dichotomous choice format result show that the mean willingness to pay for weather index based crop insurance calculated from bid one is 191. 68 ETB per hectare where as 2,942.50 ETB per hector for follow bid. Thus, the result showed that the respondents were willingness to pay between the ranges of 191.68 and 2942.5 ETB per hectare for the proposed weather index based crop insurance in the study area. Finally the study recommends that policy makers need to aware and act on different socioeconomic and institutional characteristics of households' that influence their WTP for crop insurance.

Besides, the study result showed there is a big difference in the mean WTP at bid one and follow bid levels and needs the government and stockholders to finance and support the schemes to realize national agricultural risk management strategies.

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7. APPENDIX

Appendix I

Table 1. Conversion factors used to compute Tropical Livestock Unit (TLU)

Animal category	TLU
Calf	0.25
Heifer	0.75
Cow or ox	1
Camel	1.25
Donkey	0.35
Sheep or goat	0.13
Chicken	0.013

Source: Storck et al., 1991

Appendix Table 2. Conversion factor used to calculate adult equivalent

Age category	Female

(Years)		Male
Less than 10 years	0.60	0.60
10 – 13	0.80	0.90
14 – 16	0.75	1.00
17 – 50	0.75	1.00
Greater than 50	0.75	1.00

Source: Institute Pan African Pour le Development (1981); cited in Storck et al., 1991

Survey Questionnaire

This Questionnaire is prepared by a graduate student of Haramaya University, in partial fulfillment of the requirements of master's degree in Agricultural Economics and Rural Development. The purpose of the research is to assess the willingness of smallholder farmers' to pay for weather index based crop insurance and to identify the major factors determining their willingness to pay for weather index based crop insurance in Mieso Woreda, West Hararge Zone Oromia National Regional State.

Therefore, I kindly request the respondents to fill the questionnaire in responsible manner so as to realize the general objective of this research.

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Part- I

1. Identification particulars

Name of interviewer _____ Name of Kebele_____ Village _____

Name of enumerator _____ Date of interview _____ Signature _____

1. Farmers Demographic Characteristics

Family code		Code: A	Code: B			Code: C
	Household members(start with the household head)	Relation with head	Gender	Age(year)	Education (years)	Marital Status
01						
02						
03						
04						
05						
06						

07						
08						
09						
10						

Code A: Relation with head 1. Son/ daughter 2. Grandfather/ mother 3.other

Code B.: Gender 1. Male 2. Female

Code C: Marital status 1. Married 2.Single 3.Widowed 4. Divorced

2. Farm households Scio-economic Characteristics

2.1. Do you have your own land? 1. Yes 2. No

2.2. If your answer is 'yes' what is total area of your land in hector? _____

2.3. What is the total area of your cultivated land in hector? _____

Total amount produced during the last 10 year.					Loss in **Birr** during the last **10 years** on average for each crops
Name of crop	Area under crop		Total Production (Qut)	Quantity lost (Kg)	
	Rain fed	Irrigation			
Cereals					
Maize					
Sorghum					
Vegetables					
Onion					
Cash crops					
Chat					
Coffee					
Soya bean					
Sweet potato					

3. Farm households crop production

3.1. Have you observed any changes in the rainfall pattern in the past 10 years? 1. Yes 2. No

3.2. How many times did you incur crop loss for the last 10 years from crop production? _____

3.3. What is your estimated crop loss in **Kg** and in **Birr** in one year? _____

3.4. What is your estimated crop loss in **Kg** and in **Birr** during the last ten years? _____

4. Household asset Endowments/livestock owned by households

	Asset	Number owned currently	Current cost of replacing(in Birr)
	(a)	(b)	(c)
	Livestock Type		
1	Ox		
2	Cows		
3	Heifers		
4	Calves		
5	Sheep		
6	Goat		
7	Donkeys		
8	Camel		
9	Poultry		
	Productive assets		

10	Plough		
11	Spade(akefa)		
12	Pick axe(doma)		
13	Axe(meteriba)		
14	Machete		
15	Bee hive		
	Household goods		
16	Mobile telephone		
17	Radio/ tape		
18	Watch		

5. Farm households annual Income

5.1. Please list the annual Farm income earned from the following source last year

Source of income	Unit	Quantity	Total birr
1.**Crop sale by type**			
Maize			
Sorghum			
Chat			
Coffee			
Fruits and vegetables-			
2.**Sale of live stock**			
Cow			
Ox			

Heifer			
Sheep			
Goat			
Donkey			
Camel			
Poultry			
3.**Animal product**			
Honey			
Milk& milk products			
Egg			
Sub total			
Nonfarm income/off-farm income			
Grand total			

6. Farm households' access to credit and media

6.1. Do you have credit constraints in your area? 1. Yes 2. No

6.2. If your answer in Q, 6.1, is Yes, what is the reason?

1. Lack of banks to lend money in the area 2. Lack of collateral 3. Lack of credit associations

4. Other/specify_____

7. Do you have access to media service in your area? 1. Yes 2. No

7.1. What are your sources of information?

1. Radio 2. TV 3. Extension agent 4. Other/ specify_____

7.2. If your answer in Q, 7 above is Yes, what information's you get from media (multiple answer is possible?

1. Abut expected weather evens 2. About market and price 3.About farm inputs 4. About financial services others/ specify_____

8. Farm households' access to extension service and aid

8.1. Do you have access to extension service? 1. Yes 2. No

8.2. If your answer in Q 8.1 above is Yes, how many times you have been visited by extension agents within years? _____

8.3. What were the purpose of their visits ___ (Multiple answer is possible).

1. To give advice on crop production 2. To give advice on animal production

3. To give advice on soil conservation 4. Marketing 5.To collect debt 6. Other/ specify-_____

9. Have you get any private or public aid in your area? 1. Yes 2. No

9.1. Is your answer in Q, 9 above is yes how many times did you obtain the aid in a year? _____

9.2. If your answer in Q, 9 above is yes, what type or kind of aid you receive?

1. Food aid 2. Farm inputs 3.Money 4.Seeds 5. Other/specify_____

Part II

10. Risk exposure and experiences

10.1. Did your farm get inundated in the last ten years 1. Yes 2. No

10.2. Did your family faced a sever crop loss due to weather related risks in the last 10 years? 1, Yes 2, No

11. Risk perception

11.1. How you would personally experience weather risk causing damage to crop production?

1. Event will not happen to me 2. Likely 3.Unlikely 4. Event will happen to me for sure

11.2. How do you expect the negative consequences would be of catastrophes causing damage to crop production?

1. No consequences at all 2. Small consequences 3. Large consequences

11.3. How important you reduce the negative consequences of catastrophes causing damage to crop production?

1. Not important at all 2. Little importance 3. Very important

11.4. How do you judge your own ability to protect yourself from catastrophes causing damage to crop production?

1. I cannot protect myself at all 2. I can protect myself well 3. I can hardly protect myself

12. Contingent valuation of willingness to pay for crop insurance

12.1. Are you willing to join index based crop insurance scheme for your crop per hector?
1. Yes 2. No

12 .2. If no, please state your reasons?

1. The index is inappropriate/unfair 2. I cope with everything on my own

3. I don't have enough information and am still in doubt 4. I feel the current protection level is enough 5. I don't trust the insurer 6. I can't afford the premium

12.3. How do you judge your own knowledge on insurance?

1. I know nothing 2. I know very little 3. I know slightly 4. I know fairly well

12.4. If your answer in Q 12.1, above is yes, why did you decide to buy crop insurance (multipleanswerspossible)?_____

1. I think agricultural risks (catastrophes) will increase 2. Due to promotion from insurance companies' representatives

3. My neighbors do, so I do the same 4. Due to promotion from local procurement insurances

12.5. What type of agricultural insurance do you want for your crop production?

1. Flood insurance 2. MBI 3. Production insurance 4. Price insurance
5. Drought insurance 6. Rainfall insurance

12.6. What is the expected yield during the year2017/2018? in Birr_____ in Kg _____

12.7. Have you diversity your crops during the last 10 years? 1. Yes 2. No

12.8. Have you perceived there is a risk in the future that damages your crop? 1. Yes 2. No

13. Risk and Weather Index - Insurance

13. 1. Have you incur the following main sources of agricultural risk in your area?

1. Production risks (undesirable events during production such as floods, droughts, pests and diseases, and any other hazardous events which affect crop yields)

2. Market risk (uncertainties linked with prices of inputs and outputs)

3. Financial risk (variability of interest rates or of the value of financial assets, and

Presence of credit)

4. Institutional risk (government action for instance change in policy and regulations that tends to affect farming production)

5. Environmental risks (legal responsibility of agricultural producer)

13.2. Please specify the risks faced for loss of your crop in your area?

1. Pests and diseases 2. Shortage of rain fall 3. Drought 4. Variation in yield

5. Poor access to inputs 6. Delay of rain fall (Rainfall Variability)

14. What is the effect of weather risk on your household (*Tick all that apply*)?

1. Unable to feed my household 2. Unable to send children to school 3. Loss of livestock

4. Water scarcity 5.
Others/specify_____

15. How do you cope with the effects of weather risk (*Tick as many as applicable*)?

1. Reduce consumption 2. Ration food 3. Buy more food 4. Sell assets to buy food 5. Sell livestock to buy food 6. Work off farm to generate income
8.Others/specify_____

16. Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?

1. Very willing to take risks 2. Willing to take risks 3. Indifferent to taking risks

4. Not willing to take risks 5. Not at all willing to take risks

17. Are you aware about rainfall/drought-index insurance? 1. Yes 2. No

17.1. If yes to Q17 above, have **you bought index insurance** to cover your crops loss? 1. Yes 2.No

17.2. If No to Q17 above, why have you not bought index insurance?

1. Lack of funds 2. No idea of how it works 3. It doesn't pay 4.Justdon't like it

18. What factor do you consider when deciding to buy weather insurance?

1. Trust worth of insurance company 2.prenimum price 3. Bias risk 4. Previous pay out

19. Farmer's willingness to pay for Weather Based Index Insurance

19.1. Would you be willing to pay Birr _____ as premium in order to cover one hector of your crop?

(1. Birr 250 2. Birr 300 *3.* Birr 350 4. Birr 400) four initial bids

Depending on what **initia**l **PRICE BID** (250, 300, 350 and 400) you offer the farmer and farmer's response to it, ITERATE the **bid up wards** if farmer's response is **YES** or **down wards** if response is **No,** continue asking/eliciting farmer's **WTP** for **Higher/Lower** amounts until he says **No/Yes**. Show this in Table below.

	Amount WTP Birr (for coverage of 1 hector)	**Check with a tick for Yes and X for No (or write the amount if farmers WTP in birr if any)**	
1	*0*		
2	*≤ 50*		
3	*50*		
4	*100*		
5	*150*		
6	*200*		
7	***250 initial bid for –Group-1(starting point)***		
8	***300 initial bid for Group-2 (starting point)***		
9	**350** ***initial bid for Group- 3(starting point)***		
10	*400* ***Starting bid for group -4(starting point)***		
11	*450*		
12	*500*		
13	*550*		
14	*600*		
15	*650*		
16	*700*		
	List-----birr		

19.2. How would you like the weather insurance package?

1. Only insurance premium 2. Insurance +input loan 3. Insurance + cash loan others/specify_____

19.3. Will you change your management practices simply because you buy weather insurance?

1. Yes 2. No

19.4. How will your management practices change if yes to Q 19.3.? (Tick all that apply)

1. Increase the quantity of fertilizer 2. Start using improved seeds 3. Increase the size of my farm 4. Crop diversification 5. Others _____

20. How much amount you are willing to pay for weather index based crop insurance to cover one hector of your crop?

Minimum amount WTP: Birr --------- ask the next amount that she/he is WTP: Birr _____
Maximum amount WTP: Birr_____

21. What are traditional risk coping strategies you have used to overcome weather risk in your area? 1. Crop diversification. 2. Sales of livestock 3. Saving 4. Loan from other sources /if any_____

Thanks,