# PERCEPTION AND ADAPTATION STRATEGIES OF WHEAT PRODUCING HOUSEHOLDS TO CLIMATE CHANGE AND VARIABILITY: THE CASE OF SINANA DISTRICT, BALE ZONE, OROMIA, ETHIOPIA

**MSc THESIS**

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# Perception and Adaptation Strategies of Wheat Producing Households to Climate Change and Variability: The Case of Sinana District, Bale Zone, Oromia, Ethiopia

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**A Thesis**

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**POSTGRADUATE PROGRAM DIRECTORATE**

I hereby certify that I have read and evaluated this Thesis entitled "**Perception and Adaptation Strategies of Wheat Producing Households to Climate Change and Variability: The Case of Sinana District, Bale Zone, Oromia, Ethiopia***,"* and have been prepared under my guidance by ZerihunNegashBedane**.** I recommend that it be submitted as fulfilling the thesis requirement.

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As a member of the Board of Examiners of the MSc Thesis Open Defense Examination, I certify that I have read and evaluated the Thesis prepared by ZerihunNegashBedane and examined the candidate. I recommend that the thesis be accepted as fulfilling the Thesis requirement for the degree of Master of Science in Developmental Economics.

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# DEDICATION

I would like to dedicate this thesis to my father, NegashBedane who support me by financial and guide my life in general.

## STATEMENT OF THE AUTHOR

By my signature below, I declare that this Thesis is my own work. I have followed all ethical and technical principle of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholarly matter that is included in the Thesis has been given recognition through citations and acknowledgments.

This Thesis is submitted in partial fulfillment of the requirements for "the degree of master in developmental economics" at MaddaWalabu University to the Collage of Business and Economics, through the Department of Developmental Economics.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACCCA | Association of California Community College Administrators |
| ANOVA | Analysis of Variance |
| CCA | Canonical Correlation Analysis |
| CSA | Central Statistical Agency |
| DA | Discrimination analysis |
| EEA | Ethiopian Economic Association |
| FAO | Food and Agriculture Organization of the United Nations |
| HH | Household Head |
| GDP | Gross Domestic Product |
| ILO | International labor Organization |
| IPCC | Intergovernmental Panel for Climate Change |
| MASL | Mean Above Sea Level |
| MANOVA | Multivariate Analysis of Variance |
| MDA | Multiple Discrimination Analysis |
| MM | Millimeter |
| NBE | National Bank of Ethiopia |
| NMA | National Meteorology Agency |
| PCA | Principal Component Analysis |
| SUR | Seemingly unrelated Regression |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VIF | Variance Inflation Factor |

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## *ABSTRACT*

*This study investigated to assess perception and adaptation strategies of wheat producing households to climate change and variability in the case of Sinana District, Bale Zone, Oromia, Ethiopia. The study combines both quantitative and qualitative data obtained from 191 sample size households' survey from four randomly selected kebelesdesk review, an in-depth interview and focus group discussions. Descriptive statistics and econometric models were employed for data analysis. 63.3% and the remaining households were not adapt to climate change and variability.Results of the multivariate probit model regression showed that access to climate information, on farm, farm land size, off farm income, livestock ownership, irrigated land size owned were factors affecting households adaptation strategies to climate change and variability to choose planting early maturing wheat type and change planting date. Education level of household head, off farm income and irrigated land size owned were factors affecting households' adaptation strategies to climate change and variability to choose change wheat variety. On the other hand, farm land size, off farm income and livestock ownership were factors affecting households adaptation strategies to climate change and variability to choose planting trees.The government should therefore, strengthen the households' adaptive capacity to climate change through planting early maturing wheat type, changing planting date, providing change wheat variety and planting trees householdshasanimportantadaptationstrategies.*



***Key words**: Adaptation, climate change and variability, household, multivariate probit, perception.*

# 1. INTRODUCTION

## 1.1. Background of this study

Agriculture was the main sector of the Ethiopian economy. It contributes about 38.8% to GDP (NBE, 2016), employs 83.4% of the rural population, 80% of export earnings, and provides 75% of the raw material requirement of the country's agro-industries (ILO, 2014). The capability of the country to address poverty, food insecurity and various economic problems is highly dependent on the performance of the sector (EEA, 2013).

However, agricultural production was commonly more of rain-fed, which affected by climate change and variability. Thus, climate is a primary determinant of agricultural productivity. It affects agriculture in a variety of ways. These are climate variability, drought, wind, rainfall and other climate related natural disasters have a direct impact on both quality and quantity of the agricultural production.

These perceptions strongly affects how households deal with climate cause risks and opportunities, and the precise nature of their behavioral responses to this perception will shape adaptation options, the process involved and adaptation outcomes (Adger*et al*., 2009; Pauw, 2013). Misconception about climate change and its associated risk may result in no adaptation thus increasing the negative impact of climate change (Grothmann and Patt, 2005).Rural households in Ethiopia are heavily reliant on their natural resources to provide food and income for their family and these resources is dependent on favorable seasonal climate change (Solomon *et al*., 2007).In many under-developing countries like Ethiopia with limited agricultural technology the sustainability and productivity of the agricultural system is affected by this climate change and variability.

Africa is one of the regions that will be hard hit by the impact of climate change like increasing in temperature and reduction in rainfall. Agricultural production and food security in many African countries could be affected by climate change and variability. By 2020, some countries rain-fed agriculture could be reduced by up to 50 percent, with smallholders being the most affected. The impact of climate change could be reducing the economic growing in some parts of Africa and these effects are expected to get worse. This implies that reduction in agriculture production of the smallholder farmers and would be further adversely affected food security. To sustain current levels of food production

and to meet future challenges smallholder household may have to respond to the impact of climate change using an adaptation strategies (IPCC, 2007).

Climate change affects all aspect of economic growth especially in least developing countries. To reduce the impact of climate change and enhance food security, adaptation measures are urgently required. The process of adaptation options are needed to be location, integrated and flexible. This climate change affects to all agricultural sector in a multitude ways. For example, changing weather pattern such as heavy flood and storms makes the agricultural production low, leading to extreme events of poverty, and slow down economic development. In general, there is a relationship between climate vulnerability, poverty and food insecurity (FAO, 2011).

Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Deresse, 2009).

By understanding all of these facts, effort should focus on finding strategies in which households can reduce these problems and improve effort to strength households' perception and adaptation strategies to climate change.

Therefore, this study intended to identify perception and adaptation strategies to climate change and variability's of household's on wheat production in Oromia regional state, Bale Zone, Sinana district.

## 1.2. Statement of the problem

In the agricultural sector, both adaptations to climate change and climate variability involve processes of interaction among individual households. Climate variability poses one of the major challenges facing agricultural and livestock producers around the world (Ashley and Christopher, 2009). Africa is generally acknowledged the continent most vulnerable to climate change (Apata*et al.,* 2009). The natural resource requirements to meet the food needs of increasing populations vary considerably among the major agro-ecological zones in Africa.

According to Claudia (2010), climate change leads to declines in agricultural productivity and crop yields in much of Sub-Saharan Africa, consequently the nutrition of millions of people could be compromised.

The impacts of climate change have been adversely affecting the economic growth. These impacts affect all economic sensitive sectors especially agriculture sector. Ethiopia is one of developing country and its economy is highly depending on agriculture which had failed to meet the growing food demand. This is because the negative effect of climate changes on agricultural production (World Bank, 2007).

Climate change is unexpected impact because it is a natural phenomenon that varies with location, socio economic and environmental conditions. Perception and the capacity to adapt to climate change are unequal across these varieties. Many scholars are done on perception and adaptation strategies of households to climate change. According to Deressa*et al.,* (2009) knowledge of the adaptation methods on the side of smallholder households may make it better to tackle the challenge of climate change.

According to Gutu*et al.* (2012) awareness creation on climate change, facilitation of credit availability, investment on non-farm engagement, improve good mix of livestock holding, encourage adult education, dissemination of indigenous early warning information, diversifying crops to perennial trees, and improved frequencies of agricultural extension contact be made so as to ensure households well perceive climate change and then adapt to the changes. However, his study does not identify for specific crop.

Accessibility to and usefulness of climate information (Roncoli*et al.,* 2001), the policy and institutional environment (Agrawal*et al.,* 2008), and the financial capacity of households (Ziervogel*et al.,* 2006) were found to influence households' coping and adaptation strategies to changes in rainfall and crop productivity.These all research did not identify perception and adaptation of climate change and variability to specific crop especially for wheat production.

There are nomuch empirical studies conducted on households' perceptions of climate change and their adaptation decision on agricultural production on wheat producingstrategies inSinana districts. As to the knowledge of the researcher, no earlier study was conducted on perception of climate change and adaptation strategies of

households in this study area. Specially, this study area is known by its wheat production in Oromia region state. However, no research has done on climate change and variability on wheat production. Hence, considering this knowledge gap, the researcher werestudy on the households' perception and adaptation strategies to climate change in Sinanadistrict.

## 1.3. Research Question

The present study attempt to address the following research questions:

1. How do householdsinsinana districtperceive to climate change and variability?
2. Which factors are influencing the choice of adaptationstrategiesof households in Sinana district?

## 1.4. Objectives of the Study

The generalobjective of thisstudy wasto assess perception and adaptation strategies of wheat producing households to climate change and variabilityin the case of Sinana District, Bale Zone,Oromia, Ethiopia.

The specific objectives of this study are:

1. To analyze factors affectingwheat producing households' perception to climate change.
2. To identify factors affecting households choice of adaptation strategiesto climate change.

## 1.5. Significances of the study

The study was investigated determinants of perception and adaptation strategies of wheat producing households to climate change and variability in the case of Sinana District, BaleZone,Oromia, Ethiopia. Theoutput has been help policy makers to develop evidence based future research and good development programs aimed to benefit households in the region in general,sinana district in particular. In addition, increase our household's perception for good adaptation strategies to climate change and variability. Therefore, the study was generate information on diverse set of issues related to perception and adaptation strategies to climate change and variability inSinana districtof Bale

zone,regional state ofOromia, Ethiopia.Furthermore, the study serves as a springboard for further and detailed studies on the topic.

## 1.6. Scope and Limitation of the study

### 1.6.1. Scope of the study

The study identifies perceptions and adaptation strategies of households' to climate change and variability on wheat production in the study area. It relies on randomly selected households in Sinanadistrictof Bale zone that are dependent on producing wheat using cross –sectional data collected in 2018G.C.

### 1.6.2. Limitation of the study

This study is limited to one districts of the Oromia National Regional State, Bale Zone. This is mainly due to lack of resources and budget to undertake the study at a wider scale as needed. Climate change studyusually needs more resource and budget to collect data at household level onhousehold's perception and adaptation strategies to climate change and variability. The main limitation of risk perception analysis is that risk analysis is never perfect. However, risk perception responses evaluate the respondents' gut level of risk assessment and approximate the reality. In addition, shortage of timealso another limitation for the study.

## 1.7. Organization of the thesis

The research was structured to contain fivechapters'supplemented with some references. In the first chapter, general background of the study, statement of the problem and objectives and significance of the study are presented.Second chapter presents review of literature that contain basic concept, theoretical reviews, empirical reviews and conceptual frame work.The third chapter deals with description of the study area in the context of the research objectives, population and study sample, source of data, sample size and sample selection, collection of data, data management and methods of data analysis that used to analysis the study as well as ethical and human subject issue. Fourth chaptercontainresults and discussion of theresearch. Lastly, fifth chapter contains conclusions and recommendations of finding.

# 2. LITERATURE REVIEWS

## 2.1. Basic Concept

According to the definition of the Intergovernmental Panel on Climate Change (IPCC), climate change is any change in climate over time, whether due to natural variability or as a result of human activity orClimate change is a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties that persists for an extended period, typically decades or longer (IPCC, 2007). IPCC (2014) has further given a more elaborated definition to climate change stating that climate change is a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Climate variability means deviations in the mean state of climate and inconsistencies (e.g. in occurrence of drought andflood), on temporal and spatial scales, including short term fluctuations that happen from year to year (Ziervogel*et al.,* 2006a).

According to FAO (2011), Climate change has strong impact on the agricultural sectors and forestry by modifying or degrading productive capacities and by directly and indirectly increasing the risks associated with production. Due to the fact, most of developing countries are particularly vulnerable to the adverse effects of climate change. In coming decades, millions of people whose food and livelihood security depends on farming, fishing, forests and livestock-keeping are likely to face climatic conditions that are unprecedented in the history of agriculture. To sustain current levels of food production and to meet future challenges adaptation is often underestimated by the international community.

Adaptation to climate change refers to adjustment in natural or human systems in response to real or predictable climatic inducements or their effects, which moderates harmful effects or make use of beneficial opportunities (IPCC, 2001). Historically, people whose livelihoods are dependent on agriculture have developed ways to cope with climate variability in their own way.Adaptation strategies are differing among individual farmers depending on their capacity and willingness to adopt. There are factors that are restricting adaptive capacity and willingness to adopt as a potential source of limits and barriers to

adaptation. The main constraints and barriers to adaptation are biophysical, economic, social, and/or technological in nature.

Adaptation is initiatives and measures to reduce the vulnerability of nature and human systems against or expected climate change effect. There is various type of adaptation, for example anticipatory and reactive, private and public, and autonomous and planned. Adaptive capacity is intimately connected to social and economic development but it is uneven distributed to the societies. There are many limitations that barriers the effectiveness of adaptation measures. The adaptive capacity is depend on the community productive bases, capital asset, social network, human capital and institutions, government, national income, health and technology. However, societies with high adaptive capacity may be vulnerable to climate change (IPCC, 2007).

There are many different strategies that the farmers can implement to reduce the risk of climate change impacts. Households use different adaptation strategies that fit with the types of the problems caused by climate change they faced. This is because impact of the climate change is unevenly distributed over different geographic areas and hence the adaptation mechanisms vary with types and level of the impact of climate change. Therefore, adaptation strategies that the households use to reduce the impact of climate change in different way: for instance changing crop variety, changing planting dates, mix crop and livestock production, decrease livestock, moving animals/temporary migration, change livestock feeds, soil and water management, planting trees, change from livestock to crop production, change animal breeds, seek off-farm employment, planting short season crop, and irrigation/water harvesting are among some of the several strategies available to enhance social resilience in the face of climate change (Bradshaw *et al*., 2004; Nhemachena and Hassan, 2007). Therefore, a key component of climate adaptation includes building resilience, where resilience is the capacity of a system to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes (FAO, 2009).

In general as adaptation is a process, it is required that the ongoing learning, analysis, planning and adjustment should respond to an evolving context and changing risks. This again needs to be complemented by provision of appropriate, timely and locally relevant climate information such as weather forecasts, seasonal forecasts and early warnings for

climate hazards that have to be made accessible to the people and institutions that need it, including the most vulnerable groups within communities.

## 2.2. Theoretical Literature

Several decades of works have been devoted to understanding perceived risks. Theory which dominates risk perceptions are the 'psychometric paradigm', rooted within the disciplines of psychology and decision sciences; 'cultural theory', developed by sociologists and anthropologists and 'farm structure theoretical model' which is concerned with the farm operation items, such as the size of the farming operation, which may influence such risk perceptions (Belaineh and Drake, 2005).Psychometric paradigm' uses psycho – physical scaling and multivariate analysis techniques to produce quantitative representations of "cognitive maps" of risk attitudes and perceptions. It provides an understanding of why people perceive or react to risks differently.According to cultural theory, the most important predictors for risk perception are not individual cognitive processes (as according to the psychometric paradigm), but socially shared worldviews in relation to the "culture" individuals belong to.Farm structure refers to farm size and numbers, tenure patterns, legal organization, the market arrangement under which farmers buys and sells, and the institutional arrangements therein influencing the farming industry.

### 2.2.1. Climate Change

#### 2.2.1.1. Climate Change in Africa

Agriculture is the income base of many people in Africa who also greatly depend on natural resources, especially on soil and water, as well as on climatic conditions. Climate change affects both water availability and agriculture (Gyorgyi, 2009). It is already a continent under pressure from climate stresses and is highly vulnerable to the impacts of climate change. Many areas in Africa are recognized as having climates that are among the most variable in the world on seasonal and decadal time scales. Floods and droughts can occur in the same area within months of each other. These events can lead to famine and widespread disruption of socio-economic well-being (UNFCCC, 2007).

Many factors contribute and compound the impacts of current climate variability in Africa and will have negative effects on the continent's ability to cope with climate change. These

include poverty, illiteracy and lack of skills, weak institutions, limited infrastructure, lack of technology and information, low levels of primary education and health care, poor access to resources, low management capabilities and armed conflicts (UNFCCC, 2007).

### 2.2.1.2. Climate Change and Variability Problems in Ethiopia

Ethiopia is one of the least developed countries in the world, with a gross domestic product (GDP) of slightly more than US$10 billion and a population of more than 70 million (Yusuf*et al*., 2008).At present, agriculture dominates the Ethiopian economy, accounting for nearly half of GDP and for the vast majority of employment. While the country is highly dependent on the agricultural sector for income, foreign currency, and food security, the sector is dominated by small-scale farmers who employ largely rain-fed and traditional practices, a state which renders Ethiopia highly vulnerable to climate variability(as seen during past persistent drought), and thus to climate change (ACCCA, 2010).

Ethiopia's history is associated, more often than not, with major natural and man-made hazards that have been affecting the population from time to time. Drought and famine, flood, malaria, land degradation, livestock disease, insect pests and earthquakes have been the main sources of risk and vulnerability in most parts of the country. Especially, recurrent drought, famine and, recently, flood are the main problems that affects millions of people in the country almost every year. While the causes of most disasters are climate related, the deterioration of the natural environment due to unchecked human activities and poverty has further exacerbated the situation (NMA, 2007).

Climate change is affecting agricultural regions throughout the world. Economic re-forms that would help countries negatively affected by climate change could include the introduction of flexible land-use policies and the elimination of subsidies. Increased access to financial services such as credit, marketing systems, training and irrigation would also mitigate the impacts (Sarah, 2008).

Developing countries are vulnerable to climate change because they depend heavily on agriculture, they tend to be relatively warm already, they lack infrastructure to respond well to increased variability, and they lack capital to invest in innovative adaptations (Travis and Daniel, 2010). Participation in programs for environmental protection is an

increasingly important tool for accomplishing environmental policy objectives (Dariush*et al*., 2009)

While Ethiopia is highly dependent on the agricultural sector for income, foreign currency, and food security, the sector is dominated by small-scale farmers who employ largely rain-fed and traditional practices – a state which renders Ethiopia highly vulnerable to climate variability(as seen during past persistent drought), and thus to climate change (ACCCA, 2010). According to ACCCA (2010) some of the important adaptation options of climate change are crop diversification, using different crop varieties, using short growing crop varieties, increased use of labor input per unit of land, increased use of soil and water management techniques, plating more trees at plot, use of external fertilize at plot level and borrowing lost crops from community and others.

According to IPCC (2007), the successes and failures of crops have always been subject to prevailing environmental factors. Crop production is increasingly vulnerable to risks associated with new and evolving climatic changes. These are variations in environmental conditions that pose significant challenges to smallholder households. The planet is facing more extreme weather events, such as heavy precipitation, higher coastal waters, geographic shifts in storm and drought patterns and warmer temperatures. Besides, Climate change is regularly listed as a major contributor to the food insecure state of Ethiopia and drought remains the top priority by the government (Coates *et al*., 2010). Farmers also reflect this in their claims that the weather is indeed different to what it was a few decades ago (Amsalu*et al*., 2007)

## 2.3. Empirical Literature

### 2.3.1. Households' Perceptions of Climate Change

Households' perception of climate change is the condition for their initiation of adaptation practices. Some empirical studies as Temesgen*et al*. (2008) indicated that age of the head of the household, farm income, information on climate change, household-to-household extension, number of relatives in a households group and agro-ecological settings affect the perception of climate change positively.

The higher likelihood of perceiving climate change with increasing age of the head of the household is associated with experience which lets households observe changes over time and compare such changes with current climatic conditions (Temesgen*et al*., 2008). Access to information on climate change through extension agents or other sources creates awareness and favorable condition for adoption of farming practices that are suitable under climate change (Maddison, 2006).

The agro-ecological setting of households influences the perception of farmers to climate change. According to Deressa*et al*. (2011) households living in dega (highlands) perceived more change in climate than households in Kola (lowland) did or Woinadega (mid-land).

### 2.3.2. Adaptation of Climate Change

Adaptation to climate change actually involves a two-stage process: first perceiving that climate change has occurred and then deciding whether to adopt a particular measure. This gives rise to a sample selectivity problem since only those individuals who perceive climate change will adapt, whereas making inferences about the population of agriculturalists in general is needed (Maddison, 2006).

According to Ringler*et al*. (2009), they studied on adaptation to climate change in Ethiopia and South Africa: options and constraints. Based on the finding they pointed out that, climate change is expected to adversely affect agricultural production in Africa. Because agricultural production remains the main source of income for most rural communities in the region, adaptation of the agricultural sector is imperative to protect the livelihoods of the poor and to ensure food security. A better understanding of households' perceptions of climate change, ongoing adaptation measures, and the decision-making process is important to inform policies aimed at promoting successful adaptation strategies for the agricultural sector. The study presented the adaptation strategies used by farmers in both countries and analyzes the factors influencing the decision to adapt. They find out that the most common adaptation strategies include use of different crops or crop varieties, planting trees, soil conservation, changing planting dates and irrigation.

However, despite having perceived changes in temperature and rainfall, a large percentage of households did not adjust their farming practices. The main barriers to adaptation cited by households were lack of access to credit in South Africa and lack of access to land,

information, and credit in Ethiopia. Factors influencing farmers' decision to adapt include wealth, and access to extension, credit, and climate information in Ethiopia; and wealth, government farm support, and access to fertile land and credit in South Africa. They are used a pooled dataset to analysis the factors affecting the decision to adapt to perceived climate change across both countries reveals that households were more likely to adapt if they had access to extension, credit, and land. Food aid, extension services, and information on climate change were found to facilitate adaptation among the poorest households.

Households' adaptation strategies to climate change included crop, soil fertility and soil water management practices. Concerning crop management the disparity of adoption of the strategies, clearly indicate the need to test their effectiveness to save time, effort and resource for households (Akponikpe*et al*., 2010). As stated by Akponikpe*et al*., (2010) soil fertility management permits to mitigate climate change impacts. According to Yusuf *et al*., (2008) adaptation not only enables households to cope with the adverse effects of climate change and variability, but also increases the agricultural productivity of poor farm households.

According to Temesgen*et al*., (2008) variables that positively and significantly influence adaptation to climate change include education of the head of household, household size, and gender of the head of household, livestock ownership, extension on crop and livestock production, and availability of credit and temperature.

Male-headed households are often considered more likely to get information about new technologies and take on risk than female-headed households. Farm size and annual average precipitation are negatively related to adaptation. The reason for the negative relationship between average annual precipitation and adaptation could be because, like any African country, Ethiopia's agriculture is water- scarce, and higher levels of precipitation, therefore, will not constrain agricultural production and promote the need to adapt (Temesgen*et al*., 2008).

Tessema*et al*. (2013) study examined smallholder farmers' about climate change, types of adaptation strategies, factors influencing adaptation choices and barriers to adaptation Eastern Hararghe Zone, Ethiopia. The data collects from smallholder farmers' in the study area and employed a multinomial logit model. The result revealed that planting tree, early

planting, terracing, irrigation and water harvesting. Planting tree is the major adaptation method. Results of multinomial logit model showed that non-farm income, farm-to-farmextension, access to credit, distance to selling markets, distance to purchasing markets, income affect the choice of adaptation strategies. Finally, the study identified that lack of information as the most important barrier to climate change adaptation. The other barrier include; lack of farm input, shortage of land, lack of money, lack of water and shortage of labor.

Similarly, the finding of legesse*et al*. (2012) studies on smallholderhouseholds' perceptions and adaptation to climate variability and climate change in Doba district, western Harerghe, Ethiopia. They are investigated the determinant factors influencing adaptation strategies to climate variability and change. The adaptation strategies were crop diversification and the use of soil and water conservation practices, integrated crop and livestock diversification, engaging in off-farm income activities and rain water harvesting. The result of the MNL model revealed that agro-ecological location, sex, family size, plot size, off-farm income, livestock holding, frequency of extension contact and training are the determinant of factors influencing adaptation strategies

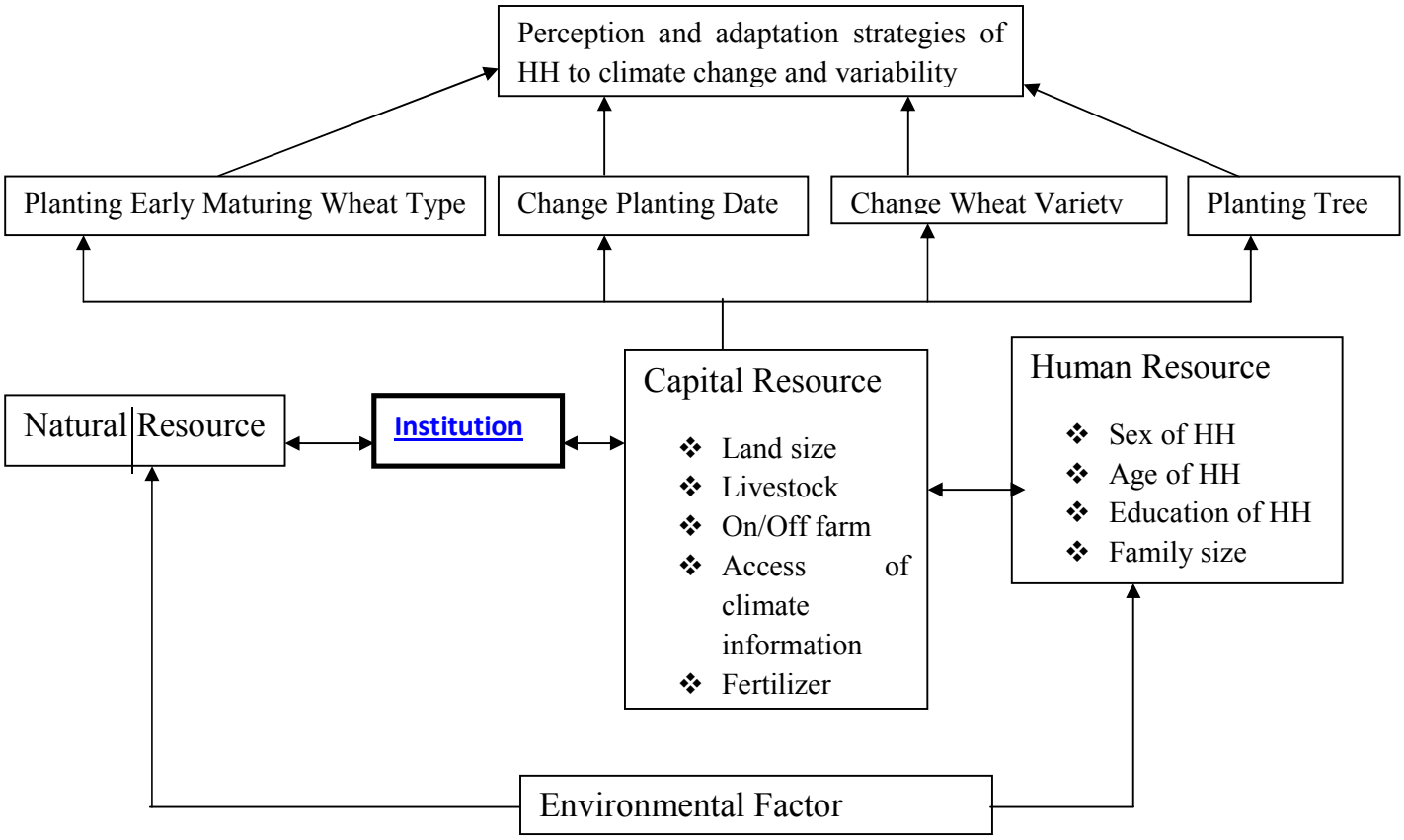
## 2.4. Conceptual Framework

The study wasexamined climate change and variability impact on wheat production and the adaptation strategies that are adapted by the household communities in sinana district.The conceptual framework that guides the study is taken from the works of Portier*et al*. (2010) and it help as a strategic tool to better understand the interaction of environmental resource, economic resources, human resources to adaptation strategiesof climate change and variability. The conceptual framework takes in to consideration the climatic variability theory that links climatic variations to environmental changes.The predominant impact on agriculture comes through environmental changes because of climate change although there are direct impacts from both climate changes and adaptation.

The four domains of the physical and socioeconomic environment namely environmentalresource, economic resources and human resources variables influence the environmental change. Each domain corresponds to a system that has its own distinct driving forces, objectives, and indicators. The economy is geared largely towards

improving human welfare, principally through increase in the consumption of goods and services. The social domain gives due emphasis to the enrichment of human relationship and achievement of individual and group aspirations. The political domain on the other hand focuses on power, policies and sharing of resources. All the four domains are affecting by climate change andvariability the balance among the four domains is critical to designing effective adaptation strategies' to climate change.

Figure 1:Adaptation strategies Conceptual framework




Source: Taken from Portier*et al*. (2010) with great modification.

# 3. RESEARCH DESIGN AND METHODS

## 3.1. Description of the Study Area

### 3.1.1. Location of stud area

The study area wasSinana district,wich wasone of the largest and potential district of Bale zones with an area of 1168km2 /116800hectars/. Sinana district is located in the northern western part of Bale zone. It is bounded with Goro and Ginir in East, Dinsho in West, Agarfa and Gasera in North and Goba and Barbare district in the south. The total area of the district is about 1168km2 which ranked as the third smallest district in the zone and their area account about 1.67 % out of the total area of the zone (6966km2).The administrative center of the district is Robe town.

### 3.1.2. Land Use and climate of study area.

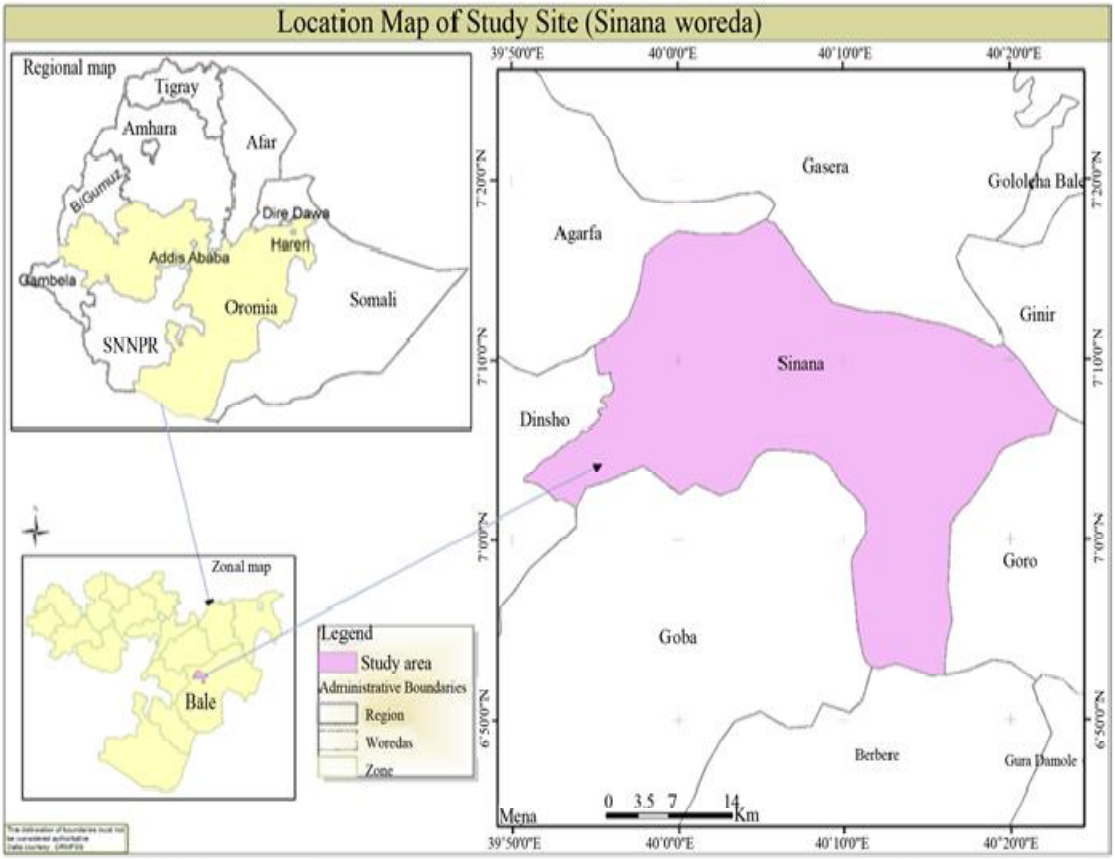
The lowest and highest altitude of the district is extended from 1650m to 2950m above sea level respectively. The highest elevation is located around boarder area of south east of Goro, namely GeradoMountain, whereas the lowest elevation is located around south east of boarder area. From the total area of the district about 73.54 % is plain land, 3.7 % is hills, 9.6 % is mountains, 12.3 % is rugged and .86 % is gorge.The climate of sinana district is divided in to three major climatic zones. Highland shares 13.3%, Semi highland 85.84 % and lowland account for 0.86%.The district has bimodal rainfall. This is due Atlantic ocean, which is the cause of summer rain, and Indian Ocean is the cause of autumn /Belg/ rain. Diverse climate, topography and natural vegetation have made the district to have a variety of wild life. The spatial distribution of wild life in the district is highly associated with agro climatic and their natural habitat. The most common animal which found in the district is Pig, Monkey, Ape, Hyena, etc. The annual average temperature is 16.5oc whereas the minimum and maximum temperature is 9oc and 23oc respectively. The annual average rainfall is 1105mm whereas the minimum and maximum rainfall is 1060 and 1150mm respectively.Agriculture is one of the main stay of the economic activity of the district in which 99% of the population are engaged on it. The district believed to be one of the self-sufficient or surplus producing districts in the zone.

The land use of the district classified as the following, land cover under crop is about 50.75 %, 19.7% cover with grazing land , 5% of land covered with forest ,0.01 % of land

cover with Barren land and 24.42% of land covered with others (for construction, rivers, gorges and others). In other way, the total area of the district is about 73.54 % is plain land, 3.7 % is hills, 9.6 % is mountains, 12.3 % is rugged and .86 % is gorge.

Land utilization is one of the principal ways to measure the performance of Agricultural production. As Land is one of the most important natural resources provided by nature for Man's aid, utilizing without any effect increase the output generate from it. This is true for Bale Zone economy especially for Sinana district where the Agricultural sector is the main stay to the livelihood of the majority people. In 2000, the total area of district is 11681km2 (116,800ha.) out of this land 50.75 % is under crop production,19.71 % is under grazing land,5.11 % is covered by forest,3.55 % covered by swampy and Marshy, 8.40 % is covered by barren/degraded area, 7.68 % is arable land and 4.7 %is covered by others( such as river ,mountains, construction etc.).Land is the basic Agricultural resource in which the societies depend largely upon for crop production. In addition the contribution of labor, capital and input to the Agricultural productions were high. The district have two major cropping seasons which is known as Maher and Belg. Cereals, pulses, Oilseed, fruit, vegetables and spice are the known crop grown in the district.

Figure 1 Map of the study area the study area




## 3.2. Population and Study Sample

According to CSA (2007) report the population of sinana district of Bale zone, Oromia regional state is reported as total population is 118,594 from which 56,626 men and 61,968women.

## 3.3. Sources of data

In order to address the stated objectives the researcher uses bothprimary and secondary data. The primary data collectedusing semi-structured questionnaire from randomly select households in the study districts. The data is expect to be consists of household characteristics and farm attributes, socio-economic and demographic characteristics, location characteristics, and other related information in the study area that was essential for this study.Secondary information and data used in the analysis are mean monthly maximum and minimum temperature and mean monthly rainfall values, nature of the soil and accessibility to markets and inputs.These data were collected from published and

unpublished documents, internet sources, reports, maps, and other relevant materials. These types of data were collected from different governmental and non-governmental bodies that are found at district, zonal, regional, and national levels.

## 3.4.Sample Size and Selection of Sample

Sample size is often determined by taking into account the level of precision, the level of confidence and the degree of variability in the attributes being measured. It is typically determined using statistical calculations. In a general for finite population, if we want to estimate μ in a population with an error no greater than 'e' by calculating a confidence interval with confidence corresponding to z, the necessary sample size, n, equals as under:

$$n = \frac{Z^2 pqN}{e^2 (N - 1) + Z^2 pq}$$

Where,

N=population size(which is 118594)

n = size of sample

e = acceptable error (the precision at 95% it is 0.005)

p = sample proportion, q = 1 – p

z = standard variate at a given confidence level (95% confidence limit i.e.1.96).

Then,

$n=1.96^2 *0.5*0.5*118,594/.005*118594+1.96^2*0.5*0.5=191$

## 3.5. Sampling Techniques

The selection of the districts isa purposive selection method that is to study wheat production influence in the district. Four kebeles from the district wereselected randomly.

## 3.6. Collection of Data

The data used for the research wasprimary data.Data collection method is house to house survey method was applied to randomly selected households from the selected kebeles for these studies. The households from kebeleswere taken randomly to include different kinds of households that represent study area.Four kebeles from the district wereselected randomly. Households from the selected kebeles were taken by the proportional sampling

to the total household of the respective kebeles. The randomly selected kebeles were asambarera, basaso, amida and horoboqa.

## 3.7.Exposure Assessment

After accomplishing of the work, the result and data will be exposure through workshops training to users. The researcher aim with best result and finally disseminate the result through publication.

## 3.8.Data Management

The researcher manages and collects data by himself as supervisor and as well as by data collectors or enumerator. After collecting data, the researcher storedthe data for future work safely in SPSS and STATA.

## 3.9.Methods of Data Analysis

The empirical data was analyzed using descriptive, inferential statistics and econometric models. The collected raw data were edited and analyzed using appropriate statistical tools such as percentages, frequencies and standard deviations to summarize and categorize information that were collected. Cross tabulation, t-test, and chi-square tests. In what follows, econometrics tools are outlined and discussed in detail.

### 3.9.1. Multivariateanalysis

This study employs a multivariate analysis model to analyze factors influencing perception and choice of adaptation strategies ofhouseholds to climate variability and climate change in Sinana district. Multivariate analysis deals with issues related to the observations of many, usually correlated, variables on units of a selected random sample. The observations are gathered as vectors; for each selected unit corresponds a vector of observed variables. An understanding of vectors, matrices, and, more generally, linear algebra is thus fundamental to the study of multivariate analysis.In general,Multivariate statistics are increasingly popular techniques used for analyzing complicated data sets.

Multivariate analysis has its own advantage. From this advantage it uses all information available, improve signal to noise ratio, statistically valid removes potential bias ant it is

fast and efficient on modern computer.In addition,lots of different methods, procedures, terminologies and difficulty to understand are its disadvantage.

### 3.9.2. Multivariate Normal Distribution

In analogy to the univariate setting, the multivariate normal distribution is heavily used in multivariate statistics. This has led to a number of techniques:

For the multivariate setting: multivariate regressions, MANOVA, CCA, discriminant analysis andfor the longitudinal setting the linear mixed-effects model, for the spatial setting the auto-Gaussian model are used.

For the same reasons as above, these techniques can be used as well, with caution, when samples are non-normal, for two reasons: merely for describing, summarizing, reducing data (such as a sample mean); and for samples that are large enough (large sample inference).

## 3.9.3. Discrimination analysis

Discriminant Analysis (DA) is a dimension reduction method that can be used to identify a linear combination of variables that produces the greatest distance between groups. DA is usually used to predict group membership in naturally occurring groups. It answers the questions: Can a combination of variables be used to predict group membership? Usually several variables are included in a study to see which ones contribute to the discrimination between groups. DA is conceptually similar to logistic regression for multivariate data, and it is computationally similar to Multivariate Analysis of Variance (MANOVA).

Discriminant analysis and classification are multivariate techniques concerned with separating distinct sets of objects and with allocating new objects to previously defined groups. The goal of discrimination is to describe graphicallyor algebraically, the differential features of objects from several known collections (populations) and the goal of classification is to sort objects into two or more labeled classes.

Thus, discrimination analysis is the appropriate statistical analysis techniques when the dependent variables are a categorical variable and independent variables are metric variables. In case that dependent variable is consist of two or more. In this study case, the

dependent is perception and adaptation strategies of households to climate change. When two classifications are involved, the technique is referred to as two-group discrimination analysis. When three or more classification is identified, the technique is referred as multiple discrimination analysis (MDA). Logistic regression is limited in its basic form to two groups, although other formations can handle more groups. It involves deriving variate. The discrimination variate is the linear combination of two independent variables that will discrimination best between the explanatory variables. In addition,it is driving equation much like that seen in multiple regressions.

$$Y_{jk} = \alpha + \beta_1 X_{1k} + \beta_2 X_{2k} + ..... + \beta_n X_{nk}$$

Where,

$Y_{jk}$ = Discrimination y score of discrimination function j for object k.

$\alpha$ = constant

$\beta_i$= discrimination weight for independent variable i.

$X_{ik}$= independent variable I for object k.

**3.9.3.1. Assumptions of Discriminant Analysis**

Multivariate Normality- DA assumes that the various independent variables in each group and all linear combinations of them are normally distributed. However, violations of the normality assumption are not “fatal” and the resultant significance test is reliable as long as skewness and not outliers cause non-normality. In univariatetests, robustness against violations of the assumption is assured when the degree of freedom for error is 20 or more for equal group sizes. Moreover, if there are at least 20 cases in the smallest group the test is robust to violations of multivariate normality even when there are unequal group sizes (Tabachnick and Fidell, 2007).

Homogeneity of Covariance Matrices- DA assumes that the variance/covariance matrix in each group of the design is sampled from the same population so they can be reasonably pooled together to make an error term. When inference is the goal, discriminant analysis is

robust to violations of this assumption (Tabachnick and Fidell, 2007). When classification is the goal, then the analysis is highly influenced by violations because subjects will tend to be classified in to groups with the largest dispersion. If this assumption is violated, appropriate remedies include transforming the data, using separate matrices during classification, using quadratic discriminant or using non-parametric approaches to classification.

#### 3.9.3.2. Theoretical Development of Discrimination

Classification analysis is concerned with the development of rules for allocating or assigning observations into one or more groups. A classification rule usually requires more knowledge about the parametric structure of the groups. The goal of classification analysis is to create rules for assigning observations to groups that minimize the total probability of misclassification or the average cost of misclassification.

Because linear discriminant functions are often used to develop classification rules, the goals of the two processes tend to overlap and some authors use the term classification analysis instead ofdiscriminant analysis. Because of the close association between the two procedures, we treat them together in this sub-section.

### 3.9.4. Multivariateprobit regression model

In order to estimate factors influencing households' choice of adaptation strategies, a multivariate probit model was used. The multivariate probit model is one form of a correlated binary response regression model that simultaneously estimates the influence of independent variables on four dependent variables and allows the error terms to be correlated. It is an extension of probit model used to estimate four correlated binary outcomes jointly. It is an appealing model of choice behavior because it allows a flexible correlation structure for the unobservable variables. The model has a structure similar to that of a SUR model, except that the dependent variables are binary indicators. As for the SUR case, the equations need not include exactly the same set of explanatory variables.

The general equation for the fourinterdependent binary probit (endogenous variables) following Greene (2012) is specified as:

$$Y_{mi}^{*} = X_{mi} + \beta_{mi} + \varepsilon_{mi}$$

$$Y^{*}_{mi} = \begin{cases} 1 if Y_{mi}^{*} = X_{mi} + \beta_{mi} + \varepsilon_{mi} > 0 \\ 0 if Y_{mi}^{*} \leq 0 \end{cases}$$

Where Y* is the binary latent variable for alternative adaptation strategies observed when Y* is greater than zero and 0 otherwise; and $X_{4i}$ is a vector of household-specific socioeconomic and demographic factors; $\beta_{4i}$'s are vectors of simulated maximum likelihood (SML) parameters and m = 1, 2, 3, 4 for multivariate probit cases.

The error terms are distributed as multivariate normal, $E(\varepsilon_{4i} / X_{4i}, X_{3i}, X_{2i}, X_{1i}) = 0$

The variance-covariance matrix of the cross-equation of the error terms has a value of 1 on the leading diagonal, and the off-diagonal elements are correlations to be estimated by

($\rho_{ji} = \rho_{ij}$, and $\rho_{ii} = 1$, for all i = 1, 2,3 and 4).

$Var(\varepsilon_{4i} / X_{4i,} X_{3i}, X_{2i}, X_{1i)} = 0$

$Cov(\varepsilon j, \varepsilon_{4i} / X_1, X_2 X_3, X_4, ..., X_n = \rho ij$

$(\varepsilon_{1i} \varepsilon_{2i} \varepsilon_{3i} \varepsilon_{4i}) \approx N(0, R)$

ρ's are correlations between endogenous dependent variables. When ρ is zero, it means that the univariate probit models will generate consistent estimates.

The marginal effects and the associated predicted probabilities can be estimated from the conditional mean as $\frac{\partial E[EM / X_1, X_2, X_3, X_4, CD_i = 1, CV_i = 1, PT_i = 1]}{\partial X_i}$

Thus, the marginal effects or marginal probabilities are functions of the probability itself and measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean.

### 3.9.5. Definition of the Model variable for Multivariate

**Dependent variables**

The study used multivariate dependent variable. Each dummy dependentvariablestaking the value 1 if the household adapted to climate change and 0 otherwise. This is done to distinguish between households who adapted and those who did not in the study area. A householdis considered to have adapted to climate change if he/she has employed at least one of the adaptation strategies such asplanting early maturing wheat type , change planting date , change wheat variety and planting tree.

**Planting early maturing wheat type**: This means that households use wheat that mature early those survive climate change and variability in adverse to climatic conditions.

**Change planting date**: This means that households could change the date of planting wheat with respect tothe change in the climate (early or late planting) that to survive in climatic change and variability conditions.

**Change wheat variety**: Changing wheat type that adapt climate change and variability.

**Planting tree**: planting trees toadapt climate change through environment protection.

**Independent variables**

The independent variables are the factors that affect perception and choice of adaptation strategies to climate change and climate variable. Different literatures were reviewed on the factors that affecting household's choices of adaptation strategies to climate change and variable. Majority of them have been focused on household characteristics, farm characteristics, institutional factors and environmental factors.

Accordingly, the researcher was conceding the following as exogenous variables i.e. factors influence households perception and adaptation strategies of wheat producing households to climate change and variability.

**Description of Independent Variables**

**Age of the household head (AGE)**: This is a continuous variable and represents the experience of the household in the farming activities.

**Sex of the household head (SEX)**:Sex of the household head is hypothesized to influence the decision to adopt changes.A study in South Africa by Nhemachena and Hassan (2007) reported that female-headed households are more likely to take up climate change adaptation methods.On the other hand Asfaw and Admassie (2004) argued that male-headed households are more likely to get information about new technologies and undertake risky businesses than female-headed households. This study therefore assumes that sex of a household head could have influence on adaptation to climate change. It is a dummy variable, assuming 1 if male and 0 otherwise.

**Education level of household head (EDUC)**: Education as a dummy variable and I if households are literate and 0 if households are illiterate. Therefore, in this study, education of the household head is hypothesized to be positively influencing households' decisions to adaptation strategies to climate change (Legase,*et al*.,2012).

**Household size (HHSZ)**: Household size is the total family member of the household and it is a continuous variable.Large number of family member can adapt the effect of climate change easily. Household size is measured by the number of members in a household. It is assumed to represent the labour input to the farm.Mano and Nhemachena (2006) contended that large household size is mostly inclined to divert part of its labour force into non farming activities. In this study therefore the variable is assumed to have positive or negative impacts on climate adaptations.

**On farm income (ONFARM)**: It is an income of household obtains from non-farming activities. It is a dummy variable. And 1 if household has farm income and 0 if household has no farm income. Thus, in this study the variable onfarm employment is to be positively or negatively related to climate change adaptation.

**Off farm income (OFFARM)**: This is an income of household obtains from non-farming activities. It is a dummy variable.And 1 if household has off farm income and 0 if household has no off farm income. Thus, in this study the variable off farm employment is to be positively or negatively related to climate change adaptation.

**Access to credit service (CREDIT)**: The availability of credit is important for the households' in order to make adaptation strategies. Credit can be used as for the households to introduce new strategies, to buy modernize crop, fertilizers and oxen. Therefore, thus was expected a positive sign for the households' who are used adaptation method to climate change and is a dummy variable, indicating 1 if the households has access to credit and 0 otherwise.

**Agricultural extension service contact(EXTN)**: It refers to the number of contacts with extension agents that the respondent households made in a year and have positive relation (Shongwe et al., 2014). In fact, agricultural extension is an important source ofinformation, knowledge and advice to households in Ethiopia. Subsequent provision of technical supports (extension services) will increase households' knowledge, skills and awareness towards new innovations. Therefore, extension contact is hypothesized to influence households' choice of adaptation to climate change and variability negatively or positively.

**Farmland size (FLSZ)**:Farmland size is the total landholding of household that uses for the farming activities. The household with holding big farm land has more to use choice of adaptation and the farmland size measure in terms of hectare. Therefore, the variable is continuous and it's expected was a positive sign for the households' who were used adaptation method to climate change and variability.

**Livestock holding(TLU)**: the number of Tropical Livestock Unit (TLU).Livestock holding is the total livestock that households can own measures it. It is a vital instrument in the case of climatic change adaptation strategies. This is due to the fact that livestock is essential for household to use as for harvesting, transportation and also for financial purpose by selling them. This implies that households with more numbers of livestock is the richer and can respond to the adverse impact of climate change through adaptation method and it is a continuous variable.

**Distance from home to the farm area**: This variable is a continuous variable represented by walking time (in minute) from households' home to their farming place. The researcher considers this as possible factor in households' decision to undertake adaptation to climate change impact. Thus, the households whose farm is far from his home is less likely to continuously follow up his farm as compared to those whose farm nearer to their home. Thus, it is expected that households who live near to their farm are likely to have regular

follow up of their farm, hence motivate to respond to the impact of climate change on their agricultural activities.

**Distance to the market (DMKT)**: This is a continuous variable which measures in terms of time spend from the home of household to the market area. The residences of households' are nearest to the market they get a lot of opportunities as compare to the far ones. Because the nearest one obtains agricultural inputs, information's and experiences. Therefore, this is variable was expected a negative sign for the farmers' who were used adaptation method to climate change.

**Access to climate information (CLMINFO)**: Availing accurate information on climate change is not an easy task. The presence of well-functioning weather stations and proper processing of weather data and dissemination of weather forecasts as well as acceptance of the information by users is assumed to influence adaptation efforts to climate change (Ayesha, et al., 2012). And it is dummy variable, indicating 1 if the householdhas access to climate changes and 0 other wise.

**Use of Fertilizer (FRTLZR):**According to literatures, fertilization of farmland could increase agricultural production and influence positively the adaptation strategies of a household.

**Use of pesticide/herbicides (PESHERB):** use of pesticide or herbicides by households. It is dummy variable, indicating 1 if the household has access to climate changes and 0 other wise.

**Irrigation:** irrigated land size owned by the household for wheat farm activities.

**Table 1 Summary of independent variables in the model**

| Variables | Description | Expected value |
|---|---|---|
| Age of the household head | Age in years (proxy for experience) | Positive or negative |
| Sex of the household head | Dummy, 1 if male 0 if female | Negative |
| Education of household head | Dummy, 1 if literate 0 if illiterate | Negative |
| Household size | Number of adult equivalent in the household | Positive or negative |
| On farm income | Farm income from wheat production | Positive or negative |
| Off farm income | Dummy, 1 if yes 0 otherwise | Negative |
| Access to credit service | Dummy, 1 if yes 0 otherwise | Negative |
| Agricultural extension service | Average number of extension contact that the household head received. | Negative |
| Farm land size | Amount of land owned in hectare that is arable | Negative |
| Livestock holding | Livestock owned by the household in TLU | Negative |
| Distance from home to the farm area | Distance in Km from house to farm land | Negative or Positive |
| Distance to the market | Distance in Km from house to market | Negative or Positive |
| Access to climate information | Use of different source of information | Positive |
| Use of Fertilizer | Dummy, 1 if Use0 otherwise | Negative |
| Use of Herbicide/Pesticide | Dummy, 1 if Use0 otherwise | Negative |
| Irrigation | irrigated land size owned by the household | Negative |

## 3.10. Ethical Issues

The researcher consider the ethics of research through doing original work, dulling acknowledged for proper citation, participants and supporters. Generally, the researcher obey the university rules and regulations.

# 4. RESULTS AND DISCUSSION

## 4.1 Descriptive Analysis Results

The data employed for the analysis of thisstudy was collected from 191 sample household head from the selected kebele of Sinanadistrict of Bale zone,OromiaNational regional state of Ethiopia.The data analysis wasdone using SPSS 20 and STATA 13 statistical software/packages. The results of the analysis are divided into different sections: Evaluation of assumptions, descriptive analysis results, stepwise variable selection and results of discriminant analysis. These results and their discussions are presented below.

### 4.1.1.Check of Assumptions

The major assumptions of discriminant analysis are the multivariate normality and the homogeneity of within covariance matrices between the two groups. The normalityassumption helps to decide whether parametric or non-parametric discriminant analysis is appropriate to analyses the data. On the other hand, the homogeneity assumption of covariance matrices helps to choose whether linear discriminant analysis or quadratic discriminant analysis is appropriate for the data.

### 4.1.2Testing Homogeneity of Covariance Matrices between Groups

This assumption states that the variance-covariance matrix of the predictor variables is the same in both dependent variables so they can be pooled together to estimate the error variance.The null hypothesis to be tested is that the covariance matrices of the two groups are the same in the population. Box's M test is used to test this hypothesis and the SPSS/STATA output is given in table below.

Table 2Box's test of the equality of covariance of matrices

| | |
|---|---|
| Box's M | 10.2 |
| F | .502 |
| df1 | 18 |
| df2 | 2735.823 |
| Sig. | .959 |

Source: Own survey data result, 2018

Test the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

The Box's M result shows that there is no significant difference between the covariance matrices of perception of households and adaptation strategies of households to climate change and variability (approximate F=0.502, p >0.959) and we do not reject the null hypothesis. Thus, the assumption of homogeneity of covariance matrices between the dependent variable is met.

Based on the above procedures, it can be concluded that the assumptions of homogeneity of covariance matrices were sufficiently satisfied. Hence, the appropriate model for analyzing the data on the households included in this study and for discriminating based on the sixteen attributes is the parametric linear discriminant analysis.

### 4.1.3. Test of Multicollinearity

Multicollinearity or singularity may occur with highly redundant predictors, making matrix inversion impossible. Analysis of data with the presence of collinearity among predictors may give unreliable results. Hence, we need to check the presence of multicollinearity before proceeding to the analysis. Some of the appropriate methods for assessing multicollinearity are variance inflationfactor (VIF) and Condition index. The SPSS and STATA outputs for multicollinearity information are given in table below.

Table 3Multicollinearity test table

| | Collinerity statistics | | | |
|---|---|---|---|---|
| Variables | Eigenvalue | Condition Index | Tolerance | VIF |
| Family member of household | 1.225 | 3.180 | 0.173 | 5.782 |
| Age of household head | 0.815 | 3.900 | 0.180 | 5.543 |
| Sex of household head | 0.554 | 4.727 | 0.651 | 1.537 |
| Education level of household head | 0.467 | 5.148 | 0.453 | 2.207 |
| Income from farm activities | 0.378 | 5.724 | 0.525 | 1.906 |
| Income from non farm activities | 0.263 | 6.861 | 0.439 | 2.278 |
| Number of livestock ownership | 0.184 | 8.216 | 0.305 | 3.276 |
| Farm land size for wheat production | 0.180 | 8.291 | 0.582 | 1.718 |

| | | | | |
|---|---|---|---|---|
| Irrigated land size owned by the HH | 0.141 | 9.385 | 0.737 | 1.356 |
| Access to credit for wheat production | 0.119 | 10.224 | 0.735 | 1.360 |
| Access to climate information | 0.086 | 11.991 | 0.537 | 1.861 |
| Use of fertilizer | 0.074 | 12.980 | 0.820 | 1.219 |
| Use of herbicide or pesticide | 0.066 | 13.672 | 0.780 | 1.281 |
| Formal agricultural service HH get | 0.030 | 20.160 | 0.641 | 1.560 |
| Distance from HH house to farm land | 0.017 | 26.636 | 0.831 | 1.203 |
| Distance from HH house to market | 0.011 | 33.996 | 0.576 | 1.737 |

Source: Own survey data result, 2018

Variance Inflation Factors (VIF) greater than 10 are generally seen as indicative of severe multicollinearity. The 1/VIF column is the tolerance and it ranges from 0 to 1, with 1 being the absence of multicollinearity. In this study case all of the VIFs are below 6 and all of the tolerances are close to one indicating that there is no problem of multicollinearity in the data. Similarly, from the eigenvalues and condition indexes no severe problems of multicollinearitywere noted except for the last three variables. As a rule of thumb a condition index below 15 is indicative of the absence of multicollinearity problem (Gujarati, 2004).

### 4.1.4Descriptive analysis of dummy variable

Under descriptive analysis result, section the responses of the households of Sinana district was analyzed by using descriptive statistical method. The results found in this part could help the researcher for the later econometric methods section. Additionally, it is also important for analyzing some of the necessary information which is not easily captured by the econometrics methods.

Thus, descriptive statistics results have shown that households in Sinana District have adapted to the effect of climate change and variability through a number of adaptation strategies. Particularly, sample households in the study area have several strategies for adapting to the impacts of climate change and variability. In addition to adaptation strategies related to wheat farming activities, households also engage in offfarm activities to complement their household income and food in case of adverse conditions in wheat farm. Majority of sample households reported that they have used more than one type of adaptation strategies. This decision implies that a single strategy is inadequate in adapting

to the impact of climate change and variability as combination of several strategies is likely to be more effective than a single strategy.

**Households' perception to climate change and variability in Sinana district**

The householdsinSinana district were asked whether they have perceived changes in the rainfall and temperature in their locality area. Then those who have perceived the change in rainfall and temperature were again asked to identify the direction of the change they had perceived. Respondents perceived the level of rainfall and temperature. Henceabout 63.4% the respondents had perceived the level of the rainfall and temperature and 36.6% of the respondents had not perceived the level of the rainfall and temperature respectively. From this the researcher concludes majority of the households in the study area perceived a decrease in the level of the rainfall but an increase in the level of temperature. They perceived the increment of temperature and decrement of rainfall in the study area.

Table 4Descriptive analysis result for dummy variable

| Variable | Response | Frequency | Percent |
|---|---|---|---|
| Perception of HH | No | 70 | 36.6 |
| | Yes | 121 | 63.4 |
| Adaptation of HH | No | 72 | 37.7 |
| | Yes | 119 | 62.3 |
| Sex of HH | Female | 31 | 16.2 |
| | Male | 160 | 83.8 |
| Education of HH | Illiterate | 91 | 47.6 |
| | Literate | 100 | 52.4 |
| On farm income | No | 54 | 28.3 |
| | Yes | 137 | 71.7 |
| Off farm income | No | 102 | 53.4 |
| | Yes | 89 | 46.6 |
| Access to credit | No | 133 | 69.6 |
| | Yes | 58 | 30.4 |
| Access to climate change information | No | 75 | 39.3 |
| | Yes | 116 | 60.7 |
| Use of fertilizer | No | 19 | 9.9 |
| | Yes | 172 | 90.1 |
| Use of pesticides and herbicides | No | 37 | 19.4 |
| | Yes | 154 | 80.6 |
| Planting early maturing wheat type | Yes | 156 | 81.6 |
| | No | 35 | 18.4 |
| Change planting date | Yes | 154 | 80.6 |
| | No | 37 | 19.4 |
| Change wheat variety | Yes | 147 | 76.9 |
| | No | 44 | 23.1 |
| Planting trees | Yes | 146 | 76.4 |
| | No | 45 | 23.6 |

Source: Own survey data result from 191 Sample size, 2018

**Households' adaptation strategies to climate change and variability in Sinana district**

The householdsin Sinana district were asked whether they have adaptation to climate change and variability in their area.As indicated in table 4119 respondent households were adapt to climate change and variability through different adaptation strategies, that in percent 62.3% and 72 of the household respondents were not adapt to climate change and variability in percent 37.7% in percent out of 191 sampled households taken for the study.

**Sex of household head**

As tables 4indicate, 160 respondent households are male that in percent 83.8% from which 86 where literates and 74 where illiteratesand 31 of the household respondents female in percent 16.2%in percentfrom which 24 where literates and 7 where illiteratesout of 191 sampled households taken for the study.

**Education level of household head**

As table4indicate,91 respondent households cannot read which in percent 47.6% and 100 of the household respondents can read and write in percent 52.4%in percent out of 191 sampled households taken for the study.

Table 5 Sex versus Education level

| | | Sex of household head | |
|---|---|---|---|
| | | FEMALE | MALE |
| Education of households | Illiterate | 7 | 74 |
| | Literate | 24 | 86 |
| | Total | 31 | 160 |

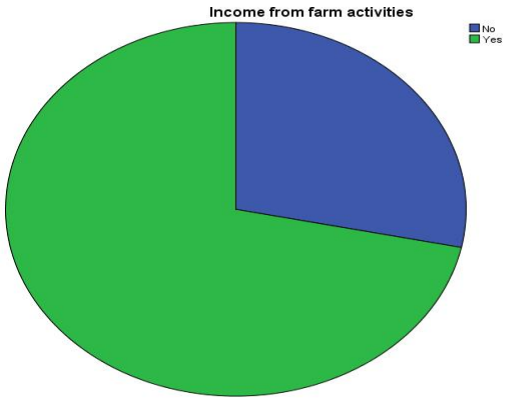
Source: Own survey data result from 191 Sample size, 2018

**Income from wheat farm activities**

As table 4aboveindicate, 137 households respond that they get their yearly income from wheat farm activities which in percent 71.7% and 54 households respond that they get their yearly income from other farm activities in percent 28.3% out of 191 sample taken respectively ,for the study in sinana district.

Thus, the figure belowshows that the majority of households in the study area get their yearly income from wheat farm activities in the district which in turn indicate Bale zone household farmer income depend on wheat production year to year.

Figure 2 Income from wheat farm activities




Source: Own survey data result from 191 Sample size, 2018

**Access to credit**

The sampled householdsin Sinana district were asked whether they have access to credit. As indicated by table 4 above, 30.4% of households reported that they have access to credit in their locality. The remaining 69.6% on the other hand reported that there is no credit access in their locality.

**Access to climate change information**

The sampled householdsin Sinana district were asked whether they have access to climate change information.As table 4 above indicate, 116 households respond that they have access to climate change information in their locality which in percent 60.7% and 75 amount of households respond that they have no access to climate change information that in percent 39.3% out of 191 sample taken respectively, for the study area. Then those who have access to climate change information in their locality were again asked to identify their access of information.

**Use of fertilizer**

Table4 aboveshows that 90.1% household's uses fertilizer for wheat production while the remaining households do not apply inorganic fertilizers to their wheat farm lands. This indicated that majority of households use fertilizer to restore soil fertility by applying inorganic fertilizers.

**Use of pesticide and herbicide**

As table 4 above shows, 154 households respond that they use pesticide and herbicide for their wheat production farm activities which in percent 80.6% and 37 households respond

where not use pesticide and herbicide for their wheat production farm activities which in percent 19.4% out of 191 samples taken respectively, for the study in sinana district.

In sum, the householdsin Sinana district were asked whether they have adaptation toclimate change and variability in their area. As indicated in table 3 119 percent 63.3%respondent households were adapt to climate change and variability through different adaptation strategies. Thus, planting early maturing wheat type 81.6%, Change planting date 80.6%, change wheat variety 76.9% and planting trees 76.4%.

### 4.1.5 Descriptive analysis of Continuous variable

Table 6 Descriptive analysis result for continuous variable

| Variable | Mean | Std. Dev. |
|---|---|---|
| Family size of household | 6.361 | 3.315 |
| Age | 39.168 | 12.924 |
| Livestock owner | 7.147 | 3.578 |
| Farm land size | 4.770 | 2.798 |
| Irrigated land owned | 0.002 | 0 .042 |
| Number of agricultural extension service contact | 3.168 | 1.102 |
| Distance from house of HH to farm land | 3.136 | 2.068 |
| Distance from house of HH to farm land | 14.414 | 4.860 |

Source: Own survey data result from 191 Sample size, 2018

**Family size of household**: From the above table 6 the average family size of household in the study area was 3.361.And standard deviation 3.315 thus show there is no as much variation of family size of sampled household in study area.

**Age of household head**: From the table 6 the average age of household head in the study area were 39.168 with standard deviation 12.924 thus shows there is variation in age of household in study area.

**Livestock owner**: The average livestock owner of households in this area was 7.147 with standard deviation 3.578 that shows there is a variation livestock holding in this area. Livestock was another asset for household in this study area income in addition to wheat farm income.

**Farm land size**: Average farm land size of households for wheat farm activities in sinana district were 4.770 hectares with standard deviation 2.798. The standard deviation result shows that there is variation of land holding of households to wheat farm in study area.

**Irrigatedland owned**: Form table 6 above average irrigated lands for wheat farm activities in study area were 0.002 with standard deviation 0.042 that show there is no variation use of irrigation. The result shows that in study area irrigation use for wheat production too small.

**Number of agricultural extension service contact**: Another continuous variable in this studywas agricultural extension service. From the above table 6 average number of agricultural extension service contact were 3.168 times per year with 1.102 standard deviations indicating there was variation number of contact from household head to household head.

**Distance from house to farm land**: Also continuous variable in this study was distance from house hold to farm land of household head. The average distance from house to farm land were 3.136km with 2.068 standard deviation.

**Distance from house of HH to farm land**: is continuous variable in this study was distance from house to market of household head. The average distance from house to market were 14.414 Km to get agricultural input such as wheat seed, fertilizer, herbicide, pesticides, etc.and its standard deviation where 4.868.

### 4.1.6.Results of stepwise variable selection

Up to now, all of the sixteen predictors under study were assumed as discriminating variables for discrimination and classification purposes. Probably the most common application of discriminant analysis is to select a subset of the original predictor variables that provide maximum discrimination between the two household groups based on their status of adaptation strategies to climate change and variability.

This study used Wilks' lambda stepwise procedure discussed in methodology part to select the best subset of variables for classification of households with minimum tolerance of F-to-enter = 0.05 and F-toremove=0.10. In each step, the stepwise discriminant analysis output produces the Wilks' lambda and the associated F-to-enter and F-to-remove for variables not in the analysis and variables in the analysis. At each step, the variable that

minimizes the overall Wilks' lambda or the variable with the largest F-to-enter is included in the analysis. The selected variables are given in Table7 below.

Table 7 Variables selected by stepwise variable selection procedure

| Step | Entered | Wilks' Lambda | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Statistic | df1 | df2 | df3 | Exact F | | | |
| | | | | | | Statistic | df1 | df2 | Sig. |
| 1 | Access to climate information | 0.818 | 1 | 1 | 189 | 41.988 | 1 | 189 | 0.000 |
| 2 | Income from farm activities | 0.737 | 2 | 1 | 189 | 33.487 | 2 | 188 | 0.000 |
| 3 | Farm land size for wheat production | 0.701 | 3 | 1 | 189 | 26.630 | 3 | 187 | 0.000 |
| 4 | Income from non-farm activities | 0.679 | 4 | 1 | 189 | 21.998 | 4 | 186 | 0.000 |
| 5 | Number of livestock ownership | 0.643 | 5 | 1 | 189 | 20.556 | 5 | 185 | 0.000 |
| 6 | Irrigated land size owned by HH | 0.626 | 6 | 1 | 189 | 18.326 | 6 | 184 | 0.000 |
| 7 | Education of household head | 0.610 | 7 | 1 | 189 | 16.724 | 7 | 183 | 0.000 |

Source: Own survey data result from 191 Sample size, 2018

Based on the stepwise discriminant analysis results presented in Table 7seven of the sixteen variables are selected for analysis to be included in the model of adaptation strategies of households of wheat production to climate change and the remaining are excluded from analysis and, hence, omitted from the model. The variables, which passed the stepwise variable selection procedure as candidate to be included in the model,areAccess to climate information, Income from farm activities, Farmland size for wheat production, Income from non-farm activities, Number of livestock ownership, Irrigated land size owned by the household, Education level of household head

### 4.1.7. Results of Discriminant Analysis and Discussion

Following the fulfillment of the assumptions, LDA was found the most appropriate model to classify the Sinana households of Bale zone Oromia region state into adapt to climate change and variability and notadapt to climate change and variability based on the discriminating variables. Hence, researcheruse SPSS and STATA to compute the linear discriminant function coefficients, which help for discriminating and classifying the households into two that are,adapt and notadapt to climate change and variability. First, it is better to begin with the test of significance of group means.

### 4.1.8.Test of Equality of group means

Over all equality of group means is, first, tested by applying MANOVA and its results are presented in Table 8. As discussed in the methodology part, the values of Hoteling's and the Wilk's lambda statistics can be approximated by F-value. The results depicted in Table 8 show that the group means are significantly different (F= 42.20, p<0.0001). This implies that the two household groups have significantly different means.

Table 8 MANOVA for Testing Equality of Group means

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| | Pillai's Trace | 0.829 | 456.558[b] | 2.000 | 189.000 | 0.000 |
| | Wilks' Lambda | 0.171 | 456.558[b] | 2.000 | 189.000 | 0.000 |
| | Hotelling's Trace | 4.831 | 456.558[b] | 2.000 | 189.000 | 0.000 |
| | Roy's Largest Root | 4.831 | 456.558[b] | 2.000 | 189.000 | 0.000 |

Source: Own survey data result from 191 Sample size, 2018

### 4.1.9Significance of the Discriminant Function

To test the significance of the discriminant function, one can test the number of eigenvalues that add significantly to the discrimination between groups. Since the dependent variable in this case has only two categories, there is only one discriminant function, which in turn has one eigenvalue. Testing the significance of the eigenvalue to the discrimination of the groups is the same as testing significance of the discriminant function.

We noted that when there are two groups, one discriminant function can be extracted from the data and its associated eigenvalue is given as $\lambda$ =WSS /BSS, where BSS = between groups sum of squares and WSS= within group sum of squares. BSS=0 implies $\lambda$ =0 and that model has no discriminatory power. The larger the value of $\lambda$, the greater the discriminatory power of the model.

Table 9 Eigenvalues

| Eigenvalue | % of Variance | Cumulative % | Canonical Correlation |
|---|---|---|---|
| 0.640 | 100.0 | 100.0 | 0.625 |

Source: Own survey data result from 191 Sample size, 2018

Based on the results given in Table 9, the eigenvalue of the discriminant function in our model is 0.640. It can also be observed that 100% of the variance is explained by the discriminant function. As a result, the cumulative percentage of the variance explained by the discriminant function is 100%. The canonical correlation $\eta = \sqrt{\frac{\lambda}{1+\lambda}}$ between the predictor variables and the discriminant scores produced by the discriminant function is 0.625.

Table 10Wilks' Lambda

| Test of Function(s) | Wilks' Lambda | Chi-square | Df | Sig. |
|---|---|---|---|---|
| | 0.610 | 91.734 | 7 | 0.000 |

Source: Own survey data result from 191 Sample size, 2018

To test the hypothesis Ho: $\lambda = 0$, $\eta$=0,we use the Wilks' lambda statistic given Table 10.

Based on the output result, the chi-square test of the Wilks' lambda is significant($\chi^2$ =91.734, p<0.0001). Hence, the null hypothesis is rejected and we conclude that the eigenvalue of the discriminant function used in this study is significantly different from zero. At the same time the canonical correlation was found statistically significant and hence there is good correlation between the explanatory variables and the discriminant scores. Significance of the eigenvalue and the canonical correlation imply that the discriminant function is statistically significant. Hence, the discriminant function best discriminates the two household groups based on the predictor variables included in this study.Since the discriminant function was found significant, its associated statistics are used in the interpretation of the effect of predictor variables on adaptation strategies of households to climate change and variability status.

## 4.2. Econometric Analysis Result

### 4.2.1. Factors affecting households' choice of adaptation strategies to climate change: multivariate probit result

The multivariate probit model was estimated jointly for four binary dependent variables, namely planting early maturing wheat type, changing planting date, change wheat variety and planting trees inorder to identify factors affecting the choice of adaptation strategies. The results of multivariate probit are presented in Table 11. These indicated that it was unlikely for households to adopt all adaptation strategies simultaneously. The Wald chi-square statistic (=86.76) that was used to test for the overall significance of the model is significant at 1% probability level. This result implies that of coefficients are jointly significant and the explanatory power of the factors included in the model were satisfactory. The likelihood ratio test of the null hypothesis of independence between the adaptation strategies test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0 is significant at 1%. Therefore, the null hypothesis that all the ρ (rho) values are jointly equal to 0 is rejected, indicating the goodness-of-fit of the model. The explanation of the effect of the significant explanatory variables is discussed below.

Table 11 Multivariate probit regression results

| Variable | Planting early maturing wheat type | | Change planting date | | Change wheat variety | | Planting trees | | Marginal effect |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff | Std.err | Coeff | Std.err | Coeff | Std.err | Coeff | Std.err | |
| EDUC | -0.457 | 0.279 | -0.454*** | 0.268 | -0.555** | 0.266 | 0.231 | 0.253 | 0.524 |
| ONFARM | -0.609** | 0.256 | -0.486** | 0.246 | -0.070 | 0.237 | -0.325 | 0.244 | 0.717 |
| OFFARM | 1.126* | 0.289 | 0.955* | 0.275 | 1.122* | 0.277 | 0.605** | 0.261 | 0.466 |
| TLU | 0.061*** | 0.037 | 0.081** | 0.036 | 0.046 | 0.034 | 0.105* | 0.037 | 7.147 |
| FLSZ | -0.073*** | 0.042 | -0.102** | 0.040 | -0.049 | 0.039 | -0.084** | 0.037 | 4.770 |
| IRRIGATI | -0.495** | 0.246 | -0.498** | 0.244 | -0.426 | 0.234 | -0.19 | 0.236 | 0.230 |
| CLMINFO | -0.502** | 0.228 | -0.494** | 0.224 | -0.578* | 0.222 | -0.347 | 0.219 | 0.607 |
| Cons | 0.715 | 0.455 | 0.642 | 0.437 | 0.360 | 0.430 | 0.010 | 0.432 | 0.524 |
| rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2 (6) = 75.6721* | | | | | | | | | |
| Multivariate probit (MSL, # draws = 5) | | | | | | | | | |
| Number of obs = 191 | | | | | | | | | |
| Wald $chi^2$ (28) = 86.76 | | | | | | | | | |
| Prob> chi2 = 0.000 | | | | | | | | | |
| Log likelihood = -392.518 | | | | | | | | | |

Note:*, **, *** are significance levels at 1%, 5% & 10% respectively.
Source: Source: Own survey data result from 191 Sample size, 2018

### 4.2.2. Interpretation of significant variables of adaptation strategies from the result of multivariate probit

**Access to climate information** is one of a significant explanatory variable at 5% and 1% level of significance. This variable affectsthe choice of planting early maturing wheat type at 5%, change planting date at 5% and change wheat variety at 1% significance level. Thus, access to climate information from different sources has significant impact on the adaptation to climate change and variability of households to wheat production.Indeed, it is an important precondition for households to take up adaptation measures (Madison 2006).

**Education of household head:** another finding of this study indicates that education of household head is significantly associated with adaptation strategies at 5% and 10% level of significance. This variable affectsthe choice of change planting date at 10% and positively the choice of change wheat variety at 5% significance level. Thus, education of household head has significant impact on the adaptation choice of households to climate change and variability of households to wheat production.

**On farm income:** Wheatfarm income of the household is one of significant explanatory variable. Households' choice of adaptation strategy to climate change and variability is also significantly affected by the amount of income that the households get from wheat farm in the study area. On farm income affects negatively choice of adapting planting early maturing wheat type and adapting change planting date at 5% level of significance respectively.

The result of this analysis reveals that farm income of ahousehold had a negative association and significant influence on planting early mature wheat and changing planting dates adaptation methods in response to climate changeandvariability. This finding is consistent with studies of Tagel (2013).

**Off farm income:**Off farm incomewas another significant explanatory variable of the study. That means households' adaptation strategy to climate change and variability is significantly affected by additional income that the households get from other works such as government job, merchant, and other additional income different from farm work of households.Off farm income affects positively choice of adapting planting early maturing

wheat type, changing planting date and change wheat variety at 1% level of significance respectively and planting tree at 5% level of significance.

**Farmland size:**is a statistically significant explanatory variable in the model. That means households' adaptation strategy to climate change and variability is significantly affected by the amount of farmlandsize for wheat production that the households owned. Thushaving farm land for wheat production has significant impact on choice of adaptation strategies to climate change and variability of households to wheat production. Farm land size affect negatively choice of adapting planting early maturing wheat type at 10% level of significance, change planting date and planting tree at 5% level of significance respectively. It may also associate with grater wealth and it is hypothesized to increase adaptation to climate change and variability.

Thus, the result of this study show those households with relatively big farmland size were more likely to take up more adaptation strategies when compared to households with small farmland size. This result is also in line with the outcome of Gutu*et al*. (2012).

**Livestock holding:**the number oflivestockowned by the households is also anothersignificant explanatory variable in this study. It affect positively choice of adapting planting early maturing wheat type, change planting date and planting tree at 10%,5% and 1% level of significance respectively.In other case, livestock is considered as an asset for the households and plays a very important role by serving as a source of income in order to purchase input forwheat farm activities. Therefore, having a large number of livestock can strengthen households' adaptive capacity to climate change and variability in the study area. On the other hand, livestock rearing is one part of agricultural activities which is also subject to climate change impact. Consequently, as the number of the livestock increased the households will look for adaptation measures that safeguard their assets against climate related problems. This result is also similar with Legesse*et al*. (2012).

**Irrigation**isanother finding of this study indicates that irrigation is significantly affect choice of adaptation strategies. Irrigation affect negatively choice of adapting planting early maturing, change planting at 5% level of significance respectively and change wheat variety at 10% significance level.

# 5. SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.1. Conclusion

This chapter provides summary and conclusion based on research findings on perception and adaptation strategies of households to produce wheat production to climate change and variability in Sinana distract Bale zone Oromia regional state, Ethiopia. The study used cross-sectional data collected from 191 households in 2018, and applied descriptive and econometric approaches to analyze the data.

The major objective of this study was to assess perception and adaptation strategies of wheat producing households to climate change and variability in the case of Sinana District, Bale, Oromia, Ethiopia. As a result, this study found thatadaptation strategies of wheat producing households to climate change and variability in the study area was determined by seven key factors.

In the study area 63.7% of the households were found adapt climate change and variability though different adaptation strategies to produce wheat and 37.7% of households were found that not adapt climate change and variability through different adaptation strategies to produce wheat, respectively. The figures indicate that the proportions of households adapt climate change and variability to producewheat is higher than the households not adapt climate change and variability to produce wheat farm activity in the sinana district, Bale zone, Oromia regional state, Ethiopia.

The adaptation strategy related factors studied through the discriminant analysis revealed that factorssuch as access to climate information, income from farm activities, farm land size for wheat production, income from non-farm activities, number of livestock ownership, irrigated land size owned by the household, education of household head were foundthe major contributors to the discrimination predictor of adaptation strategies of households to adapt climate change and variabilityof households to produce wheat production in the study area. Moreover, the predictors were ranked based on theirimportance to the discrimination of the two household groups. Accordingly,access to climate information was ranked first followed by income from farm activities, farm land size for wheat production, income from non-farm activities, number of livestock ownership, irrigated land size owned by the household, education of household head.

Multivariate probit regression analysis was employed to determine the factors influencing households' choice of adaptation strategies to climate change and variability. The result from the multivariateprobit analysis shows that education level of household head, access to climate information, on farm income, off farm income, farmland size, number of livestock owned by household and irrigation have a significant influence on households choice of climate change adaptation strategies.

Access to climate information from different sources has impact on the adaptation to climate change and variability of households to wheat production. The author concludes households that have access of climate information use different adaptation strategies to climate change and variability to produce wheat production in the study area. Similarly,onfarm income also has impact on the adaptation to climate change and variability of households to wheat production. The author concludes households that have onfarm income use different adaptation strategies to climate change and variability to produce wheat production in the study area.In addition, having farmland for this production was another explanatory variable that affect adaptation strategies on the adaptation to climate change and variability of households to produce wheat in the study area. The author conclude that having farm land make households to taken different adaptation strategies such as, planting early maturing wheat type, change planting dates and planting trees in the study area.

In addition, access to climate information, onfarm, farm land size, off farm income, livestock ownership, irrigated land size were factors affecting householdsadaptation strategies to climate change and variability to choose planting early maturing wheat type and change planting date. Education of household head, off farm income and irrigated land size owned were factors affecting households' adaptation strategies to climate change and variability to choose change wheat variety. On the other hand, farm land size, off farm income and livestock ownership were factors affecting households adaptation strategies to climate change and variability to choose planting trees.

In general, access to climate information, on farm, farm land size, off farm income, livestock ownership, irrigated land size owned, education of household head were the main factor that influences households' choice of adaptation method to climate change.

## 5.2. Recommendation

Based on the findings of this study, the following recommendations were forwarded for reducing the impacts of climate change and variability on wheat production.

- Based on the study, households with educated heads are better toadapt climate change and variability to produce wheat status than household heads with non-educated in the study area. Therefore, it is recommended that the regional and federal governments should provide access to education for farmers' household head.
- Similarly, onfarm income also has impact on the adaptation to climate change and variability of households to wheat production. The author concludes households that have onfarm income have to use different adaptation strategies to climate change and variability to produce wheat production in the study area.
- Strengthening efforts on enhancing the households' perception and adaptive capacity to climate change and variability is an important measurement to be taken by households as well as by governments also on the study area. The government should give emphasis to address this issue of climatic change through giving greater attention. Therefore, strengthen effort of the households' adaptive capacity to climate change through planting early maturing wheat type, changing planting date, providing change wheat variety and planting trees households has an important adaptation strategies.
- Finally, the author recommend for further studies to be conducted on the area of perception and adaptation strategies to climate change and variability byconsidering detail and accurate information on various variablesincluding meteorological variables, natural disasters, wind andother factors that affect wheat production.

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# 7. APPENDIX

## 7.1. Household Level Survey Questionnaire

My name is ZerihunNegashBedane. I am writing a thesis titled as "Perception and adaptation strategies of households to climate change and variabilitythe case of wheatproducing householdsin Sinana District, Bale Zone, Oromia National Regional State, Ethiopia" in partial fulfillment for MSc in Developmental Economics. The objective of this study is to identify and assess factors household's perception and adaptation strategies to climate change on wheat production. Confidently this research has a significant contribution to reduce the climate change relate problems of the households of sinana district. Therefore, your valid contribution by giving accurate information is highly valuable in achieving the objective of this research. The information I collect from you will serve only for the academic purpose and it will be kept safely. Thus, please feel free to convey the required information honestly.

**General Direction**

Put (X) marks in space provided for closed-ended questions and write your response on space provided for open-ended questions.

I. Household code ----------

II. Name of Kebele ----------

**Part I: Questions on Household Head Demographic Characteristics**

1. Please specify the number of your family size including the household head of the family_____
2. Please ask the household head the following and fill in the following table.

| Age | Sex | Education level of household head 1. Literate2. Illiterate | Experience on Wheat production (year) | Have you On farm income (yes / No) | Have you Off farm income (yes / No) | Membership in social group (Yes / no). If "yes" |
|---|---|---|---|---|---|---|
| | | | | | | 1. Ikub |
| | | | | | | 2. Idir |
| | | | | | | 3. Cooperate |
| | | | | | | 4. NGO |

3. Please ask household head regarding the livestock holding andfill in the following table.

| S. no | Livestock holding | Number | Ownership | | | |
|---|---|---|---|---|---|---|
| | | | Private | Rented | Contracted | Other |
| 1 | Oxen | | | | | |
| 2 | Horse | | | | | |
| 3 | Camel | | | | | |
| 4 | Calves | | | | | |
| 5 | Goat | | | | | |
| 6 | Sheep | | | | | |
| 7 | Pigs | | | | | |
| 8 | Donkey | | | | | |
| 9 | Mule | | | | | |
| 10 | Bull | | | | | |
| 11 | Heifer | | | | | |
| 12 | Chicken | | | | | |

4. Please fill your land size and land ownership in the following table.

| Type of plot allocate | Quantity(in hector ) | Type | |
|---|---|---|---|
| | | Non-irrigation | Irrigation |
| Total land owned | | | |
| For wheat production | | | |

5. How many of your family members were participated on wheat production in the last year? _____
6. Do you have access to credit during shortage of money? Yes ☐ No ☐
7. If "Yes for Q.6," what types of credit access did you get? Formal ☐ Informal ☐
8. Do you have access to climate information? Yes ☐ No ☐
9. If "Yes for Q.8," what is your source of information? 1. Mobile 2. Television 3. Radio 4. Other----------
10. Please ask the households the following input for the maintenance of wheat production?

| Do you use Fertilizer? Yes or No | If yes, 1.UREA2.DAP 3. Other | Do you use Herbicidesand Pesticide? Yes or No |
|---|---|---|
| | | |

**Part II. Information on institutions**

11. Please ask household head information regarding the following and fill their response in the following table based last wheat production.

| The number of Agricultural extension contact | Distance from house to plot | | Distance from house to market | |
|---|---|---|---|---|
| | In Km | In time | In Km | In time |
| | | | | |

**Part III.Questions on Perception of households Climate Change and Adaptation Methods Employed by households.**

12. Have you faced wheat production failure during the last year? Yes ☐ No ☐
13. Comparing the past years with the recent, have you perceive any changes in climate? Yes ☐ No ☐
14. Comparing the past years with the recent, have you noticed any changes in the rainfall patterns. Yes ☐ No ☐
15. If "Yes for Q.14," please specify the pattern of the change in rainfall you have noticed. ☐ Increasing Decreasing
16. Comparing the past years with the recent, have you noticed any changes in temperature. Yes ☐ No ☐
17. If "Yes for Q.16," please specify the pattern of the change in temperature you have ☐ noticed. Increasing Decreased
18. In response to climate change, have you taken any adaptation measures in order to reduce the impacts of climate change? Yes ☐ No ☐
19. If "Yes for Q.18," have you employed any of the following climate change impact adaptation strategies in your wheat production last year?

| S.no | Climate change adaptation strategies | Response | | If "No," please specify the reason why not? |
|---|---|---|---|---|
| | | Yes | No | |
| 1 | Planting early maturing wheat types | | | |

| | | | | |
|---|---|---|---|---|
| 2 | Changing planting dates | | | |
| 3 | Change wheat variety | | | |
| 4 | Planting trees | | | |

THANK YOU!!!

### 7.2. Conversion Factors

**Table A 1 Conversion factor used to estimate Tropical livestock Unit (TLU)**

| Animal | TLU |
|---|---|
| Cattle | 1 |
| Sheep/Goat | 0.15 |
| Horse | 1 |
| Mule | 1.15 |
| Donkey | 0.65 |
| Camel | 1.45 |
| Poultry | 0.005 |

Source: G. Ramakrishna and AssefaDemeke, 2002.

**Table A 2 Conversion factor used to calculate adult equivalence scales**

| Age groups(years) | Male | Female |
|---|---|---|
| 0-2 | 0.40 | 0.40 |
| 3-4 | 0.48 | 0.48 |
| 5-6 | 0.56 | 0.56 |
| 7-8 | 0.64 | 0.64 |
| 9-10 | 0.76 | 0.76 |
| 11-12 | 0.80 | 0.88 |
| 13-14 | 1.00 | 1.00 |
| 15-18 | 1.20 | 1.00 |
| 19-59 | 1.00 | 0.88 |
| 60+ | 0.88 | 0.72 |

Source: World Bank (1986)

Table 12 Multivariate probit regression results of adaptation strategies methods of households to climate change and variability, 2018

| | Variable | Std. | Err. | Z | P>\|z\| | [95% | Conf. | Interval] | Marginal effect |
|---|---|---|---|---|---|---|---|---|---|
| Planting | | | | | | | | | |
| | EDUC | -0.457 | 0.279 | -1.640 | 0.101 | -1.004 | 0.089 | | 0.524 |
| | ONFARM | -0.609 | 0.256 | -2.380 | 0.017 | -1.112 | -0.107 | | 0.717 |
| | OFFARM | 1.126 | 0.289 | 3.900 | 0.000 | 0.560 | 1.691 | | 0.466 |
| | TLU | 0.061 | 0.037 | 1.660 | 0.096 | -0.011 | 0.134 | | 7.147 |
| | FLSZ | -0.073 | 0.042 | -1.770 | 0.077 | -0.155 | 0.008 | | 4.770 |
| | IRRIGATI | -0.495 | 0.246 | -2.010 | 0.044 | -0.978 | -0.013 | | 0.230 |
| | CLMINFO | -0.502 | 0.228 | -2.210 | 0.027 | -0.948 | -0.056 | | 0.607 |
| | Cons | 0.715 | 0.455 | 1.570 | 0.116 | -0.176 | 1.606 | | 0.524 |
| chpldate | | | | | | | | | |
| | EDUC | -0.454 | 0.268 | -1.690 | 0.090 | -0.980 | 0.071 | | 0.524 |
| | ONFARM | -0.486 | 0.246 | -1.970 | 0.049 | -0.969 | -0.002 | | 0.717 |
| | OFFARM | 0.955 | 0.275 | 3.470 | 0.001 | 0.416 | 1.493 | | 0.466 |
| | TLU | 0.081 | 0.036 | 2.230 | 0.026 | 0.010 | 0.152 | | 7.147 |
| | FLSZ | -0.102 | 0.040 | -2.560 | 0.011 | -0.180 | -0.024 | | 4.770 |
| | IRRIGATI | -0.498 | 0.244 | -2.040 | 0.041 | -0.977 | -0.020 | | 0.230 |
| | CLMINFO | -0.494 | 0.224 | -2.200 | 0.028 | -0.933 | -0.054 | | 0.607 |
| | Cons | 0.642 | 0.437 | 1.470 | 0.142 | -0.215 | 1.499 | | 0.524 |
| Chwhvari | | | | | | | | | |
| | EDUC | -0.555 | 0.266 | -2.090 | 0.037 | -1.076 | -0.033 | | 0.524 |
| | ONFARM | -0.070 | 0.237 | -0.300 | 0.767 | -0.534 | 0.394 | | 0.717 |
| | OFFARM | 1.122 | 0.277 | 4.040 | 0.000 | 0.578 | 1.665 | | 0.466 |
| | TLU | 0.046 | 0.034 | 1.340 | 0.180 | -0.021 | 0.114 | | 7.147 |
| | FLSZ | -0.049 | 0.039 | -1.270 | 0.205 | -0.125 | 0.027 | | 4.770 |
| | IRRIGATI | -0.426 | 0.234 | -1.830 | 0.068 | -0.884 | 0.031 | | 0.230 |
| | CLMINFO | -0.578 | 0.222 | -2.610 | 0.009 | -1.012 | -0.144 | | 0.607 |
| | Cons | 0.360 | 0.430 | 0.840 | 0.402 | -0.482 | 1.202 | | 0.524 |
| pltrees | | | | | | | | | |
| | EDUC | 0.231 | 0.253 | 0.910 | 0.361 | -0.264 | 0.726 | | 0.524 |
| | ONFARM | -0.325 | 0.244 | -1.330 | 0.183 | -0.802 | 0.153 | | 0.717 |
| | OFFARM | 0.605 | 0.261 | 2.320 | 0.021 | 0.093 | 1.116 | | 0.466 |
| | TLU | 0.105 | 0.037 | 2.880 | 0.004 | 0.034 | 0.177 | | 7.147 |
| | FLSZ | -0.084 | 0.037 | -2.250 | 0.024 | -0.157 | -0.011 | | 4.770 |
| | IRRIGATI | -0.190 | 0.236 | -0.800 | 0.421 | -0.653 | 0.273 | | 0.230 |
| | CLMINFO | -0.347 | 0.219 | -1.580 | 0.113 | -0.776 | 0.082 | | 0.607 |
| | Cons | 0.010 | 0.432 | 0.020 | 0.982 | -0.837 | 0.856 | | 0.524 |

Source: Own data result from 191 sample size, 2018