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COLLEGE OF BUSINESS AND ECONOMICS
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**Factors that affect adoption of Weather index insurance and its intensity: The case of
Kola Tembien wereda, Tigray Northern Ethiopia.**

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Advisor
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Declaration

I, **ELENI HADGU GIDEY** hereby declare that the thesis entitled “**Factors that affect adoption of Weather Index Insurance and its intensity: The case of Kola Tembien wewda, Tigray Northern Ethiopia**”, submitted by me to the award of the Degree of **Master of Science in Economics (Development Policy analysis)** of Mekelle University, Mekelle, is original work and it hasn't been presented for the award of any other Degree, Diploma, Fellowship of any other university or institution.

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This is to certify that this thesis entitled “**Factors that affect adoption of Weather Index Insurance and its intensity: The case of Kola Tembien wewda, Tigray Northern Ethiopia**” submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science in Economics (Development Policy analysis)**, to the College of Business and Economics, Mekelle University, through the Department of Economics, done by **Ms. Eleni Hadgu** Id.No. CBE/PE094/02 is an authentic work carried out by her under my guidance. The matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief.

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DEDICATION

I dedicate this thesis to my beloved family

Abstract

Weather index micro insurance mechanisms are highly recognized as preferable ways to finance the drought risk. The objective of this paper is to analyze factors that affect adoption of weather index insurance and to examine the amount of insurance in Kola Tembien-wereda of Tigray Region. The study uses Heckman two- stage model to examine this issue. First, we determine the factors which affect the weather index insurance adoption decisions and at the second stage we focus on the amount of insurance purchase using Heckman-Two-Stage estimation procedure. The data for this study is based on the survey data by HARITA project from Kola-Tembien wereda of central Tigray. Heckman suggests a two stage estimation method to correct the bias as a result of self-selection in the decision and outcome models. In the first stage of the model, the decision equation is the household's decision to adopt or not to adopt WII which will be estimated based on the probit model. In the second stage, only the households having adopted WII have been used. The result indicate that marital status of the household head affects negatively, PSNP participation, number of oxen owned, Perception about drought incidence were found to be affecting the WII adoption positively and significant. Regarding the amount of insurance purchase education, rain fed land owned, Type of Hutsa soil were found both positive and significant.

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List of Abbreviations and Acronyms

WII - Weather Index Insurance

IBLI - Index Based Livestock Insurance

MPCI-Multiple peril crop insurance

PSNP - Productive Safety Net Program

CV - Contingent Valuation

EIC-Ethiopian Insurance corporation

LAFU-Limu Adama Farmers Union

MFI-Micro Finance Institution

NISCO-Nyala Insurance Share Company

OLS-Ordinary Least Square

WTP - Willingness to Pay

WFP- World Food Programme

WIBM- Weather index based micro-insurance

REST - Relief Society of Tigray

DECSI - Dedit Credit and Saving Institutions

HARITA - Horn of Africa Risk Transfer for Adaptation

OA - Oxfam America

IRI - International Research Institutes for Climate and Society

IAIS -International association of insurance supervisors

ENMA - Ethiopian National Meteorological Agency

IMR - Inverse Mills Ratio

CSA - Central Statistics Agency

GDP - Gross Domestic Product

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Chapter One: Introduction

1.1 Back ground of the study

Risk and vulnerability to risk are fundamental causes of underdevelopment (WorldBank 2000, Dercon 2006, and Islam 2007 in Paul, 2009). Shocks causing a loss of income and productive potential may force poor people to sell productive assets in order to smooth current consumption. This may have long-term negative effect, because poor people are likely to lose their productive assets leading them to engage in less productive activity and then falling into poverty trap (Mosley, 2009).

In economies where agriculture is a dominant sector rainfall and rainfall variability has greater impact in agricultural performance and Weather conditions and related effects of climate change, such as heavy rain leading to flooding, and prolonged drought can devastate a rural economy by damaging the major source of household income. Where there are no mechanisms to cope up with such shocks to protect against large losses from extreme weather events, household income and economic activities are likely to be depressed (USAID, 2006).

In many cases, farmers could benefit from investing in agricultural activities that require higher initial investments that ultimately would generate higher income, if the risks affecting these investments such as weather could be managed Since banks or other intermediaries that work with agricultural producers carry the same risks as their agricultural clients, they become hesitant to invest in agriculture due to potential defaults during or after a weather event (UN, 2007).

Since the resources of poor farmers are limited, they likely fail to smooth their current consumption during unexpected events, such as illness of the bread maker of that household. If a wage earner is injured or falls ill, there is not only the loss of income and labor, but the prospect that without cash in advance there will be no treatment at all. A poor person's income may be a great carry to the family's economy. Thus even small sums insured against drought can guarantee some protection and peace of mind for a poor person (McCord, 2007). Weather-related loss can quickly destroy sources of current income such as existing crops, even more devastating, they can

also destroy household assets often accumulated over years of savings and investment that are needed to generate future income(USAID, 2006).

Managing weather risk efficiently, coupled with other investment activities in the agricultural sector, could strengthen the flexibility of farmers and agribusinesses to weather shocks (UN, 2007). Weather index insurance is a product designed to provide compensation to farmers when the rainfall during a crop growing cycle is inadequate. However, weather index insurance does not measure changes in yields, but changes in rainfall assuming that if rainfall is bad, farmer's harvest will be poor also (Shadreck Mapfumo, 2007).

Insurance that may allow the transfer of risk may help small farmers to insure against risk enabling them to plan for the drought season. Weather index insurance policies can automatically pay the fixed sums insured to the farmers when the rain fall is inadequate during the critical time in crops growth and they access credit since weather index insurance serve as a substitute for physical collateral and give financial institution more comfort and incentive to lend to the sector (UN, 2007).

Weather index insurance is insurance that is accessed by low-income population provided by a variety of different unit, but run in accordance with generally accepted insurance practices (which should include the Insurance Core Principles). Importantly this means that the risk insured under a weather index policy is handled based on insurance principles and funded by premiums. The weather index insurance activity itself should therefore fall within the terms of the applicable domestic insurance regulator/ supervisor or any other competent body under the national laws of any authority (International association of insurance supervisors (IAIS), 2007).

Weather index insurance entails risk transfer against events that cause loss. If a pre-defined weather event occurs during a pre-defined time, such as a shortage of rain during a critical period in a crop's growth, this event generates pre-determined payments to farmers who buy the policy. Index refers to the fact that the insurance is based on a proxy for loss and an objectively verifiable measure of weather (HARITA, 2009).

In Ethiopia in general and in Kola Tembien (the study area) in particular, agriculture is the main source of income and employment. It accounts for about 50 percent of the Gross Domestic Product, provides for about 80 percent of employment, generates about 90 percent of the export earnings and supplies about 70 percent of the country's raw material to manufacturing activities (Craig McIntosh, 2010). Crop production is estimated to contribute on average for about 60 percent of agricultural production, while livestock accounts for about 27 percent and forestry and other sub sectors about 13 percent of the total agricultural value (Craig McIntosh, 2010).

Ethiopia is one of the few countries in the world that has been devastated by two extreme hydrological phenomenon: extreme drought and extreme flooding, both of which compound the land degradation problem (WFP, 2010). The direct results are a dramatic decrease in agricultural productivity and an increase in poverty, as a coping mechanism, some farmers have diversified crops in the case of drought or have sold cattle to repay loans or buy food (WFP, 2010).

The Government of Ethiopia's Agricultural policy aims to achieve rapid economic growth through the development of a free market economy, with the intention of liberating Ethiopia from aid dependency. Index insurance can be used to insure small farmers, so that they can engage in productive activities (WFP, 2010).

Index insurance was first piloted in the Ethiopia with assistance of the World Bank Commodity Risk Management Group in 2006 and was based on consistent rainfall data from 26 weather stations in the country (Smith & Chamberlain, 2010). The policy hence attempted to mitigate weather-risks not on the individual but macro- level and was implemented through a partnership between the World Food Programme (WFP) and the Government of Ethiopia. The main objective was to insure small farmers against the risk of drought (WFP, 2010).

In 2009, WFP gave technical support to the weather index pilot by providing a framework for the design of the insurance contracts and Nyala Insurance Company (NISCO), with guidance from WFP, designed the contracts for smallholders in the area of Bofat/Sodore near Nazareth (WFP, 2006; WFP, 2007; Syroka and Wilcox, 2006 in Smith and Chamberlian, 2010).

The project partners of HARITA work together on designing an affordable, drought insurance prototype package for Teff in Adi Ha in the year 2009, (HARITA, 2009). In late May 2009, 20% of households in Adi Ha sign up for a weather index insurance product for Teff, a widely grown cereal crop. Out of these households, 38% were female-headed and 65% were participant of the Productive Safety Net Program (PSNP), a well-established government program that serves 8 million chronically food insecure households in Ethiopia (HARITA, 2009).

1.2 Statement of the problem

Households with low incomes and limited wealth are reluctant to adopt risky, but high yield agricultural inputs (Skees et.al, 2002). Such risk averse behavior of farmers reduces households' incentive to adopt productivity enhancing technologies and to specialize in activities where comparative advantages exist (Skees et.al, 2002). Such risks also affect the credit-worthiness of rural households and constrain credit markets (Skees et.al, 2002).

It is intuitive to expect small farmers to have limited opportunities for income from farming leading these households to work and engage in off-farm activities. Working on others farm in the community for cash or in-kind payments is common among the rural poor (Skees.et.al, 2002).

Since many of the sources of income remain tied to the wellbeing of the farming sector in the community, managing drought risk through WII can protect agricultural output (Skees et.al, 2002).

Weather Index insurance is a financial product linked to rainfall index which is correlated to local yields and the contracts are written against specific perils or events (e.g. drought, flood) that are defined and recorded at regional levels (e.g. at a local weather station) (WFP 2010).

Adopting weather index insurance policies for managing agricultural risk in return for reasonable premium payments proportionate to the likelihood and cost of the risk, can handle the sum insured declared by the households (Bendig and Arun, 2011).

Since agricultural activity and farmers income is susceptible to natural events, such as rainfall and draught risk, understanding and intervention through the adoption of WII to address weather related risks may improve the wellbeing of poor rural farmers.

Having this importance of WII for the drought risk management, in 2009 the project partners of HARITA designed, drought insurance for small holder farmers in Kola Tembien wereda Tabia of Adi Ha. During the design of WII HARITA has employed different mechanisms developed in combination with farmers, such as storytelling and participatory games and others. Thus in this study, we try to investigate what are the important variables for both the adoption decision and amount of WII purchase.

1.3 Objective of the study

The general objective of the study is to investigate what factors can influence the adoption of weather index insurance and the amount (intensity) of farmers' adoption of weather index insurance. The specific objectives are:

- i) To identify and analyze factors that influence adoption of weather index insurance in the study area
- ii) To study the amount of WII purchase in the study area

1.4 Scope and limitation of the study

The study is limited to the analysis of factors influencing the adoption of weather index insurance and the amount of insurance purchase in Kola Tembien Wereda of Central Tigray

Weather index insurance is a recent practice which has been carried out in the last two years in Kola Tembien wereda. Hence limiting the study to this area and focusing in it will give a meaningful result.

The selected area is the one which is much better familiar in weather index insurance practice than other districts of the region, so it seems reasonable focus in it.

The study is based on the data collected by HARITA project from the wereda, focused only on analyzing factors that possibly can influence the adoption of weather index insurance and amount of purchase.

It is important to note that in this study is location specific; therefore, its results could not be representative at regional or national level. However its policy implications and recommendations could be used as a base for further study

1.5 Significance of the study

A study of factors influencing adoption of weather index insurance is important, because it provides information that will enable to take effective measures to improve the weather index insurance performances and their success in the rural financial markets. It will also help insurers and policy makers towards informed policy makings in relation to where and how to guide efforts in order to protect drought risk.

The study may also serve as a source material for researchers who would like to make further study in the subject matter.

1.6. Organization of the Study

This paper was organized into five chapters. The first chapter deals with the introduction of study that consist of back ground of the study, statement of the problem, objective of the study, significance of the study, hypothesis to be tested, scope and limitation of the study and , the second chapter deals with literature review including theoretical and empirical studies. The third chapter presents the research methodology including source of data, method of data analysis. The fourth chapter brings forth the results and discussion includes descriptive and econometric analysis and the last chapter depicts conclusion and recommendation.

Chapter Two: Literature review

2.1 Theoretical literature

2.1.1 Definition of Adoption

Adoption can be explained as a mental process through which an individual goes from first hearing regarding an innovation or technology to ultimate acceptance (Rogers, 1983 in Kidane, 2001). This implies that adoption is not an immediate result but a progression i.e. farmers adopt technologies gradually.

Adoption is observed as a variable indicating behavioral change that farmers experience in accepting new ideas and technologies in Agriculture (Aregay, 1979, in Kidane G, 2001). The term behavioral change refers to desirable change in knowledge, understanding and ability to follow technological information, changes in emotional behavior such as changes in interests, attitudes, objectives, values and the like; and changes in recognizable capability and skill.

The Adoption of a technological change in agriculture is not the same at the farm level. It is a complex process which is ruled by many socio-economic factors. Changes in the awareness and attitudes of farmers towards improved agricultural technologies and the institutional factors can act incentives/disincentives to agricultural practices and the farmers' resources endowment like the land holding size and labor are some of the factors of considerable importance in bringing about the technological change in agriculture (Aregay, 1979; Salim, 1986, in Kidane, 2001).

2.1.2 Adoption of Micro insurance for managing agricultural production risk

A large body of theory and empirical work in development economics argues that technology adoption (and income-maximizing production choices) may be hindered when returns are risky and insurance or other financial markets are imperfect (Gine & Yang, 2007).

Agriculture all over the world is subject to risk. But the situation in developing economies like Ethiopia is different due to the lack of well-functioning markets to mitigate the effects of risk.

Informal mechanisms exist, but available empirical evidence suggests they are either inadequate or very costly (Rosenzweig and Binswanger, 1993; Dercon, 2004, Carter et al., 2007 in Bendig and Arun, 2011).

The evolution of micro insurance promises reducing the vulnerability of poor people to negative shocks and their consequences on income and consumption (Bendig and Arun, 2011)

In developing countries like Ethiopia production risk is a major source of income fluctuations for rural households involved in agricultural activities. Because high-yield varieties are more profitable but also riskier, households who are hesitant to accept consumption fluctuations may decide not to adopt (Gine & Yang, 2007). Furthermore, in many situations the lack of access to credit has usually been considered a major obstacle to technology adoption and development (Gine & Yang, 2007).

According to Arun, (2011) rural households can manage risk at two stages, ex ante and ex post of the occurrence of such shock. First, households can smooth income by diversifying economic activities and choose traditional production or employment activities to prevent the households from the consequences of shocks before they occur. Second, households can smooth consumption by borrowing, saving, accumulating non-financial assets, changing labor supply, using formal and informal insurance arrangements to mitigate the consequences after the incidence of a shock. Using micro insurance policies for managing agricultural risk in return for regular and reasonable premium payments proportionate to the likelihood and cost of the risk, can handle the sum insured declared by the households (Bendig and Arun ,2011).

2.1.3 Definitions and concepts of Micro insurance

There are many approaches by different writers for the definition of micro insurance some of them are as follows:

Micro insurance is the provision of insurance services to low income people. This means that when the providers target or sold the insurance product to low income people it is said to be Micro insurance (Roth, et al. 2007).

Wenner, (2005) defined Micro insurance as a financial contingency contract that transfers income risk from a producer to the insurer through the payment of premium that reveals the true long-term expenditure of the insurance cover provider who is assuming the risks. The insurer pools the possible risks faced by a huge number of individuals and covers losses sustained by any one individual in the group. It provides to basically protect assets, stabilize income, and smooth consumption of low income people

According to Roth, et al. (2007) Micro insurance is a risk management mechanism under which individuals, businesses, and other organizations or entities, in exchange for payment of a premium, distribute the risk of potential financial loss by indemnifying for losses resulting from certain peril under specified situation.

The International association of insurance supervisors (IAIS) (2007) also defined Micro insurance as it covers a variety of different risks, including illnesses, accidental injuries, and death and property loss basically any risk that is insurable, and is designed to be appropriate in terms of affordability and accessibility to low-income households. They can be offered as a single risk product or as a bundled risk product. Coverage can also be provided on an individual or group basis.

According to Rachele Pierro (2007) Micro-insurance is the protection of low-income people against specific perils in exchange for regular premium payments balanced to the probability and cost of the risk involved. Specific perils can be death, small-scale assets, livestock, crop and damage to farm out puts.

2.1.4 Principles of Micro insurance

According Roth, et al. (2007) for micro insurance to be workable and sustainable, there are certain “principles” conditions for the risk to be considered insurable and for a successful market to appear.

Symmetric Information: The insurer and the policyholder should have the same information on the distribution of probable losses so that appropriate risk categorization can occur. Insurers normally do not develop premium rates on an individual basis since it would be extremely costly. Instead, insurers classify applicants into identical risk pools and calculate a premium for everyone in that group. In order to calculate probable losses for diverse groups of risks, extensive amount of reliable and accurate information is needed on weather patterns, yields, market trends, farm conditions, farm management ability, risk attitudes, and capacity to pay for the insurance.

Large Number of Similar Exposed Units to the risk: The statistical Law of Large Numbers upon which the actuarial model apply to calculate coverage, compensation, and premium levels , states that the higher uncorrelated risks that are added to a portfolio the lower the variance of result for the entire portfolio. Thus, for the actuarial models to be correct the size of the pool or collection should be large and the risks faced in a specific class or group should be parallel.

Statistical Independence of Risks: Risks should be approximately or completely independent across insured individuals and spatially uncorrelated. Micro Insurance bases the principles of diversification as a result; the key concern is the extent of association in financial losses caused by the risk to be insured. The more spatial correlation there is the less efficient insurance will be as a risk transfer system. When losses are catastrophic, the risk–pooling advantages of insurance

breaks down since the contributions of the unaffected are inadequate to cover the damages of the affected.

Quantifiable Expectancy, Frequency and extent of Loss: The insurer should be able to estimate the average frequency of the accidental event to be insured together with the average severity of loss. For low-chance risks with potentially catastrophic effects it is often hard to estimate the average expected loss, because there are very little data points.

Actual Losses must be Determinable and quantifiable: The actual loss should be clearly and principally related to the random event insured and it should be substantial and quantifiable loss. If this is not the case, claims settlements will be likely to highly debatable. Customers will lose loyalty in the micro insurance practice and insurer's administrative costs will become higher.

Potential Losses must be Significant and an Insurable Interest must exist: potential buyers must recognize the possible loss as major and ahead of their own income to cover; if not there will be no reason to pay for insurance. Furthermore, insurance cannot be provided to policyholders who have no insurable interest in a loss occurring.

Limited Policyholder Control over the Insured Event: Insurance protection must not be offered if policyholders can control whether an insured event will occur. If a policyholder has sufficient control over whether a risk can occur, they can take advantage of the insurance and generate "moral hazard or suspect claims.

Premiums should be economically affordable: for an insurance policy to be attractive to potential policyholders the annual premium cost must be substantially less than the potential benefit offered by the policy. A market for insurance may fail to appear, if the majority of clients are very poor, very inaccessible, and/or the chances of losses are high. A fully loaded premium could exceed the estimated cost of a one-time loss and make the product uneconomical and useless.

2.1.5 Types of micro insurance products

The types of micro insurance products are almost as varied as that of commercial insurance i.e. the range of micro insurance products on offer is also wide. However, in this paper we are concerned with the following three types: Traditional insurance, weather index insurance and micro life and health insurance.

2.1.5.1 Traditional insurance

Traditional insurance makes an indemnity payment when the farm household sustains a loss. To pay indemnities, the insurance provider makes estimate of loss for each farm household that makes a claim (USAID, 2006).

Traditional agricultural insurance consists of multi-peril or single-peril insurance tools that involve an insurance adjustor to physically verify assets (ex ante) and losses (ex post) on an individual farm basis. Under single-peril insurance, indemnities are paid for losses incurred for a single risk, such as hail or fire. Under multiple-peril insurance, indemnities are paid for losses incurred from a broad range of risks (Arias & Covarrubias, 2006).

Multiple peril Crop insurance (MPCI) also called yield based crop insurance. Insured yield (e.g. tones/ha) is established as a percentage (typically 50-70 percentage) of the historical average yield for the insured plot. If the realized yield is less than the insured yield, an indemnity is paid based on the difference between the actual yield and the insured yield (Skees and Barnett, 2004). As it is usually difficult to verify the exact source of loss, MPCI typically protects against many different causes of yield loss. When insuring for multiple perils, it is very difficult to first to identify the set of perils that may have created losses and then perform loss assessment that attempts to separate the actual loss peril. It is often difficult to tell whether the loss was due to an insured event (e.g. drought) or to poor management practice (Skees, 2008).

2.1.5.2 Weather index insurance

Weather index insurance is one of a number of index-based financial risk transfer products that have the potential to help protect people and income against climate shocks and climate risk. It is insurance that is related to a weather index such as rainfall, rather than a potential consequence of weather, such as crop failure. Unlike traditional insurance against crop failure, the insurance

company does not need to visit farmers' fields to determine premiums or to assess damages (reducing transaction costs). If the rainfall amount is below the earlier agreed-upon threshold, the insurance pays out. This method also eliminates the moral hazard of crop insurance, where farmers may actually prefer their crops to fail so that they receive a payout. With index insurance, the payout is not connected to the crop survival or failure; hence the farmer has the incentive to make the best effort for crop survival (IRI, 2007).

Weather indexed risk management products signify a newly developed alternative to the traditional crop insurance programs for smallholder farmers in the rural financial markets. These products are based on local weather indices; the index is highly correlated to local yields. Indemnifications are triggered by pre-specified guide of the index, not by actual yields this also depends on factors beyond the control of farmers, which reduces the occurrence of moral hazard and adverse selection. It also avoids the need for field visits, which speeds up claim settlement and considerably reduces costs. Because the insurance is based on a consistent and independently verifiable index, it can be reinsured, allowing insurance companies to transfer part of their risk efficiently to international markets (UN, 2007)

Index-based micro insurance can be implemented at different levels: micro level (Individual or Group policies) and macro level (Multi-countries and National policies). The micro level offer protection to weather risks that affect a farmer directly in terms of his agricultural production. The macro level focuses on risk at an aggregate level and when crop production is affected on a regional, national or multi-country level. Usually, macro level projects focus on different policy objectives and target different segments of the rural population with different risk profiles, who therefore have different risk management needs. The indexed based micro products focus on increasing the productivity and income of the less poor farmers, they are usually offered with packages of credit and input supplies. The macro index insurance is intended to provide mechanisms that protect poor farmers and the poorest of the poor in the occurrence of weather shocks. Direct insurance may not be the most suitable solution for the macro group; they need other direct investments to deal with chronic levels of risk they face before they can fully benefit from micro tool (Rachele Pierro, 2009).

2.1.5.3 Life & Health micro insurance

Life insurance provides cover against death risks, whereas Health insurance helps households cover the costs of hospital and surgical expenses, medications, and doctor's fees. Health insurance policies usually pay for some or all of the costs incurred as a result of specified accidents or illnesses. These costs are generally reimbursed to the household after verification of a claim or paid directly to the care provider. The choice of health problems covered and the expected cost of treating these problems determine the premiums and the degree of risk for the insurer (Brown and Churchil, 1999).

Provision of health insurance is more risky and more complex than either life or WII for two reasons. First, the causes of health risks are much more varied and require more detailed information to identify and classify the relative risk-level associated with a prospective policyholder. Second, there is a greater risk of unexpected increases in claims due to adverse selection and moral hazard and insurers must protect against potential claims misuse by both the insured and the health care provider (Brown and Churchil, 1999).

2.1.6 Micro insurance development in Ethiopia

Considering Ethiopia's dependency on agricultural employment and income and its exposure to weather risks, there have been a number of insurance pilot projects in the country that attempt to deal with particularly the risk of variable rainfall and drought. These pilot projects all involved several studies conducted through index-based insurance.

According to Smith & Chamberlain, (2010) there are three recent pilot projects or experiments with weather-index insurance in Ethiopia.

World Bank crop insurance pilot

Throughout the 2006 crop season, the World Bank supports the progress of a pilot project on weather-based index insurance for rainfall risks associated with maize production in the Alaba woreda of the Southern Nations, Nationalities, and People's Region (SNNP). The Ethiopian Insurance Corporation (EIC) was chosen to give underwriting for the insurance project and

product marketing was assisted by two cooperatives in the region. Farmers living close to the weather station in the Alaba woreda were identified as potential clients. While individual farmers would be the policyholders, the cooperatives were used as client representatives to facilitate the contract with farmers. Given that only 28 farmers decided to purchase the product, no reinsurance was obtained (AFTS2 & CRMG, World Bank 2006 in Smith & Chamberlain, 2010).

Nyala Insurance crop insurance pilot

In 2007, Nyala Insurance, jointly with Swiss Re, piloted an agricultural insurance product for low-income farmers that are members of the Lome-Adama Farmers' Cooperative Union (LAFU). LAFU operates in 3 woredas east of Addis Ababa. The major crops in this area include teff, wheat, beans and maize. LAFU has 24 primary farmers' cooperatives with a total of 20,000 members (approximately 80,000 family members if an average family size of 4 is assumed) (Meherette, 2007 in Smith & Chamberlain, 2010). The union provides various inputs (including tractors, better yield seeds and pesticides) and after-harvesting services (storage and marketing support) to farmers. One of the main reasons for selection of LAFU for the pilot was its proximity to 5 weather stations which had 20-35 years of historical rainfall and temperature data.

The insurance provided covers a package of risks and perils, including rainfall risks (drought and excessive rainfall), fire, windstorms, fire and lightning, explosion and certain special perils such as hail, floods, impact of aircraft/aerial devices. Yet, the vastness of the risk cover provided is based on rainfall. Although an index approach was used for rainfall risks, the other perils and risks would require loss adjustors to visit the farmers and evaluate the damage (Meherette, 2007, in Smith & Chamberlain, 2010).

In this pilot 120 members of LAFU were selected to buy the insurance product. No claims were experienced during the pilot period 2007. In 2008; Nyala extended its pilot to include a second union (Meherette, 2007 in Smith & Chamberlain, 2010).

World Food Programme (WFP) humanitarian insurance: Experimentation with macro-level weather-index insurance

The world's first humanitarian assistance insurance policy was purchased by the United Nations World Food Programme (WFP) from Axa Re in the year 2006. The policy provided US\$7m cover in emergency assistance in the case of severe drought in Ethiopia during the 2006 agricultural season (World Food Programme, 2006). The insurance pilot was developed with assistance from the World Bank Commodity Risk Management Group and was built around standardized rainfall data from 26 weather stations in Ethiopia. Pay outs to be effected based on a significant fall of the rain fall lower than the historic rainfall averages in the period March to October 2006(WFP, 2006 in smith and Chamberlian, 2010).

The pilot policy issued to manage weather-risks not on individual but macro-level. If a drought had occurred during the covered period, Axa Re would have paid US\$7.1 million to the WFP for a premium of US\$930,000, which would then have transferred the funds to the Ethiopian government. These funds would have been paid out as cash aid to households. The reach of the benefits of the policy would thus have been dependent on the Ethiopian government's ability to effectively distribute the funds to households in need.

There was no drought in 2006 all over the country therefore there was no payout but according to WFP, this pilot project has shown that drought risk is suitable for transfer to international markets (WFP, 2006 in Smith and Chamberlian,2010).

In 2009, WFP gave technical support to the weather index pilot by providing a framework for the design of the insurance contracts and Nyala Insurance Company (NISCO), with guidance from WFP, designed the contracts for smallholders in the area of Bofat/Sodore near Nazareth (WFP, 2006; WFP, 2007; Syroka and Wilcox, 2006 in Smith and Chamberlian, 2010).

The project partners of HARITA with IRI and Swiss Re in the guide at the international level, and Nyala Insurance Co., Dedebit Credit & Savings Institution (DECSI) & REST at the regional level work together on designing an affordable, drought insurance prototype package for Teff in

Adi Ha in the year 2009, (HARITA, 2009). In late May 2009, 20% of households in Adi Ha sign up for a weather index insurance product for Teff, a widely grown cereal crop. Out of these households, 38% were female-headed and 65% were participant of the Productive Safety Net Program (PSNP), a well-established government program that serves 8 million chronically food insecure households in Ethiopia (HARITA, 2009)

2.2 Empirical literature

Even though limited numbers of studies have been executed on the adoption of WII in some countries; most of them indicated that the availability of micro insurance for rural households has positive effects on agricultural productivity.

A study by Gine & Yang, (2007) employed a randomized field experiment as part of the Malawi Technology Adoption and Risk Initiative. This paper presents the results from an experimental study that tested whether managing risk promote technology adoption. The study asks 16 “uninsured” (control) localities and 16 insured (treatment) localities with similar baseline characteristics on average. Nearly 800 maize and Groundnut farmers in Malawi (where the dominant source of production risk is the level of rainfall) were offered credit to purchase high-yielding hybrid maize and improved groundnut seeds in advance of the planting season. Farmers were randomized into two groups that differed in whether the loan was insured against poor rainfall. Take-up was 33. Percent for farmers who were offered the uninsured loan. Contrary to expectations, take up was lower, by 13 percentage points, among farmers offered insurance with the loan.

They also provide suggestive evidence that reduced take-up of the insured loan was due to the high cognitive cost of evaluating the insurance: insured loan take-up was positively correlated with farmer education levels & statistically significant at the 10% level. By contrast, take-up of the uninsured loan was uncorrelated with farmer education. This suggests that marketing efforts devoted to reducing the complexity of the insurance from the farmer perspective can help ease the acceptance of such insured or contingent loans.

In this study for nearly all the variables presented (gender of the respondent, female headship of the respondent’s household, household income, respondent’s age, land ownership, risk tolerance, having experienced a drop in income due to drought, trust in the insurance company and an

index of housing quality constructed from indicators for various household facilities), the difference in means is not statistically different from zero. The sole exception is that years of education among treatment group respondents is 0.82 years lower than in the control group, and this difference is statistically significant at the 10% level and seen as farmer years of education is a key variable.

Cai H. et al. (2010) conducted a study in Southwestern China from a large randomized natural field experiment on Animal Husbandry Workers that evaluates the effect of micro insurance on subsequent production for 480 villages in the experimental sample. In this study OLS model was used to analyze the effect of insurance on subsequent sow production. In the OLS the number of sows in a village was regressed against the number of insured sows, number of sows measured in March 2008 and June 2008, about three and six months after the experiment respectively, on the number of sows insured during the experimental period.

However, in order to estimate a causal effect of insurance on production it uses the random experimental group assignment as instruments for the number of insured sows in order to recover the causal effect of insurance access on subsequent production. The result indicates that having access to formal insurance significantly increases farmers' tendency to raise sows.

A study conducted by Chantarat, et al. (2009), in Northern Kenya in five arid and semi-arid locations on Willingness to pay for Index based Livestock insurance (IBLI) is designed for managing livestock asset risk. Livestock is considered the major source of income for households in these study areas with an average of 63% share of livestock income from total income. Household's insurance demand in this study is modeled as a sequential decision as they first choose proportion of herd to be insured and then make willingness to pay decision conditional on the chosen coverage. To estimate this a modified Heckman two-step conditional expectation correction approach was applied to estimate pastoralist insurance demand with first step ordered probit model and second step bounded likelihood model to estimate the insurance coverage and WTP decisions, respectively.

Income, availability of coping strategies and household's expectation of loss are found to be the key drivers for insurance coverage decision. Conditional on chosen coverage, wealth, risk preference, perceived basis risk and subjective expectation of loss thus serve as the key WTP

determinants among sampled households, well informed about mechanics and value of IBLI contract.

A study by Cole et al, (2007) in rural Gujarat reports the results from a large-scale randomized field experiment that offered weather insurance to farmers in over 50 villages for a sample of 1500 households. Overall, 72% of the households reported agriculture as the main source of income. Many more households reported agricultural labor (45%) as their primary source of income, relative to own cultivation (19%). The households in this study are very poor and only 17% of the sample, on average, reported being illiterate.

The finding presents that education, income, and risk aversion are correlated with the decision to purchase weather insurance, though; they find that more risk-averse households are less likely to purchase insurance.

Furthermore the second set of findings related to the effects of marketing manipulations it is found that awareness had a significant effect on household decisions to purchase insurance, increasing take-up by twelve percentage points. The study also presented demand for insurance was very price sensitive, having large effects on household purchase decisions (Cole et al, (2007)).

Empirical study made in India by Bhat & Jain 2006, using two stages Heckman model based on survey and collection of primary data from Anand districts of Gujarat where Charotr Arogya Mandal is offering a health insurance scheme. This study showed that the determinant factors which affect the health insurance demand and put the result that income and health care expenditure are significant determinants of health insurance purchase.

Age, coverage of illness and knowledge about insurance were also found to be affecting health insurance purchase positively. For the decision regarding amount of health insurance purchase, income was found to be having significant but non-linear relationship. In addition, number of children in the family, age, and, perceptions regarding future healthcare expenditure were found to be significant.

Bendig and Arun (2011) presents evidence on the determinants of micro life & health insurance participation using probit models on household survey data from Sri Lanka, conditional on

household's microfinance institution enrolment. The study also employs multivariate probit regressions to analyze factors affecting household's decision to participate in which type of micro insurance i.e. life, health and other insurances, offered by microfinance institutions in Sri Lanka.

Furthermore, results of the study site reveal several patterns. First, female-headship of a household is positively associated with the enrolment in a MFI and the use of micro health insurance in Sri Lanka. Micro insurance providers, especially in the case of micro health insurance, should take into consideration the higher propensity of female headed households to participate in such schemes. Second, household size is negatively linked with the membership in a MFI. In contradiction to this, they found that household size is positively associated with the participation in micro life and any other insurance. Third, a u-shaped age pattern may be confirmed. Household heads have a decreasing willingness to pay up to a specific age, before the willingness to pay for insurance increases due to higher incentives to protect their families from certain hazards. Fourth, they found that better off households are more likely to become a member of a respective MFI, while the poor have a lower accessibility to enter any MFI under study. Conditional on household's enrolment in a MFI, the poor are more likely to be excluded from the insurance market. Particularly, the poor are significantly less likely to participate in a micro life and micro health insurance scheme.

There is strong evidence that the micro insurance products they study have not yet succeeded in proportionately reaching the most vulnerable households that presumably would benefit most from protection against hazards such as death, illness or any other insurable peril. Extending the financial accessibility through MFIs and better suitability to the specific target group may therefore be two strong pillars of a strategy for improving access to insurance products for the low-income population groups.

In addition, there is evidence that education of the household head is a significant determinant of household's MFI enrolment and insurance participation in Sri Lanka. Finally, they reported that remittances may function as an additional financial resource for household's MFI membership and especially for insurance participation (Bendig and Arun, 2011).

A study conducted by Alam, (2010) in Bangladesh coastal zone, one of the most vulnerable regions to climate change. Thus Weather index based micro-insurance (WIBM) is one method of

reducing such climate risks and minimizing income and consumption variability faced by the rural poor in coastal regions. A total of 480 households from 16 villages in the coastal zones were surveyed. Tobit model analysis was used to estimate the willingness to pay for WIBM, identify its determinants and test for commercial viability. Of the surveyed households, a significant portion was vulnerable to cyclone and nearly half participated in at least one NGO micro-credit program.

The model's results show that household's vulnerability to cyclone, economic status, respondent's sex and level of education, awareness, perception of cyclone occurrence, access to media and NGO micro-credit membership positively affects the willingness to pay whereas dependence on aid has the negative effect.

According to Hill et al, (2011) examine the determinants of willingness to pay for weather insurance among 1400 rural Ethiopian households to assess the characteristics of households that would be likely early entrants into weather index insurance markets in Ethiopia. The respondents in this study were households that have been under study for 15 years as part of the Ethiopian Rural Household Survey, providing information on both historical experiences and current characteristics with which to assess willingness to pay.

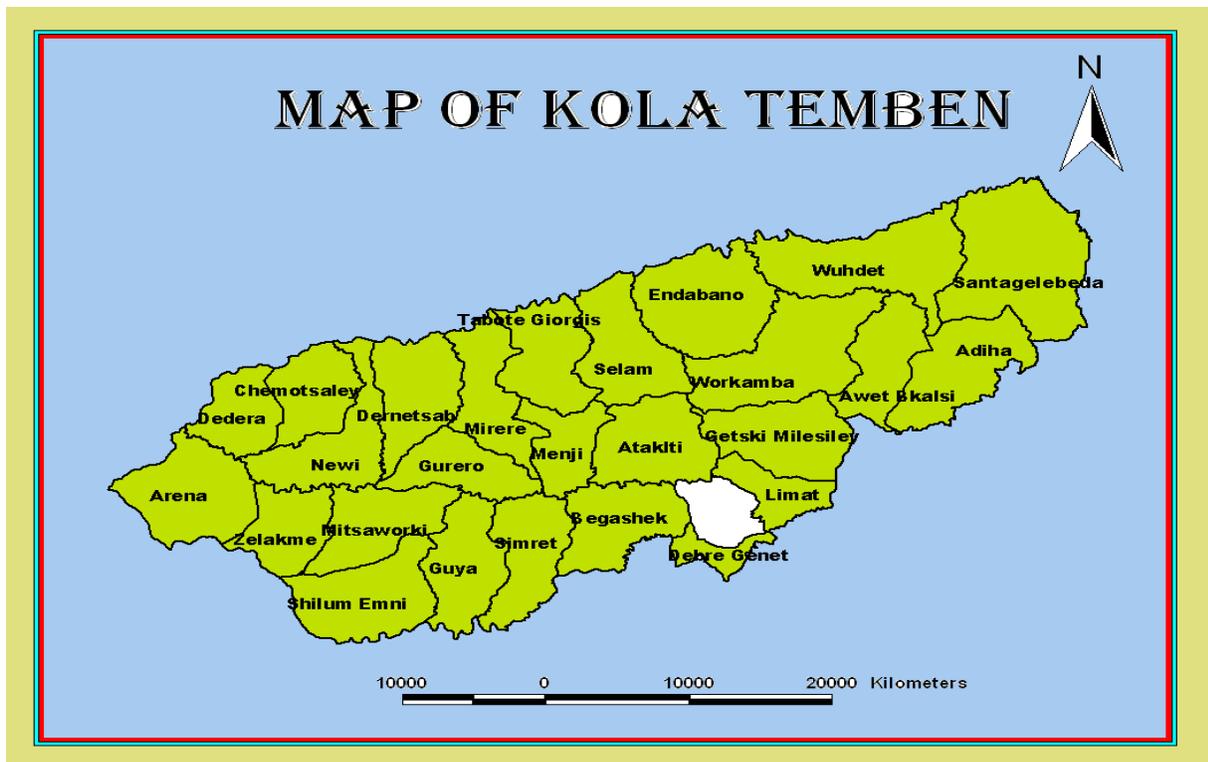
They find that, at least initially, insurance markets will likely be entered into by educated, rich and proactive individuals. They estimate the willingness to purchase this hypothetical product using a probit and present the results in terms of the marginal effects of the covariates. Risk aversion was associated with low insurance take-up, suggesting that models of technology adoption can inform the purchase and spread of weather index insurance. While those who face higher rainfall risk are more likely to respond that they would choose to purchase insurance, those who behaved in a less risk adverse manner were found to be more likely to purchase insurance. This, in combination with the importance of education and a measure of individual agency, suggests that models of technology adoption can inform the purchase and spread of weather index insurance.

They also assess how willingness to pay varied as two key characteristics of the contract were varied i.e. they found that basis risk reduced demand for insurance, particularly when the price of the contract was high, and that provision of insurance through groups was preferred by women and individuals with lower levels of education.

Chapter three: Data and Methodology of the study

3.1 Site and description of the study area

Kola Tembien is one of the nine weredas in the central zone of Tigray. It includes 27 tabias and 94 kushets. According to Development plan (2011), the population of Kola Tembien is 148,282 and the population density is 100 per hectare. The total area of the wereda is estimated at 1352.25 km sq or 147,427 hectares of land (Development plan, 2011) out of which 31021 hectares is farm land, while 69624 hectares is grazing, 3680 hectares residence, 21200 hectares forestry and 21474 hectare for other use (source). Over 134312 of its population 85 % are engaged in agriculture and 15% trade and other activities. The wereda is bordered by wereda Hawzen in the north-east, wereda Degua Tembien in the East, wereda Tanqua Abergele in the south and Tselemti & werda Naeder Adet in the west and wereda Wer`e Leke in the North. The agro climatic zone of the wereda is 58% Kola and 42% Dega. Altitude varies from 1501 meters above sea level (masl) to 2500 masl. Estimated annual rainfall ranges from 500mm to 800mm, while temperature varies between 250c and 300c.



Map of Kola Tembien Wereda (Development plan, GIS, 2011)

3.1.1 Weather index Insurance Design in kola Tembiem wereda

Oxfam America (OA), Swiss Re, the Relief Society of Tigray (REST), the International Research Institute for Climate and Society (IRI), Nyala Insurance, Dedebit Credit & Saving Institution, and overother organization have come together to launch an innovative climate change resiliency project called "Horn of Africa Risk Transfer for Adaptation (HARITA)".

The Introduction of Weather Index Insurance (WII) in Kola Tembien and its integration with weather risk reduction

In most index insurance pilots, farmers have been required to take insurance and credit as a package. Under HARITA, however, farmers may choose to bundle the two, but they are not required to do so. The independence of credit and risk transfer means that farmers do not lose access to insurance once they have repaid their loans, and that farmers who do not want a credit can still obtain insurance.

Farmers in Adi Ha have been central participants in the design of the weather index insurance package by contributing ideas, feedback, and advice. Toward that end, a team of five community members were elected by their peers to join the Pilot Design Team to manage the initiative. In addition, a focus group of 21 farmers participated in a number of test workshops on climate change, financial literacy, and insurance. In addition, IRI conducted experimental economic risk simulation and focus group discussions with farmers to understand their preferences for key parts of the insurance contract, such as coverage levels and frequency of payout. Thus they learned through this process of engagement resulted in a much more attractive product, and improved the financial service providers' ability to educate farmers effectively.

Designing rainfall index insurance normally requires at least 30 years of reliable, daily rainfall data (WFP, 2006). In most developing countries, rain gauges are sparsely distributed and limited in quality and duration.

Typically, most weather insurance pilot locations have been selected for the quality of local rainfall records. These data-supply-driven pilots have demonstrated that weather insurance products are viable at the pilot level; however, the general lack of weather data is a serious barrier to extending weather insurance to the vast majority of poor communities

(HARITA,2009). For this reason, HARITA has been working with IRI to explore new techniques to enhance sparse local datasets through a combination of satellite imagery, rainfall simulators, and statistical tools that incorporate information from the closest stations (HARITA, 2009). IRI carefully studied the time series in Adi Ha and surrounding areas, and developed a viable index and an open-source methodology for handling data gaps. While continued improvement will be necessary, IRI's approach was examined and accepted by the insurance and reinsurance providers, Nyala Insurance Co. and Swiss Re (HARITA, 2009).

While some index insurance pilots have involved solid demand from farmers, it is imprecise why take-up has not been automatic or stronger given the many theoretical benefits of risk transfer. HARITA has tried to overcome the problem by employing understandable methods developed in combination with farmers, such as storytelling and participatory games. The HARITA partners also believe that in-kind premium payments allow poor clients who may not be able to pay in cash, but who are rich in labor to purchase much more coverage than they could afford otherwise. There is a reason to believe overcoming these barriers, as indicated in the strong uptake of insurance, the HARITA joined risk management package offered by Ethiopia's Nyala Insurance Company in late May 2009. Over the course of two days, approximately 600 farmers attended project enrolment activities, and 200 households signed up for the package, representing roughly 20% of the village. Roughly 38% of enrollees were female-headed households and 65% of enrollees were participants in the PSNP (HARITA, 2009).

3.1.2 Weather index Insurance practices in Kola Tembien

Insurance can play a vital, role to risk reduction interventions by facilitating rapid recovery from low-frequency, severe climatic shocks like prolonged droughts. HARITA proposes introducing micro- insurance to the PSNP's existing range of benefits. Insurance could potentially strengthen the PSNP by addressing the non-chronic; unpredictable needs not covered under the program. Through HARITA, farmers enrolled in the PSNP have the option to work extra days beyond those required for their normal payments, but instead of earning cash or food for this additional labor, they earn an insurance certificate protecting them against deficit rainfall. In other words, through this premium-for-work arrangement, farmers can receive predictable transfers for

unpredictable events. (Note that wealthier farmers who do not participate in the PSNP are encouraged to purchase insurance with their own cash; as such, they constitute a potentially important subset of clients for the Ethiopian insurance industry.) (HARITA, 2009)

3.2 Data sources

The source of data for this study is the rural household survey conducted during 2010 by the Horn of Africa Risk Transfer for adaptation (HARITA) project in collaboration with Mekelle University. The study also uses secondary sources from journals, books and other necessary materials.

The data was collected using different sampling techniques and structured questionnaire. The study area and the target population were selected using purposive sampling method where drought poorness and presence of PSNP were used as a basis. Proportional sampling method was employed to determine the sample size of each tabia. Finally the sample of adopters and non-adopters were selected using systematic random sampling from the sample frame that contains both adopters and non- adopters.

Similarly for this study we use the data collected from wereda Kola Tembien of the two treated tabias(Adiha and Awet Bekalsi) and a sample of 114 households were taken of which 57 were adopters and the remaining 57 were non adopters.

The survey data contains complete information on household demographic and household characteristics, agricultural inputs including human labor, seed, fertilizers, pesticides, farm size, credit & insurance use, income and ownership of farm inputs etc.

3.3 Techniques of data analysis

From the literature review we can see that there are many areas in the field for the demand of micro insurance. There were also studies made in the last year's MSc graduating class in WII demand. But our intension in this study is, in addition to the determinant factors for WII adoption we try to see the scale of coverage (extent or amount insurance)

3.3.1 Descriptive Analysis

The tools for data analysis will be descriptive statistics such as percentages, frequencies, mean and standard deviations.

3.3.2 Econometric analysis

Heckman two step econometric model has been employed to analyze factors influencing the amount (intensity) of WII. Heckman suggests a two stage estimation method to correct the bias as a result of self-selection in the decision to participate (adoption) in the WII and outcome models. In the first stage of the model, the decision equation is the household's decision to adopt or not to adopt WII which will be estimated based on the probit model. In the second stage, only the households having adopted WII have been used.

3.3.3 Empirical Model for impact of Weather index insurance on households' income

A vital issue in estimating program impact is self-selection bias. Selection bias results from estimation on a sub sample of individuals who have essentially selected themselves for participation in a particular program. Several techniques have been developed to correct for this bias, most notably a two-stage technique attributed to Heckman (1976). In the Heckman two-stage method, the binary participation variable P is estimated on the total sample of participants and non-participants in the outcome equation probit analysis is the most commonly used method in the estimation(Wang,1984).The predicted participation probabilities are used to calculate a correction term. The correction term is then entered into the outcome equation; the outcome model is then estimated via ordinary least squares on the total sample and used to suggest the net impact of the program.

Selection bias potentially threatens both internal and external validity. Selection bias is a threat to internal validity in that independent variables are correlated with a disturbance term (error term) and analyses based on biased samples can lead to inaccurate estimates of the relationships between variables (e.g., regression coefficients). Selection bias also potentially threatens external validity because a final, biased sample might not be generalizable to the intended population.

One of the earliest sample selection correcting methods is known as the “Heckman” two-step estimator (Heckman, 1976, 1978, 1979 in Cuddeback et al, 2004).

Sample selection issues arise when a researcher is limited to information on a non- random sub-sample of the population of interest. Specifically, when observations are selected in a process that is not independent of the outcome of interest, selection effects may lead to biased inferences regarding a variety of different outcomes (source). In impact analysis, one common approach to this problem is Heckman two-step estimator (source). This approach involves estimation of a probit model for participation followed by the insertion of a correction factor—the inverse Mills ratio, calculated from the probit model into the second OLS model of interest (Bushway, 2007).

3.3.4 Model specification

Factors influencing adoption of WII and the amount of WII adoption will be analyzed. The commonly econometric models used in adoption are qualitative choice models including linear probability, logistic distribution (logit) and normal distribution function (probit) and the Tobit model. But in this study Heckman two stage probit models is employed due to this study in addition to the adoption decision of WII it also assesses the amount of WII purchase.

The two stage model used in investigating both the adoption decision and the amount of insurance purchase is the following:

- $D_i^* = \beta_i Z_i + \epsilon_i$ decision equation.....i
- $Y_i = \alpha_i X_i + U_j$ outcome equation.....ii

Where $(\mu, \epsilon,)$ assume joint Normality of the distribution of the error terms in the decision and outcome equation with mean zero and variance σ^2 and σ^2 , respectively and covariance σ and (μ, ϵ) is independent of X and Z, assumes that both error terms are independent of both sets of observables (Source). Thus, the study defines a dichotomous variable which takes a value 1 if the latent variable $D_i^* > 0$ and 0 otherwise. In this way, $D_i = 1$ indicates the adoption of WII and $D_i = 0$ non adoption. From the decision equation we found correction factor of the sample selection bias or the inverse Mills ratio, calculated from the probit model and entered into the second equation, which is an outcome equation in this case and formulated as follows.

$$Y_i = \beta_i X_i + \lambda + \mu_i - \lambda \frac{\phi(\beta_i X_i + \lambda)}{\Phi(\beta_i X_i + \lambda)} \quad (3)$$

, Where λ is the inverse Mills ratio

Equations of the Heckman Two-Stage model

Our econometric model is specified as follows

First stage of the model, which is a binary (probit) model in nature was specified as:

$$\text{adoptionwii} = \beta_0 + \beta_1(\text{maritalstatus}) + \beta_2(\text{genderhhhed}) + \beta_3(\text{agehhhead}) + \beta_4(\text{incomehhheadag}) + \beta_5(\text{edulevhhhead}) + \beta_6(\text{communtyriskpool}) + \beta_7(\text{psnpartici}) + \beta_8(\text{irriglandownd}) + \beta_9(\text{rainfedlndownd}) + \beta_{10}(\text{qtyofox}) + \beta_{11}(\text{understandwii}) + \beta_{11}(\text{perceptiondrought}) + \epsilon_i$$

while, the second stage (outcome equation) was specified as follows:

$$\text{Premium} = \beta_0 + \beta_1(\text{genderhhhed}) + \beta_2(\text{agehhhead}) + \beta_3(\text{age2}) + \beta_4(\text{incomehhheadag}) + \beta_5(\text{edulevhhhead}) + \beta_6(\text{qtyofox}) + \beta_7(\text{training}) + \beta_8(\text{rainfedlndownd}) + \beta_9(\text{understandwii}) + \beta_{10}(\text{perceptiondrought}) + U_j$$

3.4 Description of Variables and hypothesis to be tested

I) Dependent variable: in this study are, the first step of Heckman model is whether or not the household adopted WII which is the selection equation, while the second step or outcome equation is a continuous variable which is the amount of premium as proxy of intensity (amount of WII purchased) measured in terms of the Birr paid as a premium by the participating households.

II) Independent variables: in line with the theoretical background and on the basis of the previous studies on similar subjects the following explanatory variables were hypothesized to affect the dependent variables.

Age/ Age2 of household head (agehhhead/age2): Farmers age can be assumed to negatively affect farm households' adoption of WII. The age variable has a non-linear relationship with adoption of WII. That is younger household heads are more likely to adopt new things like insurance and thus they participate in the insurance program whereas when age becomes older they are unwilling to adopt insurance since they are traditional and not ready to know and accept

new technology. Therefore, this variable is hypothesized as younger household heads are more likely to adopt WII buy large amount of WII as compared to older heads

Gender of household head (genderhhed) this is a dummy variable which takes a value of 1 if the household head is female 0 otherwise. Gender differentials among farm households play a significant role in the economic performance of a given household. Gender differentials can be related to access to insurance. In this case, one may expect that female headed households have less access to insurance because they are less experience, less access and marginalized from accessing socio economic services as compared to male. This may be due to females are more preoccupied with child care and home management than men. Therefore this variable is hypothesized as female headed households are less likely to adopt WII and buy less amount of insurance as compared to male headed

Marital status of the household head (maritalstatushh): this is a dummy variable which is equals 1 if the head is married, 0 otherwise. This variable has an ambiguous effect on both the adoption and extent of adoption of WII.

Education level of household head (edulevhhead): this is also dummy variable takes value of one if the head is literate, 0 otherwise. There is evidence that education of the household head is a strong determinant of household's insurance participation (Gine & Yang, 2007). Education levels have a bearing on farmers' access to improved farm technique and effective use of information available on technologies. This implies that the education level of household head, as expressed in number of years of schooling, would have positive effect on both the adoption decision and positive impact on income. Education is hypothesized to have positive effect on the adoption as well as intensity of WII

Participation of PSNP (psnppartici): this is considered as a dummy variable that takes a value 1 if the household participate in PSNP and 0 otherwise. It is hypothesized that participation in PSNP has a positive effect for adoption of WII. Because, Empirically for the PSNP in-kind premium payments were allowed to poor clients who may not be able to pay in cash, but who are

rich in labor to purchase much more coverage than they could afford otherwise (HARITA, 2009).

Quantity of Oxen Owned (qtyox) - is a continuous variable which entail that the number of oxen be in possession of the household. It is predicted that this variable affect the adoption of insurance positively. A study by Peterson & Mullally (2009) established that wealth categories were largely defined in Adi Ha tabia of Kola Tembien wereda by the number of oxen owned. Thus number of oxen is used as a proxy variable to measure wealth of the household. If the household has large number of oxen they considered as wealthier and they are more likely to purchase WII with the intention to be protected from drought risks. This can hypothesized as Household's oxen holding is positively related with the probability and amount of adoption of WII

Participation in community based risk pooling organization membership (communityriskpool): This variable is entered in the model as a dummy which takes a value 1 if the household has access to community based risk pooling organization Membership, 0 otherwise. Thus this variable can have positive or negative effect on a farmer's decision to adopt or not. The positive effect can be due to community risk pooling organizations can give access farmers to know about the insurance and they can choose WII as a risk coping mechanism especially, when the drought risk affects the community as a whole they considered the difficulty to use the informal organizations. Contrary to this the community risk pooling organizations can have negative effect on the adoption of WII; since those who are members of the informal organizations can feel secured as a result they may want to buy WII.

Size of rain fed Land owned in tsimad (rainfdlndplant): is a continuous variable measured the size of cultivated rain fed land in tsimad. The size of rain fed land owned reflects ownership of an important farm asset. Larger rain fed farm size owned implies more resources and greater capacity to invest in farm and increased production (Ellis, 1988 in Kidane,2001). Thus farmers with larger rain fed cultivated land are expected to have higher adoption of insurance and higher intensity of WII adoption.

Size of Hutsa type of soil owned (typehustasoil): this variable is a continuous and measured in terms of the amount of tsimad of Hutsa type of land owned. This factor is expected to have a positive value on both adoption and extent of WII. This may be due to Hutsa type of soil has low water holding capacity to sufficiently grow the crops planted thus they need to be protected against such risks.

Size of irrigated Land owned in tsimad (irriglndownd) this is a continuous variable measured in tsimad of irrigated land owned. This variable is hypothesized to have inverse relation with insurance adoption. This is due to those households who have larger irrigated land are not subject to drought risk and as a result they are less likely to adopt WII. Households' land holding is hypothesized to have a positive scale effect on the probability of adoption and amount of WII

Understanding and training about WII (understandwii) offering insurance training can enhance farmers knowledge of insurance, and the insurance understanding gained during a session can be effectively diffused to farmers through social network this can also create demand to buy insurance (Cai & Berkeley, 2010). Thus insurance understanding is hypothesized as farmers' understanding about WII leads to high adoption rate of WII

Perception about drought incidence (perceptiondrought): this is a dummy variable which takes a value of 1 if the household perceived that drought will occur and 0 otherwise. This variable is expected to have a positive effect on both households WII adoption and the extent of WII adoption. This may be due to the fact that when the households highly perceives about drought risk they are more likely to purchase WII relative to those who do not perceive. Households who perceive the high likelihood of drought risk are more adopters of WII than with low likelihood perception.

Chapter Four: Results and discussion

This chapter presents the results of descriptive and econometric analysis.

4.1 Descriptive analysis

Table 4.1 presents a descriptive statistics of variables included in the regression. Accordingly, we observe that the mean age of adopter and non-adopter household heads was about 39 and 44 years, respectively, which the t-test indicates a significant difference (at 5% significance level) in favor of non-adopters.

Table 4.1 descriptive statistics of Continuous variable used in the model

Description of variables	Adopters		Non-adopters		Significance of differences t-test
	Observation	Mean (Standard Deviation)	Observation	Mean (Standard Deviation)	
Age of household	57	39.140 (13.214)	57	43.965 (14.11)	2.001**
Number of oxen owned	57	1.965 (.731)	57	.719 (.619)	-10.541***
Irrigated land owned in tsimad	57	.429 (.595)	57	.569 (.709)	1.1312
Rain fed land owned in tsimad	57	5.079 (13.545)	57	1.719 (1.426)	-1.862*
Husta type of soil owned in tsimad	57	2.464 (1.454)	57	.614 (.856)	-6.4767***

*** Significance at 1%, **significant at 5%,* significant at 10%, values in parenthesis are Standard Deviation

moreover, the average number of oxen owned by the adopters and non-adopters was 1.97 and 0.72 respectively and significant (at 1% level of significance) supporting the argument that oxen holding may have positive effect on adoption of WII. The descriptive statistics also illustrate that the average irrigated land owned by adopters was about 0.43 tsimad and 0,57 tsimad by the non-adopters on average, while average rain-fed land holding of adopters and non-adopters was

about 5 and 1.7 tsimad, respectively. Furthermore, the data indicates that the average land holding (in tsimad) of hutsa soil type, adopters and non-adopters was about 2.4 and 0.6, respectively showing significant (at 1% level significance) difference.

Table 4.2: Summary of discrete variables used in the model (descriptive statistics)

Variable	Adopters	Non-adopters	chi2 (p-value)
	Mean	Mean	
Gender Female (=1) Male	.456 (.501)	.404 (.495)	(0.571)
Marital status Married (=1)	.596 (.495)	.667 (.476)	(0.437)
Education category Literate =1	.684 (.469)	.298 (.462)	(0.000)***
PSNP Participant =1	.825 (.384)	.491 (.504)	(0.000)***
Community risk pool organization Participant =1	.263 (.444)	.281 (.453)	(0.833)
Perception about drought High perception =1	.895 (.309)	.123 (.331)	(0.000)***
Understanding about WII Have understanding =1	.842 (.368)	.211 (.411)	(0.000)***
Attending training session =1	.789 (.411)	.175 (.384)	(0.000)***

*** Significance at 1%, **significant at 5%,* significant at 10%, values in parenthesis are Standard Deviation

Of the total surveyed household heads about 45.6 % adopters and 40.4 % non adopters were female headed. Among both the adopters and non-adopters, 59.6 and 66.7 percent of them (reapectively) were married. About 68.4 and 29.8 of adopter and non-adopter households, respectively were found to be literate where we found significant difference (at 1% level of

significance). As presented in the table 4.2, about 26.3 % of the adopters and 28.1 % of non-adopters have access to community risk pooling although we found no significant difference between these two groups. Moreover, we found that about 82.5 % of the adopters and 49.1% of non-adopters have participated in the PSNP. Farm households to information was peroxide by whether a farm household has attended training in relation to WII and found that about 78.9% of adopters and 17.5% of non-adopters have attended a training session (see table 4.2 above). Accordingly, we found that about 53% of the total sample households have awareness (understanding about WII).

The other important variable in the study is perception towards the risk of drought, which about 89.5 % of adopters and 12.3% of non-adopters have perceived that drought may occur in the coming cropping season.

4.2 Econometric analysis

In this study we make an attempt to analyze factors that affect farm households' decision to adopt or not to adopt Weather Index Insurance and the intensity of adoption peroxide by the amount of premium that the adopting households have bought. We used a Heckman Two-Stage econometric model.

Checking for Multicollinearity and Heteroskedasticity Problem

One assumption of the multiple regression model is that the absence of Muticollinearity among the regressers included in the model (Gujrat,2004), because multicollinearity potentially causes variances between collinear parameters in the estimation. Thus, we checked the inverse of the correlation matrix where the diagonal elements of this matrix are also called Variance Inflation Factors (VIF). A high VIF indicates the presence colinearity. As a rule of thumb, for standardized data a $VIF_i > 10$ implies serious colinearity. As a result we found the VIF for all the independent variables in both equations (the decision and outcome models) were low indicating that our data does not suffer from problem of multicoliearity. Another important assumption of the multiple regression model is that the disturbance terms are not homoscedastic implying that they have different variance. It is also noted that the problem of Hetrosedasticity is likely to be more common in cross-sectional data than in time series data (Gujrat, 2004). Hence, we test for

hetrosedasticity using White's hetrosedasticity test and identified the chi2 value of 19.39 with 9 degrees of freedom, and the critical chi2 value with 9 degree of freedom is 21.7 at 1% level of significance. Therefore since the estimated chi2 value is less than the critical chi2, it indicates that there is no hehetroscedasticity problem in our data.

4.2.1. Results of the decision equation

The result suggests that out of the 12 variables selected marital status of the household head, quantity of oxen owned, participation in PNP, understanding about index insurance and perception about the drought incidence were found statistically significant (at different level of significance) (see Table 4.3).

Household characteristics

Marital status is a dummy variable that takes a value of 1 if married, 0 otherwise. The estimated coefficient of this variable has negatively associated with adoption of WII and significant at 10%. The negative sign of the coefficient implies that those households' heads that are married are less likely to adopt WII.

Participation in PNP- we found that participation in PNP positively and significantly (at 10% significance level) affects farm households' adoption of WII. According to the working procedures of the PNP in the Tigray region, the poorest households get priority to participate in the PNP. Hence, the positive effect of participation in PNP in the adoption decision of WII may imply that access to PNP gives buffer to solve financial constraints to adopt WII as a coping mechanism of the negative effects of climate change, such as drought. Our findings are in line with the approach of HARITA to incorporate PNP with the WII. This can imply that the adopters of WII were the most vulnerable households. Empirical study also reports that HARITA has made important penetration in expanding effective access to insurance to the most vulnerable households in Adi Ha (HARITA, 2009).

Quantity of Oxen owned: is a continuous variable which entail that the number of oxen be in possession of the household. It was hypothesized that oxen ownership affects the probability of adoption of WII positively. Accordingly, we found that oxen ownership positively and significantly affects the adoption of WII. A study by Peterson & Mullally (2009) established that

wealth categories were largely defined in Adi Ha Tabia of Kola Tembien wereda by the number of oxen owned. Thus number of oxen is used as a proxy variable to measure wealth of the household

Understanding about WII this is a variable and one of the important reasons for buying WII. Our results indicate that this factor came significant and positive which indicates that awareness about WII will influence the probability of participation in WII. Empirical study by Alam, (2010) in Bangladesh confirms that understanding and awareness about insurance was found as one of the key determinants and drivers of insurance adoption.

Perception about the occurrence of drought was found to positively affect farm household's adoption of WII in Kola-Tembien of Tigray, Ethiopia implying that if a household perceive that drought will occur in the next cropping season, they are more likely to participate and buy WII as climate change adaptation. Empirical study by Alam, (2010) in Bangladesh also indicated that perception about the weather risk occurrence has found positively affects the willingness to pay for weather index based micro insurance.

Table 4.3 Regression Results of the Probability of Adoption of WII (Heckman Two-Step)

Description of Variables		
Dependent Variable: Adoption of WII	Coef.	Std. Err.
cons	-6.82	[4.110]
Marital status=1 if married	-3.001**	[1.339]
Gender of household head = if female	-1.036	[.917]
Age of the household head	.0341	[.052]
Education level of the household head=1 if literate	1.433	[1.032]
Membership in community risk pool organization=1 if member	-1.039	[1.005]
PSNP participation =1 if participated	2.424*	[1.315]
Irrigated land owned in tsimad	-.105	[.643]
Rain fed land owned in tsimad	.232	[.239]
Number of oxen owned	2.355*	[1.379]
Understanding about wii =1 if yes	1.487*	[.795]
Perception about drought=1 if yes	3.453**	[1.479]

*** Significance at 1%, **significant at 5%,* significant at 10%, figures in Parenthesis are standard errors.

4.2.2 Results of the outcome equation

In the second step of the Heckman selection model, we try to investigate the amount (intensity) of WII insurance purchased by the adopting farm households. the amount (intensity) of WII has been captured by the total cost premium paid for the WII policy cover. The IMR (Inverse Mills Ratio) has estimated from the first equation has entered into the outcome equation to control for the sample selection bias.

Table 4.4 Regression Results of the amount of insurance purchased (Heckman Two-Step)

Description of variables		
Dependent variable: premium	Coef.	Std. Err.

_cons	-152.688	[189.902]
Marital status=1 if married	-9.669	[47.374]
Gender of household head= 1 if female	-11.224	[45.661]
Age household head	8.861	[.566]
Age2	-.076	[.087]
Education =1 if literate	61.255*	[35.998]
Rain fed land owned in tsimad	2.169***	[1.092]
Training= 1 if attended	-41.838	[38.682]
Type of hutsa soil in tsimad	27.695***	[10.512]
Number of oxen owned	19.041	[24.391]
mills	62.514***	[29.733]

*** Significance at 1%, **significant at 5%,* significant at 10%, figures in parenthesis are standard errors

The regression result in table 4.4 shows that there are three variables significantly affect the amount of purchase of WII.

Dummy variable education of the household head, which is value 1 when literate and 0 otherwise. We identified this variable is both positive and significant at 10 % level. This positive meaning when the household head is becoming literate the amount of WII purchase increase by a significant amount.

The regression result also shows that rain fed land owned which is a continuous variable measured in terms of tsimad affects the amount of premium paid to purchase WII positively and significant at 1% level. This indicates that ownership rain fed land has positive and significant effect on the amount of insurance that a farm household can purchase.

The regression result shows that Hutsa type of soil which is a continuous variable measured in terms of tsimad affects the amount of premium paid to purchase WII positively and significant at 1% level. This indicates that ownership land of Hutsa type of soil has positive and significant effect on the amount of insurance that a farm household can purchase.

Empirically Marc. C,et al,(2000) in Desta,2011) reports that rekik soils are found on the upper parts of the top soil and mostly are shallow. The shallowness on the upper slope is Sandy (Hutsa), and having lower water holding capacity becoming highly infertile.

Finally the result also indicates that the IMR (inverse mills ratio) variable estimated from the first stage probit equation is statistically significant at 1% level and it has a positive sign. The positive sign indicates that there is positive correlation between the error term in the selection and outcome equations and to mean that those unobserved factors that make the household to adopt WII are likely to be positively associated with amount of purchase of WII.

The significance of IMR suggests that the use of Heckman two-step method estimation was correct, in the OLS model (second stage) and if we would have used only one equation model we would have lost some valuable information in the analysis.

Chapter Five: Conclusion and recommendation

5.1 Conclusion

Agricultural activity and farmers income is susceptible to natural events, such as rainfall and draught risk; hence, understanding and intervention to address weather related risks may improve the wellbeing of poor rural farmers. One important mechanism to mitigate such risks is WII, which is recently introduced in Ethiopia.

This study was carried out by using HARITA's 2010 survey data carried out in wereda Kola Tembien of Tigray Region where data from about 114 sample households, of which 57 adopters and 57 non adopters of WII was used.

A large portion of the households remains uninsured in most of this insurance design. This can raise important questions focusing on first, what determines the decision to adopt WII and the amount of insurance purchase.

This study makes an attempt to analyze factors that affect the adoption of WII and amount of premium. We used Heckman -Two stage model to study both the adoption of WII and amount of premium simultaneously

Our result shows that households who participate in the Productive Safety Net Program are more likely to participate in the WII program. As the PNSP gives leverage for poor farm households to pay in labor rather than cash, its role to ease financial and consumption stress that poor farm households may have is paramount. Moreover, those who participate in PNSP are not obliged to sell their asset to participate in the WII, its impact in farm households capital accumulation can be positive. The study also shows number of oxen owned by a farm household has positive and significant effect on the likelihood of farm households' participation in WII as a climate adaptation strategy. However, this in turn may implicate that those poor households (more likely female headed households) could be rationed out from participating in the WII program..

The result shows that WII adoption decision was positively related to the amount of rain fed land owned. This means that households belonging to lower amount of rain fed land have lesser probability for purchase of WII adoption.

The number of oxen owned was another significant variable for the adoption decision.

The results indicate that the perception of households towards drought risk was also found significant and positive in relation to adoption of WII. Understanding about insurance was found positive and significant variable which determine the WII adoption decision. This means that households with better understanding about WII have higher probability of adoption of WII.

5.2 Recommendation

The results of this paper can indicate important suggestion for insurers and policy makers.

The finding revealed that the positive and significant effect of PSNP for adoption of WII implies, more attention was given to the expanding access of WII to the most vulnerable households in the study area. This can be consistent with the study made in Kenya by Chantarat,(2009) most households vulnerable to falling into a poverty trap have demand for index based insurance, despite their potentially highest dynamic welfare gain from the insurance. Therefore, it is useful for policy makers to give support and maintain appropriate mechanisms in designing similar insurance policy in other drought prone areas.

The study indicated that understanding and perception variables have both positive and significant effect on adoption of WII. This can provide important suggestion for insurance companies to educate people about concepts, contract and benefits of WII.

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Annex III

White's Test of Heteroscedasticity

imtest

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	19.39	9	0.0221
Skewness	18.32	3	0.0004
Kurtosis	0.83	1	0.3616
Total	38.55	13	0.0002

White Heteroskedasticity- Consistent Standard Errors and Covariance

Annex IV

Correlation Matrix among Explanatory Variables

. cor maritalstatus genderhhhed agehhhead age2 rainfedlndownd training typehutsasoil
edulevhhead qtyofox
(obs=114)

	maritatus	genderhhhed	agehhhed	age2	rainfed	training	typehutsal	edulevhhd	qtyofox
maritalstats	1.0000								
genderhhhed	-0.6593	1.0000							
agehhhead	0.0201	-0.0984	1.0000						
age2	0.0250	-0.0985	0.9870	1.0000					
rainfed	-0.1036	0.0785	-0.0799	-0.0785	1.0000				
training	-0.0268	-0.0227	-0.1163	-0.1037	0.1495	1.0000			
typehutsal	-0.0405	-0.0228	-0.0068	0.0052	0.2046	0.4130	1.0000		
edulevhhd	0.2776	-0.1443	-0.2062	-0.2090	-0.0405	0.2101	0.1787	1.0000	
qtyofox	0.1066	-0.0728	-0.1489	-0.1528	0.1585	0.4443	0.4302	0.3226	1.0000

Correlation Matrix among Explanatory Variables

```
. cor maritalstatus genderhhhed agehhhead edulevhhhead communtyriskpool psnppartici
irriglandownd rainfedlndownd qtyofox understandwii perceptiondrought
(obs=114)
```

	maritals	genderhd	agehhd	edulevhd	communl	psnppar	irrigld	rainfed	qtyofox	undersi	percept
maritals	1.0000										
genderhd	-0.6593	1.0000									
agehhead	0.0201	-0.0984	1.0000								
edulevhd	0.2776	-0.1443	-0.2062	1.0000							
communl	0.0172	-0.0527	-0.0791	0.0304	1.0000						
psnppart	-0.1291	0.2526	-0.2787	0.0428	0.0252	1.0000					
irrigld	0.2244	-0.1778	-0.0013	-0.0257	0.1641	-0.1425	1.0000				
rainfed	-0.1036	0.0785	-0.0799	-0.0405	-0.0679	0.0793	0.0762	1.0000			
qtyofox	0.1066	-0.0728	-0.1489	0.3226	-0.0130	0.1280	-0.0509	0.1585	1.0000		
undersi	0.0038	-0.0280	-0.1500	0.2645	-0.1704	0.1676	-0.1626	0.1424	0.4694	1.0000	
percept	0.0134	0.1088	-0.1652	0.3337	0.0879	0.2900	-0.0525	0.1518	0.5585	0.5438	1.0000