# SMALLHOLDER FARMERS'ADAPTATION PRACTICES TO CLIMATE CHANGE: A CASE STUDY OF CHIRO WOREDA OF WEST HARARGHE ZONE, OROMIA REGIONAL STATE, ETHIOPIA

**M.A THESIS**

**KETEMA HABTAMU KENENI**

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# Small Holder Farmers' Adaptation Practices to Climate Change: A Case Study of Chiro Woreda of West Hararghe Zone, Oromia Regional State, Ethiopia

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**KETEMA HABTAMU KENENI**

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## HARAMAYA UNIVERSITY

## POSTGRADUATE PROGRMA DIRECTORATE (PGPD)

I hereby certify that I have read and evaluated this thesis prepared under my guidance, by Ketema Habtamu, entitled: "Small Holder Farmers' Adaptation Practices to Climate Change: A Case Study of Chiro Woreda of West Hararghe Zone, Oromia Regional State, Ethiopia**".** I recommended that it is submitted as fulfilling the thesis requirement.

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| Solomon Asfawu (PhD) | ---------- | ---------- |
| Name of Major Advisor | Signature | Date |
| Admasu Bogale (PhD) | ---------- | ---------- |
| Name of Co-Advisor | Signature | Date |

As a member of the Board of Examiners of the Thesis Open Defense Examination, I certify that I have read and evaluated the Thesis prepared by Ketema Hbatamu and examined the candidate. I recommended that the Thesis be accepted as fulfilling the Thesis requirements for the Degree of Master of Art in Geography and Environmental Studies.

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| Name of Chairperson | Signature | Date |
| ---------- | ---------- | ---------- |
| Name of Internal Examiner | Signature | Date |
| ---------- | ---------- | ---------- |
| Name of External Examiner | Signature | Date |

Final approval and acceptance of the Thesis is contingent upon the submission of its final copy to the Council of Postgraduate Program (CPP) through the candidate's Department or School Graduate Committee (DGC or SGC)

## BIOGRAPHICAL SKETCH

Ketema Habtamu Keneni was born in 1979 G.C in Bito Milki *Kebele*, Wara jarso Woreda, North Shewa Zone, and Oromia Regional State, Ethiopia. He attended primary school in Tullu Milkii, Junior and secondary school in Garba Gurrachaa town. After completion of his high school education, he joined Gander College of medical Science and graduated in Medical Laboratory Technology in Diploma in 2002. Then, he joined Haramaya University for 1$^{st}$ degree and graduated with Bachelor of Art (BA) in Economics at Haramaya University in 2008. He worked at Deder Hospital, Harar Federal police Hospital and Ethiopian Red Cross Society of East and West Hararghe Zone for the last 15 years. He joined School of Graduate Studies of Haramaya University to pursue his Master of Art degree in Climate Change and Disaster Risk Management.

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The research was carried out in four kebeles of chiro Woreda, Oromia Regional State. I would like to acknowledge Agricultural office of Chiro Woreda, and sample household heads for their support by providing necessary information and relevant data collected from the study sites.

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# ACRONOMY AND ABBREVIATION

BIC Bayesian Information Criterion

CCV Climate Change/variability

CRGE Climate Resilient Green Economy

CSA Central Statics Agency

CV Coefficient of Variation

ETB Ethiopian Birr

FAO Food and Agricultural Organization

FDGs Focus Group Discussions

GDP Gross Domestic Product

GHG Green House Gas

GTP Growth and Transformation Plan

IIA Independence of Irrelevant Alternative

IPCC Intergovernmental Panel for Climate Change

MOA Ministry of Agriculture

MoFED Ministry of Finance and Economic Development

MNL Multi Nominal Logit

MNPM Multinomial Probit Model

NAPA National Adaptation Program of Action

NGO Non-Governmental Organization

NMSA National Metrological Service Agency

PANE Poverty Action Network of civil society organizations in Ethiopia

SPSS Statistical Package for Social Science

UNDP United Nations Development Program

UNFCCC United Nations Framework Convention on Climate Change

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## Abstract

The main objective of this study was to investigate smallholder farmers' adaptation strategies towards climate change on agriculture in three kebeles of chiro woreda, West Hararghe Zone, Oromia Regional State. The agricultural sector remains the main source of livelihoods for rural communities in Ethiopia, but faces the challenge of changing climate. This study investigated how smallholder farmers perceive climate change, what adaptation strategies they practice, and factors that influence their adaptation decisions. Both primary and secondary data were used for the study, and a multinomial logit model was employed to identify the factors that shape smallholder farmers' adaptation strategies.

The results show that 90% of farmers have already perceived climate variability, and 81% made attempts to adapt using practices like crop diversification, planting date adjustment, soil and water conservation and management, increasing the intensity of input use, integrating crop with livestock, and tree planting. The econometric model indicated that education, family size, gender, age, livestock ownership, farming experience, frequency of contact with extension agents, farm size, access to market, access to climate information and income were the key factors deter-mining farmers' choice of adaptation practice.

Conclusion-Climate change is a pressing problem, which is beyond the capacity of smallholders to respond to autonomously. Farmers' capacity to choose effective adaptation options is influenced by household demography, as well as positively by farm size, income, access to markets, access to climate information and extension, and livestock production. This implies the need to support the indigenous adaptation strategies of the smallholder farmers with a wide range of institutional, policy, and technology support; some of it targeted on smaller, poorer or female-headed households. Moreover, creating opportunities for non-farm income sources is important as this helps farmers to engage in those activities that are less sensitive to climate change. Furthermore, providing climate change information, extension services, and creating access to markets are crucial.



Keywords: Climate change, Climate variability, vulnerability, Adaptation, Diversification, Livelihoods, Smallholder farmer Resilience

# 1. INTRODUCTION

## 1.1. Background of the study

It is now well recognized and established in science that the global climate is already changing towards higher temperatures. Much of the analysis by climatologists and in public debate focus on the average global temperature change, which increased by 0.74º C per century in the period 1906-2005 (Collins et al., 2013). More recently, the World Meteorological Organization (WMO, 2015) announced the likelihood that the planet has already warmed by 1º C since the pre-industrial era. The bulk of warming occurred in recent decades in an accelerating trend but one of the ten hottest years since records began have occurred between 2000-2010 years while the period 2011–2015 was the warmest five-year period on record globally (WMO,2011).

The Intergovernmental Panel on Climate Change, reported that warming of the climate system is unequivocal that since the1950s many observed changes are unprecedented over decades to millennia. Due to climate change, the atmosphere and the ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases' effects have increased. According to the same report, human-made causes are taken as the largest contribution to increase the atmospheric concentration of $CO_2$. It was projected that there will be temperature change by 2100 of between 1.5°C ($2.7^0$F) and 4.8°C ($8.6^0$F). (IPCC, 2013)

Recent evidence and predictions indicate that global climate changes are accelerating and will lead to wide-ranging shifts in climate variables. There will be changes in the mean and variance of rainfall and temperature, extreme weather events, food and agriculture production and prices, water availability and access, nutrition and health status (Tyler, 2010). The most adverse impacts are predicted in the developing world because of geographic exposure, reliance on climate sensitive sectors, low incomes, and weak adaptive capacity (Zhang and Liu, 2012).

African countries are among the most affected parts of the world by climate change because of their reliance on rain fed agriculture, lower financial, technical, institutional capacity to adapt, land degradation and desertification (Signgh and Purohit, 2014; Rose and Hummel, 2015). East African

countries such as Burundi, Eritrea, Ethiopia, Kenya, Uganda, Tanzania, Rwanda, and Somalia and Sub-Saharan Africa (SSA) are among the regions of African where effects of climate change are being felt (Feyssa and Gemeda, 2015). Particularly, in the SSA, climate change affected food and water resources that are critical for livelihoods where much of the poor population rely on local supply systems that are sensitive to climate variation (Kadi et al,.2011).

The government of Ethiopia designed an impressive portfolio of public policy to address climate variability and change so as to capitalize on the opportunities provided by climate change policies, like access to climate finance, technology and capacity building measures to realize its ambition of reaching middle income country status before 2025 (Fikreyesus et al.,2014).

Climate change mitigation and adaptation have become instrumental response strategies to climate changes. However, it's locally specified and its effectiveness depends on local institutions and socioeconomic setting which mediate and translate the impact of external interventions to facilitate adaptation to climate change (Groisman et, al, 2015. Gebreyes M., 2018). Smallholder farmer's perception on determinants and indicators of climate change may vary as some taking a more scientific approach.

By understanding all of these facts, effort should focus on finding mechanisms in which smallholder farmers can reduce these problems and improve effort to strength community's' adaptation to climate change. Generally, it is believed that the copying strategy of the community (smallholder) on Agro pastoralist to climate change is imperative to enhance the resilience of agricultural sectors.

Therefore, this study has been intended to identify smallholder farmers' adaptation practices to climate change and variability's by taking Chiro Woreda as a case study.

## 1.2. Statement of the Problem

The direct impacts of climate change and variability include extreme precipitation, heat stress, pluvial and fluvial flooding, landslides, drought, increased aridity, and water scarcity with widespread indirect impacts on people, economies and ecosystems (IPCC, 2014a). These impacts are severe in developing countries like Ethiopia, where rain-fed agriculture of production is predominant and population growth rate is over 2.8% to double itself within 25 years. The erratic and declining pattern in mean annual rainfall and steady rise in mean air temperature in the region adversely affected crop production (Solomon, 2013).

Agriculture in Ethiopia is heavily dependent on rain and geographical location and topography, plus a low adaptive capacity, make the country highly vulnerable to the adverse impacts of climate change (Zenebe G.,et.al., 2011). Changing rainfall and temperature patterns due to climate change have different effects on crops and livestock production. The production system of the study area totally depends on rain fed which is highly sensitive to climate change impact.

The major crop produced in the study area includes Cereals (maize, sorghum & finder millet), pulse and oil (haricot bean, sesame & groundnut), horticultural (sweet potato, mango & Hot pepper) and others (coffee & Chat). Maize and sorghum play important role in ensuring households food security while coffee and chat was the major cash crop in the study area. (CWAO Report 2018)

However, the production and productivity of crops declined due to different environmental factors like drought, shortage and erratic rain fall, shortage of improved variety, diseases and erosion. Livestock production contributes very important role to ensure households food security and family income in the study area. Cattle, shoat, poultry, donkey are major livestock reared in the woreda. Natural resource of the study area declined from time to time due to deforestation, Population pressure, and expansion of agricultural land and impact of climate change. According to FGD participants, due to natural resource degradation problem in the study area climate change happened and impose difficulty on farming community's livelihoods. Climate change exerts pressure on rainfall availability, crop and livestock production & productivity and natural resource of the study area.

However, the communities practiced adaptation strategies to cope up with climate change. These practices includes drought tolerant and early maturing crop variety planting, shifting from maize production to sorghum and groundnut production, pond construction and water harvesting during rainy season, migration to other area and serve as daily laborer, participating on non-farming activities (petty trading especially women), adjusting cropping time, shifting from cattle raring to Goat and camel production, migration to search feed and water, reducing livestock flock and good land preparation are the major adaptive techniques of the community.

Adaptation is an essential strategy to enable farmers to cope with the adverse effect of climate change and variability which in turn to increase the productivity and livelihood of poor farmer households (Yusuf et al., 2008). Similarly, knowledge of adaptation methods on the side of smallholder farmers may make it better to tackle the challenge of climate change (Deressa et al., 2009).Despite extensive research and increased availability of information, existing knowledge on how to adapt to climate change at the grassroots level is extremely fragmented and dispersed (Reid et al, 2009).

Therefore, a better understanding of the local dimensions of the climate change is important to develop an appropriate Adaptive measures and appropriate policies. Chiro woreda of West Hararghe Zone of Oromia Regional state which is a vulnerable woreda to climate change. In this study area, the impact of climate change is adversely affecting the livelihood of the community especially agriculture. Therefore, the area is seriously affected by the climate change and weather variability. As to the knowledge of the researcher, no earlier study was conducted on the climate change impact on Agriculture and Adaptation strategies of smallholder farmers in this specific study area. Hence, considering this knowledge gap, the researcher has study the local adaptation strategies of climate change impact at Chiro Woreda of West Hararghe zone.

## 1.3. Objectives of the Study

### 1.3.1. General objective

The general objective of this study was to Examine climate change adaption strategies of smallholder farmers and their determinates in chiro Woreda of West Hararghe Zone. Ethiopia.

### 1.3.2. Specific objectives

1. To assess level of smallholder farmers understanding towards climate change in the study area.
2. To identify Existing adaptation strategies used by Smallholder farmers' in the study area.
3. To identify factors that determine Smallholder farmers' adaptation strategies to climate change in The Study Area.

## 1.4. Research Questions

1. What does the climate change perception level of smallholder farmers looks like in the study area?
2. What are the major climate change adaptation strategies practiced by smallholder farmers in the study area?
3. What are the major factors that determine farmers' choice of adaptation strategies to climate change in the study area?

## 1.5. Significance of the Study

This research has intended to study the smallholder farmers' adaptation strategy to climate change impact of Chiro woreda. Therefore, the study has been conducted at micro level, so that it helps to use as a guideline document for further research in this study area In addition, it helps to use indigenous practices and knowledge on agricultural adaptation to climate change and variability (for planning, action and response processes).

## 1.6. Scope of the Study

This study was designed to assess Smallholder farmers' adaptation strategies to climate change impact in selected three kebeles of Chiro woreda, West Hararghe Zone of Oromia regional state. This was because farmers of these kebeles were highly dependent on rained agriculture and livestock rearing in which mostly affected by climate change and variability in the study area. .The principal reason why only three kebels selected for the study was limitation of time and financial resource. The study could have been much more interesting if it includes more kebeles in chiro

Woreda and beyond. However, due to the mentioned reasons, the study was undertaken only in selected three kebeles.

### 1.7. Definition of key Terms

**Climate Change:** refers to a statistically significant change in measurements of either the mean state or variability of the climate for a given place or region (UN/ISDR, 2004).

**Climate Variability:** refers to changes that occur within smaller timeframe such as a month, a season, or a year in a given area (WMO, 2011).

**Smallholder Farmers:** refers a farmers who own or control small plots of land, produce small amount of volume and less well-resourced community group (Economic Report on Africa, 2009)

**Socio-economic Impacts:** refer to effects of climate change on lives, livelihoods, health, economies, social aspects, cultures and services of the local community (IPCC, 2014).

**Vulnerability:** refers to the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (IISD, 2012).

**Adaptation:** is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2005).

**Resilience:** refers to capacity of community potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure (UN/ISDR, 2004)

## 1.8. Organization of the Thesis

The major study is organized in to five chapters. Chapter one presents introduction including background of the study, statement of the problem, objective of the study, research questions, significance of the study, delimitation and limitation of the study, definitions of key terms, and organization of the thesis. Chapter two reviews important literatures related with climate change, its impact and adaptation mechanisms. Description of the study area and data gathering method is presented in chapter three. Chapter four presents result and discussion of the survey while, summary, conclusion, recommendations are presented in chapter five. Finally, references and appendices are attached at the end of the thesis for further references.

# 2. LITERATURE REVIEW

## 2.1. Definition and Concepts of Climate Change and Variability

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (UNFCCC, 2015).

Climate change is a reality; it has changed in the past, it is changing at the present, and it will change in the future (Burroughs**,** 2007). The change of climate could be slow and gradual, rapid and catastrophic, short-term or long term could be at local, regional and global scales; and it could be due to natural factors or anthropogenic factors. The overwhelming majority of climate change researchers have reached the understanding-based on decades of evidence, modeling, and debate-that it is extremely likely that human activities are responsible for the rising temperatures on Earth. Human behavior will continue to be a major factor in climate change (NSF, 2009).

Climate Variability is variations in the mean state and other statistics (such as standard of deviations, the occurrence of extremes, etc.) of the climate on temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (Levina and Tirpak, 2006). Climate variability is a reality; it has changed in the past, it is changing at the present, and it will change in the future (Burroughs**,** 2007). The variabilities of climate could be slow and gradual, rapid and catastrophic, short-term or long term could be at local, regional and global scales; and it could be due to natural factors or anthropogenic factors.

The human factors that contribute to climate change are in the form of greenhouse gases (GHGs) emissions and land-use/cover changes (Aklilu and Alebachew 2009a; World Bank, 2008; FAO, 2008). Most important GHSs are emitted from electric power station, various industries, the transport sector and deforestation due to human activities. These activities increase the concentration of different greenhouse gases. The relative share of carbon dioxide, chlorofluorocarbons, methane and nitrous oxides to GHGs emission up to 1990 were 51%, 20% 16% and 16% respectively (Singh and Sweta, 2008).

In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate. Evidence of observed climate change impacts is the strongest and most comprehensive for natural systems. Some impacts on human systems have also been attributed to climate change, with a major or minor contribution of climate change distinguishable from other influences. Impacts on human systems are often geographically heterogeneous because they depend not only on changes in climate variables but also on social and economic factors. Hence, the changes are more easily observed at local levels, while attribution can remain difficult (IPCC, 2014).

### 2.1.1. Global Overview of Climate Change and Variability

Climate change is a widespread challenge affecting many parts of the world. This change will not occur without marked impacts upon various sectors of our environment, and consequently of our society (Chavas et al., 2009). The change in climate will appear and will have important positive or negative impacts on rain fed crop production. Climate change has raised much concern regarding its impacts on future global agricultural production varying by region, time, and socio-economic development path (Liambila and Kibebew, 2016).

According to the Intergovernmental Panel on Climate Change (IPCC, 2013), human influence has been detected in warming of the atmosphere and the ocean, changes in the global water cycle, reductions in snow and ice, global mean sea level rise, and changes in some climate extremes. It is extremely likely that human influence has been growing and is the dominant cause of the observed warming since the mid-20th century.

Future projections of climate change depend upon the path of future emissions. Even if all emissions of GHSs were ended today, the world would continue warming over the next few decades because the ultimate environmental effects of emissions are not realized immediately. Based on a wide range of models with different assumptions about future emissions, the IPCC (2013) estimates that: increase of global mean surface temperatures for 2081–2100 relative to1986–2005 is projected to likely exceed 1.5°C ($2.7^0$F) and might be as high as 4.8°C ($8.6^0$F). The Arctic region will warm more rapidly than the global mean, and mean warming over land will be larger than over the ocean.

### 2.1.2. Current Overview of Climate Change and Variability in Ethiopia

Climate change will be manifested through changes in climatic and atmospheric factors (rainfall, temperature and $CO_2$ concentration), and a host of other changes and interactions. Temperatures across the African continent will rise, and it is likely that under high emission scenarios the mean annual temperature increase will exceed 2 °C by the middle of the twenty-first century (Niang et al., 2014).

Changes in precipitation will be less uniform across the continent, with a varying degree of consensus between models across the regions. For southern Africa, most projections suggest a drying of the climate. For eastern Africa, however, an opposite trend is projected, with the Ethiopian highlands in particular likely to witness an increase in average and extreme rainfall. In many areas of West Africa, the changes predicted by different climate models are divergent (Niang et al., 2014). Besides trends in the mean climate, changes in weather variability and frequency of extreme events are expected, with still low but increasing confidence in the projections (Porter et al., 2014).

Ethiopia's topography is characterized by large regional differences which are the main factor for high annual variation of precipitation. The country has three rainy seasons: June–September (*kiremt*), October–January (*bega*), and February–May (*belg*). *Kiremt* rains account for 50–80 percent of the annual rainfall totals and most severe droughts usually result from failure of the *kiremt*. The lowlands in the southeast and northeast are tropical with average temperatures of 25°–30°C while the central highlands are cooler with average temperatures of 15°–20°C. Lowlands are vulnerable to rising temperatures and prolonged droughts, while highlands are prone to intense and irregular rainfall (NCEA, 2015).

Ethiopia is currently faced with serious challenges arising from climate change, which include erratic rainfall, severe droughts, and floods, among others. The country is indeed rated as among the most vulnerable to climate change as a result of its high dependence on rain-fed agriculture, natural resources and low adaptive capacity (FDRE, 2011a).

The country has frequently experienced extreme events like droughts, floods, and other climate-related hazards. The variability of rainfall and the increasing temperature are blamed for the frequent droughts that at times lead to famine and affect livelihood of the people. Since the early 1980s, Ethiopia has suffered seven major droughts, five of which led to famines in addition to dozens of

local droughts. Major floods also occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996 and 2006 (World Bank, 2010; FDRE, 2011c; FDRE, 2011e).

According to Oxfam International (2016), climate changes can result in numerous extreme events like drought mostly in developing countries including Ethiopia, which experienced worst droughts for 50 years and also has left many poor and vulnerable families with nothing. The El Niño weather system, exacerbated by climate change, comes off the back of 12 to 18 months of erratic or failed rains. It led to crop failures of the 2015 meher harvest of between 50 and 90 percent, particularly in the eastern part of the country including Oromia Regions; the El Niño has dried up many water sources. Hundreds of thousands of livestock have died and malnutrition is at alarming levels.

Crop agriculture is dominated by small-scale subsistence farmers who remain heavily dependent on rain, employ low-intensive technologies and lack access to services. This leaves the sector highly vulnerable to changing rainfall and other climate patterns. Limited water storage capacity further increases vulnerability to climate risks. Crop productivity may increase in the short term due to warmer temperatures, but continued high temperatures will result in heat stress and crop failure. By one estimate, Ethiopia will forgo more than 6 percent of each year's agricultural output if the current decline in average annual rainfall levels continues in the medium term (Aragie, E. 2013).

## 2.2. Impacts of Climate change /variability

### 2.2.1. Impacts on Crops Production

Climate change is exacerbating the challenges faced by the agriculture sector. Climate change-induced increases in temperatures, rainfall variation and the frequency and intensity of extreme weather events are adding pressure on the global agriculture system, which is already struggling to respond to rising demands for food and renewable energy (OECD, 2015). Besides, agriculture is sensitive to climate, even under current conditions. All types of farming, from highly mechanized capital-intensive farming to manual subsistence agriculture have the potential to be significantly impacted by current climate variability, as well as by future climate change (UNDP, 2010).

According to UNDP (2010), farming can be impacted by a multitude of environmental issues that may influence agricultural production in the future. These include:

a) **Temperature:** Higher winter temperatures and less frost days may mean that some crops benefit. However, other crops may suffer from higher summer temperatures. The shifts in temperatures may shift the ideal planting and harvesting times for some crops or shift the type of crop varieties which should be grown. Temperature can also have a direct impact on livestock health and reproduction.

**b) Precipitation and soil moisture:** an increase in average global temperatures will also mean an increase in the intensification of the global water cycle. Higher temperatures will mean more evaporation, and possibly more intense rainfall in some regions – which can lead to flooding. Other regions may however experience longer spells of drought. The changes to the water cycle are critical to consider when examining the agricultural sector.

**c) Climate change and extreme events:** while long-term changes in the average climate may require adaptation measures, greater risks to food security may be posed by changes in year-to-year variability and extreme events. Extreme temperatures, droughts and floods may result in greatly reduced productivity, and in some cases crop failure.

The observed effects of past climate trends on crop production are evident in several regions of the world (Porter *et al.*,2014), with negative impacts more common than positive ones, including several periods of price spikes following climate extremes in key producing regions. There is evidence that climate change has already negatively affected wheat and maize yields in many regions and also at global level (Lobell et al., 2011).

Climate change has been found to pose risks to producer incomes in other areas as well. Bárcena *et al*., (2014), summarize the results of a series of studies of projected impacts of climate change on agricultural revenues. They stated that impacts of climate change are generally found to be negative across a wide range of locations, temperature increases and assumptions. In another recent study modeling the potential effects of climate change on agricultural incomes across a wide range of farming systems in Central Asia, the authors found positive income gains for large-scale commercial farmers in northern Kyrgyzstan, but negative impacts for small-scale producers in arid areas of Tajikistan.

According to Gaillard (2010), agricultural production in many African countries and regions will likely be severely compromised by climate change and climate variability. This would adversely affect food security and exacerbate malnutrition. Agricultural yields and dependence on natural resources constitute a large part of local livelihoods in many African countries. Agriculture is a major contributor to the current economy of most African countries, averaging 21% and ranging from 10% to 70% of GDP with indications that off-farm income augments the overall contribution of agriculture in some countries.

In Niger and Ethiopia, both rainfall and maximum temperature variability appear to exert a negative impact on consumption expenditure, household income and food security, which points towards the absence of income-smoothing behavior. In Uganda, however, the limited impact of climate shock on household welfare together with highly significant effects of other socio-demographic and wealth indicators could indicate a consumption and income-smoothing behavior. In most of the East African countries, the most vulnerable rural households are more adversely affected by a rainfall deficit compared with the households in the top income quintile (Erickson et al., 2011).

### 2.2.2. Impacts on Livestock Production

According to Thornton et al., (2009), direct effects of climate change on livestock production are manifested through impacts of increased temperature on feed intake and animal physiology, affecting growth, health, fertility and milk production. Although the exact impact of heat stress in animals is not well established for the tropics it is likely that with increased temperatures, African livestock keepers may have to shift to more heat tolerant breeds or species. Livestock are indirectly affected by changes in forage and crop residue production and grazing resources.

Livestock are a major asset among rural communities, providing a range of essential services, including saving, credit and buffering against climatic shocks and other crises. Beyond agriculture and food security, the income from livestock thus directly contributes to education and human health. In SSA, more than one person in two keep livestock and one in three can be considered as poor livestock keeper (FAO, 2012). Livestock, especially small ruminants and chicken, are also key to women's empowerment and gender equity.

In Italy, Crescio et al., (2010), reported that high temperatures and air humidity could lead to a 60 percent increase in cattle mortality. Likewise, in countries of SSA, 20 percent to 60 percent losses in animal numbers were recorded during serious drought events in the past two or three decades. Moreover, Niang et al., (2014), reported that dairy yields may decrease by 10 to 25 percent under certain climate change scenarios. In South Africa, another case study reported by the same authors estimated a 23 percent rise in the cost of supplying water to animals from boreholes in Botswana.

According to FAO (2010), climate change affects livestock production in multiple ways, both directly and indirectly. The direct effects of climate change will depend very much on the livestock production and housing system, with high-output breeds in confined systems being better protected from natural adversities than breeds in extensive grazing systems. The need for increased production efficiency while reducing the environmental footprint of livestock will continue to be major future challenges. The same report indicates that climate change will increase the need for resource-efficient livestock production and may thus intensify current trends with a growing dichotomy between livestock kept in extensive and those in intensive systems.

## 2.3. Social Impacts

### 2.3.1. Impacts on Education

Educational system should be oriented towards resolving socioeconomic constraints of the country or region. However, during climate change induced impacts such as prolonged droughts and flooding, schools would become victims of climate shocks and hazards, hence vulnerable to climate change impacts. Consequently, schools teaching-learning processes will be interrupted, educational facilities and institutions will be destroyed, and in the final analysis will bring about either complete school shut down with whole educational processes to cease or leading to a significant increasing in number of student dropouts (BoFED, 2008).

As study conducted, for example, in west Arsi zone revealed that 35 schools in Siraro district depicted high student dropouts, and school dropout has increased from 2% during normal time to 21.76% during the drought event (WAZ FS-DPPO, 2008). Moreover, low class attendance, late coming and early departure, low educational achievement and high teacher turnover was also indicated in the report. In addition, another study reported by Senbeta (2008) has showed that more student dropouts and poor educational performance took place during the drought events due to climate change imposed drought and famine or malnutrition.

Considering the importance of child health and education for long-term prospects, productivity and income, even a moderate impact of climate change on these dimensions could affect poverty visibly over the long-term. Moreover, since poor households are suffering disproportionally from impacts, it would increase the poverty legacy and reduce the chance for children from poor families to escape poverty, reducing further social mobility. Climate change impacts are expected to disproportionately affect the welfare of the poor in rural areas, such as female-headed households and those with limited access to land, modern agricultural inputs, infrastructure, and education (IPCC, 2014).

### 2.3.2. Impacts on Human Health

Climate variability will affect human health and well-being through a variety of mechanisms. Climate variability can adversely affect the availability of fresh water supplies, and the efficiency of local sewerage systems (WHO, 2000). Africa is vulnerable to a number of climate sensitive diseases including malaria, tuberculosis and diarrhea (Guernier, 2004). Under climate variability, rising temperatures are changing the geographical distribution of disease vectors, which are migrating to new areas, and higher altitudes, for example, migration of the malaria mosquito to higher altitudes will expose large number of previously unexposed people to infection in the densely populated east African highlands (Boko, 2007)

Health challenges are not limited to shocks: malnutrition can be a chronic condition linked to usual economic and climate conditions. Climate change may reduce future agricultural yields and threaten food security by accelerating the risk of malnutrition and stunting. Lloyd et al., (2011), estimated that climate change will lead to an increase in moderate stunting of 1-29% by 2050 in compared to a future with no climate change while severe stunting could increase by up to 23% in SSA, and 62% in South Asia even.

Climate change also causes scarcity of water resources and severe floods that leads to outbreaks of waterborne diseases. African countries suffer serious health problems because of climate change (UNECA, 2011). Moreover, UNECA also justified that, Africa is the most susceptible continent to climate change related to health problems due to the existing poverty and weak institutions to deal with health challenges posed by climate change.

In Oromia National Regional State, existing linkages between impacts of climate change and human health related diseases show strong relationships, where with increased droughts and climate stresses, human diseases occurrence and prevalence marked increasing trend. Accordingly, ORHB (2010) indicated that 65% of Oromia's population was troubled by Malaria with 1 million clinical cases every year. In an effort to curb the hitch, the regional health bureau implemented the national malaria prevention and control strategies. Nonetheless, lack of adequate human resources, analytical skills, and inadequate and inconsistent reporting hindered the region from further attainment.

## 2.4. Predicted Negative and Positive Effects of CCV

### 2.4.1. Predicted Negative Effects

According to report of IPCC (2013), scientists have modeled the effects of a projected doubling of accumulated carbon dioxide in the earth's atmosphere. Some of the predicted effects are: (a) loss of land area, including beaches and wetlands due to sea-level rise, (b) loss of species and forest area, including coral reefs and wetlands, (c) disruption of water supplies to cities and agriculture, (d) health damage and deaths from heat waves and spread of tropical diseases (e) increased costs of air conditioning, (f) loss of agricultural output due to drought, (g) disruption of weather patterns, with increased frequency of hurricanes and other extreme weather events,(h) sudden major climate changes, such as a shift in the Atlantic Gulf Stream, which could change the climate of Europe to that of Alaska and (i) positive feedback effects,18 such as an increased release of carbon dioxide from warming arctic tundra, which would speed up global warming .

Climate change is expected to affect food and water resources that are critical for livelihoods in SSA where much of the population, especially the poor rely on local supply systems that are sensitive to climate variation. Thus, climate change would have a profound effect on food security in SSA, as increasing temperatures and shifting rain patterns reduce access to food (Kadi et al., 2011).

Climate change will have huge effects on rain fed agriculture such as for instance, in Ethiopia, crop productivity, among other agricultural activities, continued high temperatures will result in heat stress and crop failure. By one estimate, Ethiopia will forgo more than 6 percent of each year's agricultural output if the current decline in average annual rainfall levels continues in the medium term (Aragie, E., 2013).

### 2.4.2. Predicted Positive Effects

Positive effects of climate change and variability might include: increased agricultural production in cold climates, lower heating costs, less deaths from exposure to cold, modest reductions in cold-related mortality and morbidity in some areas due to fewer cold extremes, geographical shifts in food production, and reduced capacity of vectors to transmit some diseases. But globally over the 21st century, the magnitude and severity of negative impacts are projected to increasingly outweigh positive impacts (IPCC, 2014).

As a result of climate change, changes in agricultural productivity, with gains in some places will affect the income of workers in the agricultural sector, and therefore poverty in countries such as Burundi, Burkina Faso, Ethiopia, Mozambique, Sierra Leone, and Tanzania. World Bank household survey data indicate that more than 75% of workers are in the agricultural sector and between 75 and 95% of poor adults are farmers. The income growth of workers in the agricultural sector is therefore a key determinant of poverty eradication (Nelson et al., 2014).

## 2.5. Adaptation Strategies to Climate Change & Variability

Adaptation is used to increase food security through increased agricultural productivity through strategies of risk management, diversification and sustainable intensification. Risk management typically aims to reduce the variance of an outcome (e.g. crop yield), whereas intensification primarily aims at increasing the mean of the outcome. Diversification may lead to a shift in both the variance and the mean. In other words, mitigation can be conceived as a co-benefit of increased productivity and adaptation. To this end, crop, livestock and rangeland management options, while indicating some important institutions that could enable the adoption of these options (Campbell et al., 2014).

Risk management strategies, such as choosing adapted animal types and breeds, may decrease greenhouse gas emissions rates because of a smaller proportion of non-productive animals in the herd. Agro forestry is a diversification option providing improved feed from (often leguminous) trees or shrubs, while at the same time sequestering carbon (Mbow et al., 2014).

Non-agriculture-based livelihoods are likely to play an increasingly important role in building resilience among agricultural populations due to projected population growth patterns as well as potential climate change impacts to consider how to improve pathways for low-income and food-

insecure people in both the agriculture and non-agriculture sectors to access resilient livelihoods (HLPE, 2013).

According to Deressa et al., (2009), adaptation to climate change has many barriers, which emanate from different social, economic and institutional situations. The most important factor mentioned as barrier to adaptation is lack of information about climate change and adaptation strategies. This is attributed to various factors including lack of institutional support mechanisms and failure to mainstream the issue of climate change in the public extension system of the country.

Lack of farm inputs including seed, chemical fertilizer and oxen are the second most important impediments. Diversification of both on-farms with increased number of varieties, through mixed systems such as crop/livestock, or processing products, and off-farm, by getting a non-agricultural job, is an important element of climate change adaptation (Thornton and Herrero, 2014).
As reported by IPCC (2014), in Africa, the primary concern is adapting to the negative impacts of climate change. In the short term, integrating climate change adaptation and disaster risk reduction will help withstand shocks to human security and economic development. The same report indicates that, African governments, businesses and communities can do much to anticipate and reduce risk, rather than reacting after impacts have occurred. Support for effective disaster relief and recovery needs to continue, along with proactive efforts to reduce risk, such as integrating comprehensive risk assessments and risk reduction measures into national economic and development policy.

The bulk of climate change impacts and thus adaptation costs will occur after 2030. For example, the annual costs for Africa in 2030, based on current policy projections, is expected to be 15 USD 2012 billion, but it is expected to grow to 35 USD 2012 billion in 2040, and to 70 USD 2012 billion in 2050. Agricultural production and wages provide a large share of household income for all farm sizes (Thornton and Herrero, 2014).

Migration can be one of ways of solving weather events and climate change impacts, and thus of reducing welfare impacts (Jülich, 2011; Black et al., 2011b; Adger et al., 2014). In that case, migration increases the set of opportunities available to an individual or household, improving well-being and prospects. However, there is some evidence that the poorest households have lower capacity to migrate, and may therefore be unable to use this option. This is also the case for households in conflict and fragile areas, or those facing exclusion.

Ethiopia is already implementing the adaptation options as reflected in its draft Climate Change Adaptation Action Plan of Water and Energy Sector, the Ethiopia's National Adaptation Programme of Action (NAPA) and Ethiopia's Programme of Adaptation to Climate Change (EPACC), the Water Sector strategy and also in the 5-year Growth and Transformation Plans (GTPs). The following are further examples of adaptation options that Ethiopia needs to scale up to increase the resilience of the people and ecosystems by improving access to water and ecosystem services for sustainable environments and livelihoods: expansion of rainwater harvesting for groundwater recharge for cultivation through irrigation; adoption of water transfer schemes; increased storage capacity by building reservoirs and improvement of water-use efficiency (NAPA, 2007).

Ethiopia needs to adapt to climate change since its mainstay economic sector, agriculture, is highly susceptible to climate shocks. Currently, the country is implementing the Climate Resilient Green Economy (CRGE) strategy to achieve the vision of becoming a low carbon; middle income economy by 2025. This strategy will also enable the country to strengthen its capacity to adapt to the effects of climate change. The CRGE strategy is considered to be an additional positive step to resist the adverse effects of climate change and build an economy that will provide sustainable development (FDRE, 2011b, 2011f).

## 2.6. Conceptual Framework

Climate change has far-reaching consequences for livelihood of the households who are reliant of rain fed agricultural activities. Greater risks of crops and livestock production as a result of drought, cooling as well as heavy rain are already imposing economic losses and undermining food security. The change in frequency and intensity of drought, flooding and cooling can result in long term water and other resource shortage, worsening soil condition, diseases and pest out breaks on crops and livestock. Due to these extreme events and their subsequences vulnerable areas are expected to experience losses in agricultural productivity, primarily due to reductions in crops yields (Kurukulasuriya et al., 2003).

Climate variability is one of the all-encompassing global environmental changes that have deleterious or harmful effects on natural and human systems, economies and infrastructure. The risks associated with it call for a broad spectrum of policy responses and strategies at the local, regional, national and global level. UNFCCC highlights two fundamental response strategies: mitigation and adaptation. While mitigation seeks to limit climate variability by reducing the amount of emissions of GHG and by enhancing sink opportunities, adaptation aims to alleviate the adverse impacts through a wide-range of system-specific actions (Fussel and Klein, 2002).

The impacts of climate change on smallholder farmers, who depends only on rain-fed agriculture are among the most disadvantageous and vulnerable groups (Tetteh et al., 2014). Similar to crop productions, climate change also adversely affects livestock's productions. According to Getu (2015), agriculture is among climate sensitive sectors. The negative impacts of climate change are more severely felt by poor people in developing countries who mainly depend on the natural resources base for the livelihoods.

CONCEPTUAL FRAME WORK FOR CLIMATE CHANGE/VARIABILITY PROCESSS

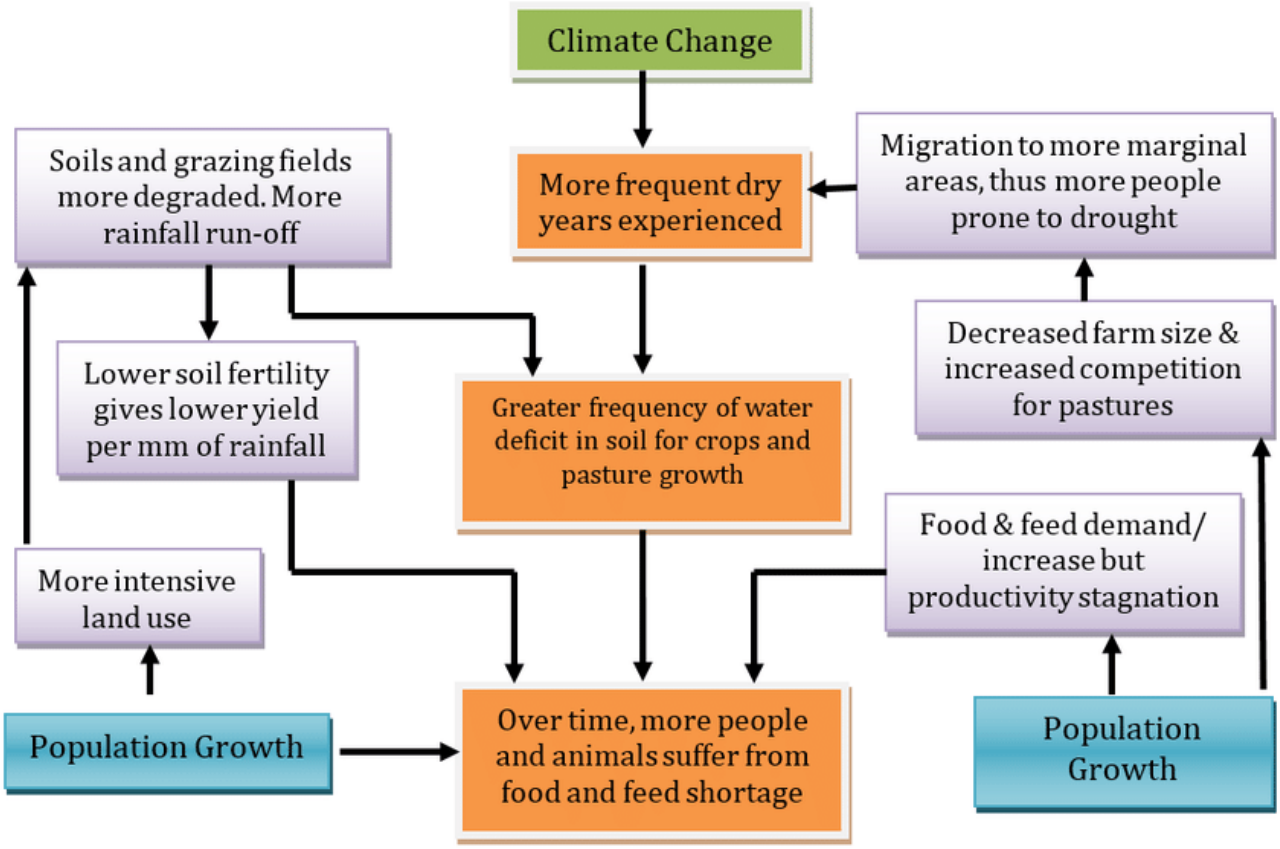



**Figure 1. Conceptual Framework for Socio-Economic impacts of CCV of the Study Area**

**Source:** Adapted from reviewed literatures of Siraj (2013); IPCC (2013, 2014) and Nelson et al (2014

# 3. RESARCH METHODOLOGY

## 3.1. Description of the Study Area

### 3.1.1. Location and size of the study area

This study has been conducted in Chiro District of Western Hararghe Zone; Oromia Regional State, Ethiopia .The district is located at about 325 km east of the national capital Addis Ababa. . Geographically, it is located between 10°24′N and 10°66′N latitudes, and between 38°43′E and 38°81′E longitudes. The study area covers about 362 km$^2$ and bordered with Miesso in the North, Gemechis in the South, Guba-koricha in the West and Tulo in the East.

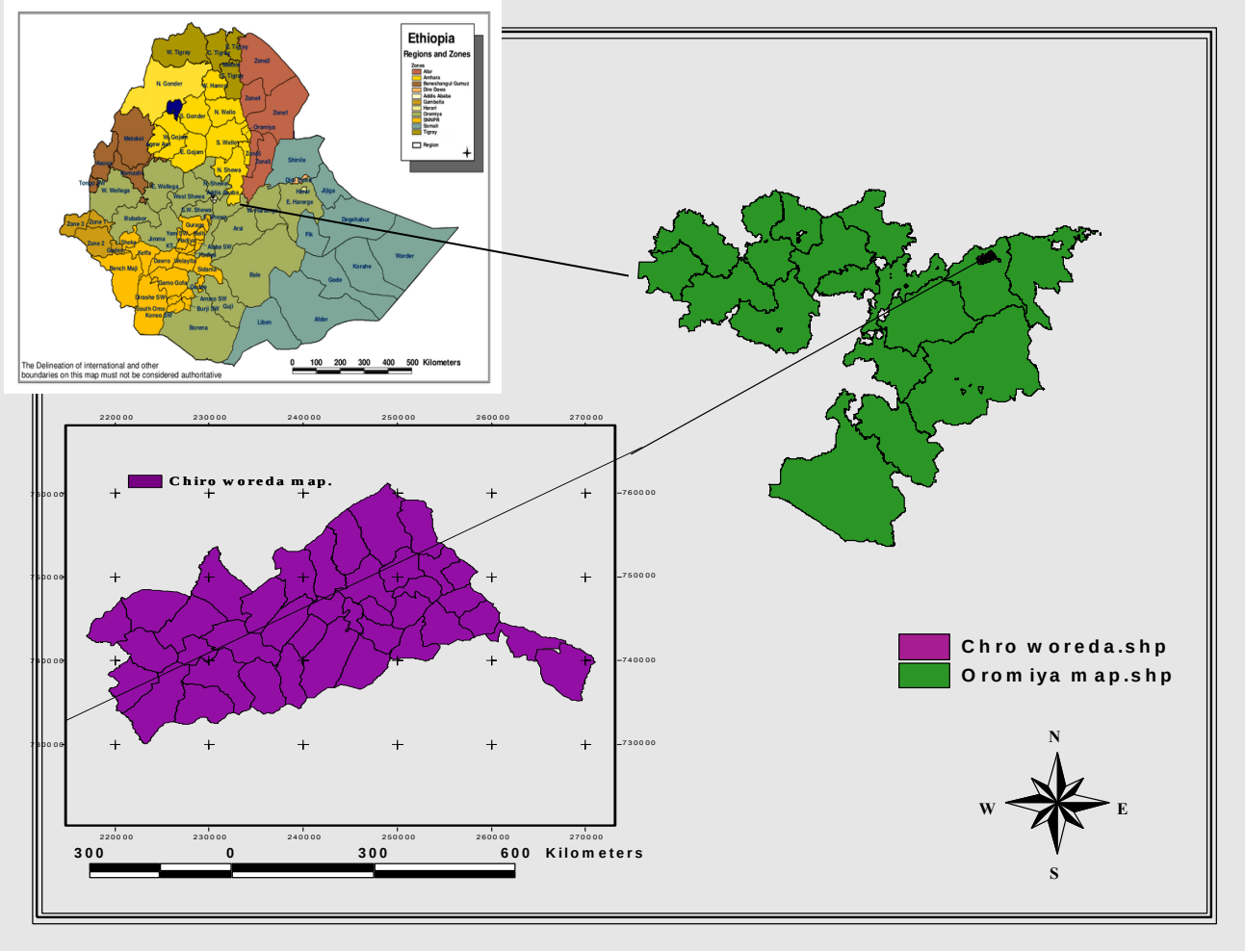



**Figure -2** Map of the study area
**Source**: Developed from Arch GIS (geographical information system), 2010.

### 3.1.2. Topography and soil

The topographic of the study area is mainly characterized by sloppy, mountainous & rugged type which is highly vulnerable to soil erosion. According information from Woreda Land use & Administration Office CWLUAO, (2018), from the total land area of the district, 25% is plain and 75% steep slope .The elevation of the area ranges from 1500 – 2800m above sea level. The highest point is Mount Jelo (1872 meters) and rivers include Legarba .Major soil type in the district are loamy soil, sandy soil & clay soil covering 42.5%, 25.5%, and 32% respectively, information obtained from Chiro District. Land Use & Administration Office CWLUAO,(2018) .The soil types vary with the topography, mainly black soils are observed in the highland and midlands & sand , clay & red soil in the lowland areas ,moreover , average land holding size per HH < 0.5 Hectare

### 3.1.3. Climate of the study area

The study area is characterized by three agro-climatic zones, which varies from Kolla, Woina Dega and Dega. According to the National Metrological Services Agency (NMSA) rainfall is bimodal and erratic in nature occurring on mid-February - April (small rains) and June – August (main rainy season).It has a mean annual rainfall of 700 mm - 1800mm and a mean monthly temperature that ranges from 12°C to 23.5°C.

### 3.1.4. Demographic characteristics

The district inhabited a total population of 207,553 of which 106,277 are males and 101,276 are females. From these 192, 194 are rural dwellers and 15,359 are urban dwellers (CSA 2013). The District known to have a heavy population density per square kilometer. According to Chiro woreda Agricultural & Natural Office ,CWAO (2018) .Information from chiro woreda Health Office, CWHO (2018), an average family size of a house hold in the district is 5 with fertility rate per women is 5.9 of which 3.3 is for urban and 6.4 for rural & growth rate is estimated to be 2.9%. Data obtained from West Harerghe CSA Office on age classification show, 97,549 (47%) are below 15 years of age while 4981(2.4%) are above the age of 65 years & economically active groups (15-64 years) is 103776(50%).In addition, as per the woreda, the total household of the District is 41,510 out of which 31133 are males and 10,376 is females. The average family size of the woreda's population is 4.9.

### 3.1.5. Socio-economic characteristic of the study area

Agriculture is the main economic activity and source of livelihood in the study area. Land is the most important asset of households for the productions of crops and rearing of animals. Mixed crop livestock farming system is subsistence which covers about 98% while the remaining 2% are pure pastoralist .Major food crops of the area are cereal crop such as sorghum, maize, haricot bean and chickpeas, moreover, chat is dominants cash crops. Livestock comprising small and large ruminants such as: goats, sheep and cattle are also an important source of household income and food. Overexploitation of natural resources exacerbated soil fertility, agricultural production, water tables and forest resources & put livelihood at risk for about decade in the study area (CWAO 2009)

## 3.2. Research Design

This study basically used a mixed approach, which enabled the investigator to collect relevant and adequate quantitative and qualitative data at the same time in research procedure to analyze the quantitative and qualitative data separately and compare or combine the results so as to interpret the data and draw conclusion.

## 3.3. Types and Sources of Data

The data required for the study was obtained from both primary and secondary sources. The original information has been collected through questionnaire, interview, focused group discussion and personal field observation. Secondary data were collected using available sources of information such as published and unpublished documents. This includes data from Chiro Woreda Agricultural office, National Metrological Agency, Chiro Woreda and Town Administrative offices, government health office and Hospital, Central Statistical Agency, and published and unpublished documents in and out of Haramaya University.

## 3.4. Sample size Determination and Sampling Procedures

Purposive sampling technique was used to select three keels, (one from highland, one from midland and one from lowland) to compere climate impacts and their adaptive strategies in the study area. In these sample kebeles, Smallholding farmers might have been affected by climate change and variability for their agricultural activities. This was the reason why the investigator was interested to focus on these kebeles.

**Table 1.** Selected keles and Smallholder House holds

| Study woreda | Total kebeles | Sample kebeles | Agro ecology | Total Smallholder HHs (N) | No of Smallholder HHs selected (n) | Sampling |
|---|---|---|---|---|---|---|
| Chiro | 39 | Arberekete | High land | 371 | 52 | Systematic Random Sampling |
| | | Arbahore | Low land | 293 | 39 | |
| | | Madicho | Low land | 343 | 35 | |
| Total | | 3 | | 1,007 | 126 | |

**Source:** Chiro Woreda agriculture Office, 2021

Using probability proportional to size, 3 Kebeles (Arbarakate, Arbahore and Madicho) has been selected from pure agro pastoralist kebeles and, in order to know perceptions regarding climate change trends and its effect on agricultural productivity. A Simplified formula provided by Yamane (1967) is used to determine the required sample size at 95% confidence level, 5% degree of variability and 8% level of precision. Then from a total of 1,007 population, the sample size for the study is statistically used to estimate the number of Households. But, because of disqualified questioners and unwillingness of the respondents, the researcher intentionally used 126 households for this research purpose.

$n = N/1 + N(e)2$

*n = 1,207/1+1,207(0.05)2*

*n* = 1207/6.1725

n = 126

$$n = \frac{N}{1 + N(e)^2}$$

Where, e = Deviation of Sampling/error (e = 0.05)

N = Population Size and

n = Sample size

## 3.5. Methods of Data Collection

### 3.5.1. Questionnaire

Questionnaire was one of the principal tools used to gather data from respondents. It was prepared in English and translated in to Afan Oromo language in which both open and closed-ended format of questions have been incorporated and has been distributed to predetermined 126 respondents to collect quantitative and qualitative data. Pilot study was undertaken in a kebele inside of the study area before distribution of the main questionnaire and helped the investigator to get socio-economic information in the targeted kebeles and to modify the instrument based on the experience gained during the pretest.

The instrument helped the respondents to select responses from the provided alternatives and also it provided them with opportunities to express their long experiences, opinions and views regarding socio-economic impacts of climate change (Kothari, 2004). Besides, the investigator used the instrument because it was easy to administer, less expensive and provided a wide coverage of data.

### 3.5.2. Interview

This study has used an interview as another principal tool to extract information upon face-to-face basis between an interviewee or a respondent and the interviewer. It is a straightforward and less problematic way of finding things out (Robson, 1995). The interview (both structured and semi-structured) was made with a total of 66 households heads (20 farmers from each kebeles with better understanding and educated and 6 civil servants from three selected kebeles) based on their educational status. The reason for purposely selecting these respondents was that they were believed to have better understanding about climate change and variability and its socio-economic impacts. The discussion has been conducted about socio-economic impacts. The main purposes of conducting interview were to clearly understand the perception of the sample household heads on socio-economic impacts of climate change and variability the responses of the community, government and NGOs. In addition, it was used to triangulate the household survey.

### 3.5.3. Focus group discussion

Three focus group discussion has been conducted at each targeted kebeles. Because Focus group discussion (FGD) was another instrument used to collect quantitative and qualitative data from predetermined 6 key informants selected from each targeted kebeles proportionally, who were believed to have better knowledge on the issue and different from an interview. The discussion has been conducted about socio-economic impacts of Climate change and variability on the households among 2 elders, 2 officials (chairmen) of kebeles, 1 model farmers, 1 staff of the agriculture and rural development in the same time.

### 3.5.4. Field observation

Transect walks across the selected kebeles were conducted in order to obtain all necessary physical information. This technique involved semi structured interviewing with villagers meet during transect wakes and helped to acquire useful and detailed information. So the investigator has systematically and carefully observed physical socio-economic aspects of the households in relation to climate change and Variability. The investigator has used check list during field observation.

## 3.6. Methods of Data Analysis

The Mixed research approach was used both quantitative and qualitative method of data collection and analysis was applied. After it has been collected, data was categorized, coded and summarized in to numeric values and then entered in to SPSS Statistical program. Information that was obtained from Interviews and FGDs are mostly in the form of verbal/narrative information. These were written and summarized as per the major component of the study. This information is more qualitative in nature and used to triangulate during analysis. Descriptive statistics like frequency distributions, cross tabs, mean and standard deviation and trend analysis for temperature and rain fall data was used and analyzed using Microsoft Excel. Temperature and rainfall data were gathered from NMA Chiro Mieso.

This study also used a Multinomial Logit (MNL) to analyze determinations of climate change/variability Strategies because it was widely used in adaptation decision studies involving multi choices and is easier to compute than its alternative,

## 3.7. Definition of the Model variable for Multinomial Logit Model

### 3.7.1. Dependent Variables

The dependent variables of this study were the adaptation options that the farmers' employed in response to climate change. The most common adaptation methods cited in the literatures include; different crop varieties, mixed crop and livestock farming, soil conservation, tree planting, changing planting date, diversifying from farm to nonfarm activity and irrigation (Hassan and Nhemachana 2007, Deressa et al 2008).

Based on the literatures and researchers knowledge in area, the study used the endogenous variables such as crop varieties, improving crop and livestock farming, soil and water conservation, irrigation and no adaptation.

**Crop variety -** This means that farmers could change the date of planting crops with respect to the change in the climate (early or late planting) that survive in adverse climatic conditions.

**Improving crop and livestock**: This includes planting of short duration crop, drought tolerant crop and improved livestock variety both for milk and meat

**Soil and water Conservation -** Includes soil erosion preservation, management and care of soil in order to make it suitable for their crops, dam construction, conservation of rain water for watering the crops in times too little rain, ground water harvesting and agro forestry, etc.

**Irrigation**: Includes irrigation development from rivers or lakes in order to cope up with the challenges of climate change

**No adaptation:** Is the other option that smallholder farmers may not response (not use an adaptation method) to climate change.

### 3.7.2. Independent variables

The independent variables are the factors that affect choice of adaptation methods to climate change. Different literatures were reviewed on the factors that affecting farmer' choice of adaptation method to climate change. Majority of them have been focused on household characteristics, farm characteristics, institutional factors and environmental factors. Accordingly, the researcher was conceded the following as exogenous variables i.e. factors influence farmers choice of adaptation strategies to climate change.

**Age of the household head (age);** This is a continuous variable and represents the experience of the household in the farming activities. This variable was expected a positive sign.

**Gender of the household head (sex);** Gender is a dummy variable which indicate 1 if male household head and 0 otherwise. The expecting sign of this variable was indeterminate.

**Level of education of the household head (edu);** this is the number of years spent by the head of the household for acquiring education and the expected sign was positive. As the level of education of the household head increased the farmers' proximity for new information and the probability of accepting new technology also increase.

**Household size (hhsize)** household size is the total family member of the household. Large number of family member can adopt the effect of climate change easily. Therefore, it was expected that household size has a positive sign for the farmers' who are used adaptation method to climate change. This variable is also a continuous variable.

**On farm income (onfarm);** on farm income is an income return to the household from farming activities. This was measured in the form of Ethiopian Birr. This is a continuous variable and expected a positive sign for the farmers' who were used adaptation method to climate change.

**Off farm income (offarm);** this is an income of household obtains from outside of farming activities. For example trade, remittance and governmental employer are among others. Such income is makes the farmers not to follow up or motives properly to agriculture.

Therefore, the expected sign of this variable was negative for the farmers' who are used adaptation method to climate change and it is a continuous variable. This variable also measure in Ethiopian Birr.

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

if the farmers has access to credit 0 otherwise.

**Agricultural extension service (agriexs)**; this is a formal service and plays a great role that affects for farmers' to adopt strategies in response to climate change. This variable is also a dummy which represent 1 if farmers' get agricultural extension service 0 otherwise and the expecting sign was a positive.

**Availability of farm to farm extension service (ffexts**); this service is crucial to make farmers' to adopt strategies. The farm to farm extension service serves as a source of information and exchange and sharing of experience among farmers'. This variable is a dummy variable which indicating 1 if the farmer has available of farm to farm extension service 0 otherwise. The expected sign of this variable was a positive.

**Farm size; Farm;** size is the total landholding of the farm household that uses for the farming activities. The farm household with holding big farm land has more to use adopted and the farm size measure in terms of hectare. Therefore, the variable is continuous and it's expected was a positive sign for the farmers' who were used adaptation method to climate change.

**Livestock holding (TLU);** livestock holding is the total livestock that farmers can own on the livelihood. Livestock is a vital instrument in the case of climatic change to adopt. This is due to the fact that livestock is essential for farm household to use as for harvesting, transportation and also for financial purpose by selling them. This implies that farmers with more numbers of livestock is the richer and can respond to the adverse impact of climate change through adaptation method. This is a continuous variable and expected a positive sign for the farmers' who were used adaptation method to climate change.

**Distance from home to the farm[5] (*dfarm*):** This variable is a continuous variable represented by walking time (in minute) from farmers' residence/home to their farming place. We consider this as possible factor in farmers' decision to undertake adaptation to climate change

Impact. We expect that the farmer whose farm is far from his residence is less likely to continuously follow up his farm as compared to those whose farm nearer to their home. Thus, it is expected that farmers who live near to their farm are likely to have regular follow up of their farm, hence motivated to respond to the impact of climate change on their agricultural activities. Therefore the expected sign is negative for the farmers' who were used adaptation method to climate change.

**Distance to the market (dmkt):** This is a continuous variable which measures in terms of time spend from the residence of farm household to the market area. The residences of farmers' 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(climinfor):**This is dummy variable indicating 1 if the household head access to climate change 0 otherwise. This variable is also expected a positive sign for the farmers' who were used adaptation method to climate change.

## 3.8. Ethical Consideration

According to Bell (2004), research ethics is a type of agreement that researcher enters into with his or her research respondents. In this case, he or she has to reach on an agreement with respondents based on the objective and propose of data collecting. All participants are offered the opportunity to have adequate awareness and that information they give is treated with restricts confidentiality. Based on this theoretical framework, the investigator has attempted to contact sampled households in order to keep prior permissions to administer all types of data collection instruments. For this effect, the investigator has provided the respondents with all necessary respect and has given them full assurance that the information was used strictly for academic purpose.

# 4. RESULTS AMD DISCUSION

This chapter deals with presentation, analysis and interpretation of the collected data from sample household heads, key informants and participants of focus group discussion by employing questionnaire, interview and FGD. In addition, some relevant data were gathered through field observation. An attempt has been made to identify the observed temperature and rainfall changes and their impacts. Finally, efforts were made to display the data by using tables and figures, which made the results clearer and more precise, so that it could be easily understandable.

## 4.1. Background of Sample Household Heads

### 4.1.1. Demographic Characteristics of Sample Household Heads

According to Table 2 shown below, about 89.6% of sample Household heads were male-headed and the remaining 10.4% were female-headed household heads (HHs). Age distribution of the respondents ranged from 20-65 years and the average age was 40 years old. Although the average family size of the sample household heads is 5, the absolute size of them ranged from 1 to 12 members. According to report of CSA (2012), the average size of family members is slightly greater than that of Oromia (4.8) and the national (4.7) ones.

Table 2. Demographic Characteristics of Sample Household Heads

| Variables | | Frequency | percent |
|---|---|---|---|
| Sex of HHs | Male | 113 | 89.6 |
| | Female | 13 | 10.4 |
| | Total | 126 | 100 |
| Age of HHs | 20 - 30 | 38 | 30 |
| | 31 - 45 | 63 | 50 |
| | 46 - 65 | 25 | 20 |
| | Total | 126 | 100 |
| Marital status | Married | 117 | 93.5 |
| | Single | 4 | 3.2 |
| | Divorced | 5 | 3.3 |
| | Total | 126 | 100 |
| Family size | 1 - 3 | 26 | 20.7 |
| | 4 - 6 | 89 | 70.8 |
| | 7 - 9 | 11 | 8.5 |
| | Greater than 10 | 0 | 0 |
| | Total | 126 | 100 |

**Source:** Own Field Survey, 2021

### 4.1.2. Socio-Economic Characteristics of Sample Household Heads

As depicted in Table 2 above, out of the total, 93.5% of the sample household heads were married, 3.2% were single 1.3% widowed and 2% of them were divorced. In terms of educational status, the great majorities of the sample household heads (76.6%) were illiterate with no formal education, while 23.4% of them were able to read and write.

The results from the MNL model indicated that the sex of the household head positively and significantly influenced the use of soil and water conservation practices. This indicates that male-headed households are most likely to adopt soil and water conservation practices than female-headed households. Thus, because of this adaptation strategy's labor-intensive nature, it is less practiced by female-headed households. Moreover, such an adaptation strategy also takes more time, making it difficult for female-headed households to adapt because of their multiple roles. The result is in line with studies conducted by Legesse et al. (2012) and Deressa et al. (2011) who reported that male-headed households use different adaptation measures than female-headed households. However, it contradicts with results reported by Charles et al. (2014) who found that female headed households are more likely than male headed households to adopt adaptation alternatives.

Years of schooling of the household head affected adjusting planting date positively and significantly at a 1% significant level, indicating that farmers with better years of schooling have the probability of choosing this adaptation strategy. Adjusting planting dates include early and late planting that can help farmers to reduce the probability of crop failure resulting from water stress during the early stage of crop development. Because the study area is significantly affected by drought adjusting the planting dates is critical in reducing crop failure. Such an adaptation strategy depends on farmers' ability to access, realize and interpret climate information to make essential decisions that are directly related to farmers' education level. The result agrees with previous studies (Asfaw et al., 2017; Belay et al., 2017).

Regarding income of the sample household heads, it was difficult to establish because the household heads could hardly tell sincerely their household earnings. However, an attempt had been made to know their income by asking the current amount of agricultural production (crops, livestock and vegetables) per year and converting it into Ethiopian birr based on the current market price.

Accordingly, the income distribution of the sample household heads ranged from 12,000-170,000 Ethiopian birr with an average income of 5,239 birr per month.

#### 4.1.2.1. Types of Crop Production

As indicated in Table 4, of total sample respondents, 95.5%, 75.3% and 90.3% regularly and mainly cultivate chat, maize and sorghum as food crops on their farms respectively. Moreover, as additional responses obtained from the interviewed groups reveal, the sample household heads sometimes grow pea, wheat and soybean and among these crops, chat is grown as cash crop and use as main source of family's income. These crops shared 95.5% of households' income (CWAO, 2021). Regarding earning, average monthly and annual income derived from crop products was 4,300 and 40,000 Ethiopian birr respectively.

*Table 4.* Distribution of Sample Respondents by growing Crops

| S.N | Type of crop cultivated | Number of Households | Percent |
|---|---|---|---|
| 1 | Sorghum | 108 | 90.3 |
| 2 | Maize | 84 | 75.3 |
| 3 | Chat | 113 | 95.5 |
| | Bean | 18 | 15 |
| 4 | Wheat | 7 | 6 |
| | N = 126 | | |

**Source:** CWAO and Own Field Survey, 2021

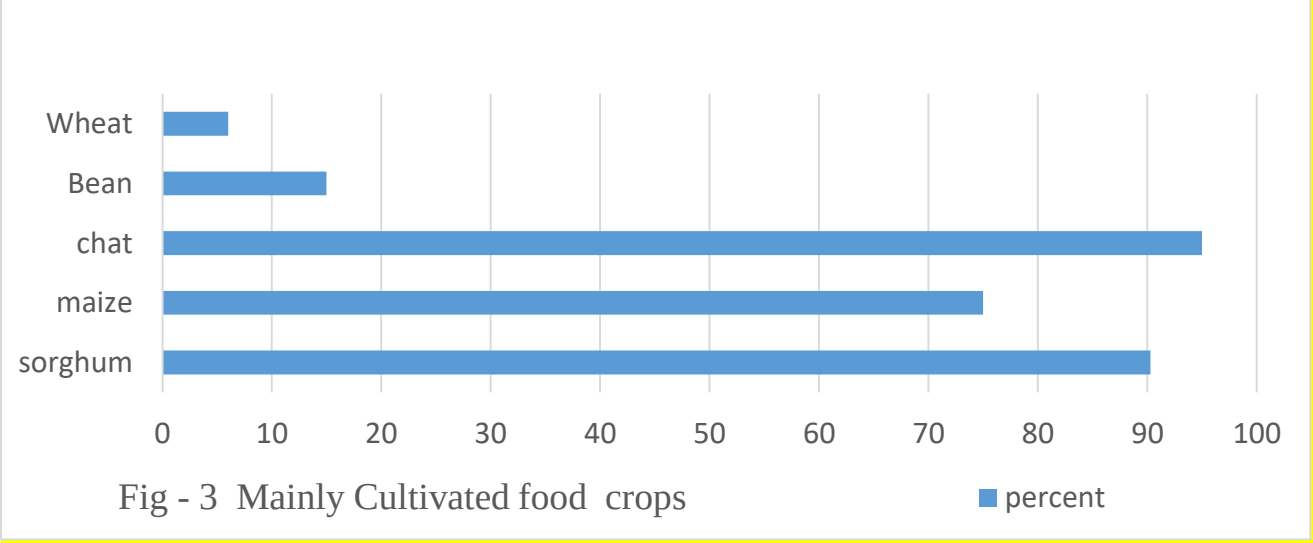



Fig - 3 Mainly Cultivated food crops

#### 4.1.2.2. Livestock Husbandry

Table 5 depicts that the sample household heads rear different types of livestock. Out of the total sample household heads, 44.8%, 50%, 55%, 60%, 10% and 15% rear/have cow, oxen goat chicken sheep and donkey respectively. On average, monthly and annual income gained from livestock products was 4,468 and 27,620 Eth. Birr respectively. Moreover, this economic activity shared 23% of the households' annual income (CWAO, 2021). This finding is in contrast with study report of Leta and Mesele (2014) states that farmers increase their livestock numbers if they have no other livelihood sources. Therefore, the proportion of possessing livestock and its share of annual income is important in the study area. The researchers stated that livestock keeping is of large importance for both the livelihoods and the national economy of Ethiopia.

Table 5 Major Types of Livestock of the Sample Household Heads

| S.N | Livestock | Number of Households | Percent |
|---|---|---|---|
| **1** | Cow | 69 | 44.8 |
| 2 | Oxen | 77 | 50 |
| 3 | Donkey | 23 | 15 |
| 4 | Goats | 85 | 55 |
| 5 | Sheep | 15 | 10 |
| 6 | Chicken | 92 | 60 |
| | N = 126 | | |

**Source:** CWAO and Own Field Survey, 2021

Table 6 below shows that the sample household heads institutional factors. Out of the total sample household heads, 70%, have a shortage of finance for the purchase of agricultural inputs and only 39% of the sample households have an accuses for formal credit like Oromia credit and saving company. The remaining 61% have no any formal credit accuse for their agricultural inputs purchase. The result indicates that farm households using credit can fulfill the necessary farm inputs on time and adjust their planting date accordingly. Other studies (Gutu et al., 2012; Tazeze et, al, 2012; Temesgen et al, 2009) also reported similar results.

Table 6. Institutional factors of sample Household Heads

| **Type of Inputs (Factors for HHs productivity)** | **Response** | **Frequency** | **Percent** |
|---|---|---|---|
| Shortage of finance for agricultural input purchase of HHs | Yes | 88 | 70 |
| | No | 38 | 30 |
| | **Total** | **126** | **100** |
| Access to formal credit of HHs | Yes | 49 | 39 |
| | No | 77 | 61 |
| | **Total** | **126** | **100** |

**Source:** Own Field Survey, 2021

Table 7 depicts that the sample household heads Negative impacts of climate change on agricultural products and livestock. Out of the total sample household heads, 89%, 78%, 88.3%, 93.5%, 79.8% and 92.2% decline in crop, livestock, water quality, and animal fodder increase in livestock death, communicable disease respectively. On average, monthly and annual income gained from livestock products was 4,468 and 27,620 Eth. Birr respectively

Table-7 Climate change related impacts observed by Household respondents

| Climate change related impacts | Response | Frequency | Percent |
|---|---|---|---|
| Food insecurity | Yes | 274 | 89 |
| | No | 34 | 11 |
| | **Total** | **126** | **100** |
| Flood | Yes | 98 | 78 |
| | No | 28 | 22 |
| | **Total** | **126** | **100** |
| Risk of crop damage | Yes | 100 | 79.8 |
| | No | 26 | 20.2 |
| | **Total** | **126** | **100** |
| Decrease in water availability | Yes | 118 | 93.5 |
| | No | 8 | 6.5 |
| | **Total** | **126** | **100** |
| Drought | Yes | 116 | 92.2 |
| | No | 10 | 7.8 |
| | **Total** | **126** | **100** |

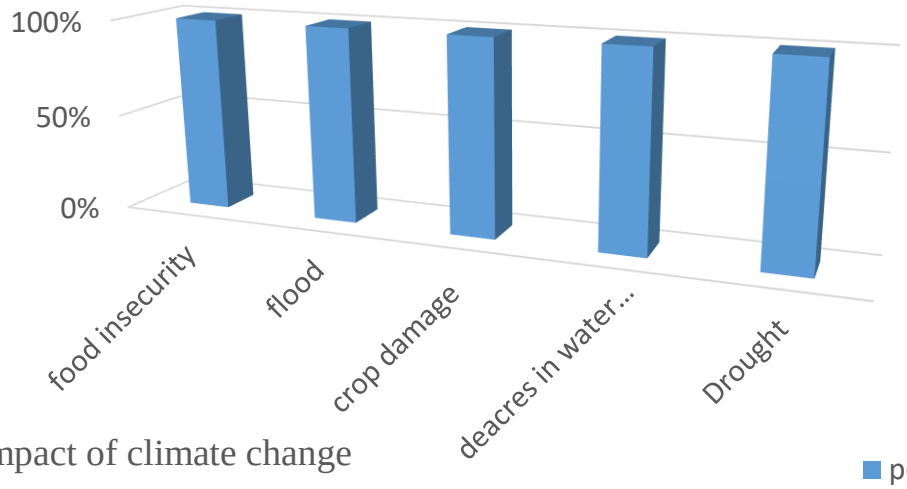



Fig- 4 Impact of climate change

### 4.1.2. Perceived Features of Climate Change and Variability by Respondents

Regarding rainfall pattern of the study area, most of the respondents (85%), perceived well that the current amount of rainfall is decreasing while the remaining (15%) reported as it is increasing significantly.

Table 8. Perceived Feature of Changes in Rainfall by Sample Household Heads

| **Options** | **Frequency** | **Percent** |
|---|---|---|
| It is decreasing in amount | 107 | 85 |
| It is increasing in amount | 19 | 15 |
| **Total** | **126** | **100** |
| | | |

**Source:** Own Field Survey, 2021

## 4.2. Economic Impacts of Climate Change and Variability

### 4.2.1. Impacts on Crops Production

As it is depicted in Table 10, a great majority of the sample household heads (89%) replied that they gained low amount of yields from crops in this year (2021) when compared to the past 10 years. The remaining (11%) said that the amount of the yields were medium. The reason, as they stated, was occurrence of severe drought which damaged almost all chat plants and partly sorghum.

Table 9. Comparison of Current Agricultural Yield with that of Past 10 Years

| **Options** | **Frequency** | **Percent** |
|---|---|---|
| Medium | 13 | 11 |
| Low | 113 | 89 |
| **Total** | **126** | **100** |

**Source:** Own Field Survey, 2021

An attempt was also made to compare the number of products in the past 10 years and the current year (2021). Accordingly, all respondents stated that relatively good productions were obtained from different types of crops in the past 10 years. But currently (2021) low amount of yields was harvested due to impact of local climate change and variability.

**Rainfall situation of the study area**

Table 10. Mean Monthly Rainfall Concentration of Chiro Woreda

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 14.24 | 23.23 | 58 | 126 | 104 | 57.6 | 112 | 142.3 | 126 | 46.2 | 26.04 | 20.64 |
| RC | 0.5 | 0.9 | 0.9 | 1.0 | 0.9 | 1.0 | 1 | 0.9 | 1 | 0.9 | 0.7 | 0.5 |
| Desg | Dry | Rainy | Rainy | BRM | Rainy | BRM | BGM | Rainy | BRM | Rainy | Rainy | Dry |

**Source:** NMSA, 2021

When the seasonal distribution of rainfall of Chiro woreda concerned, the summer season received about 38% followed by spring received 35% of the total rainfall while the rest autumn and winter season received 23 % and 4% respectively.

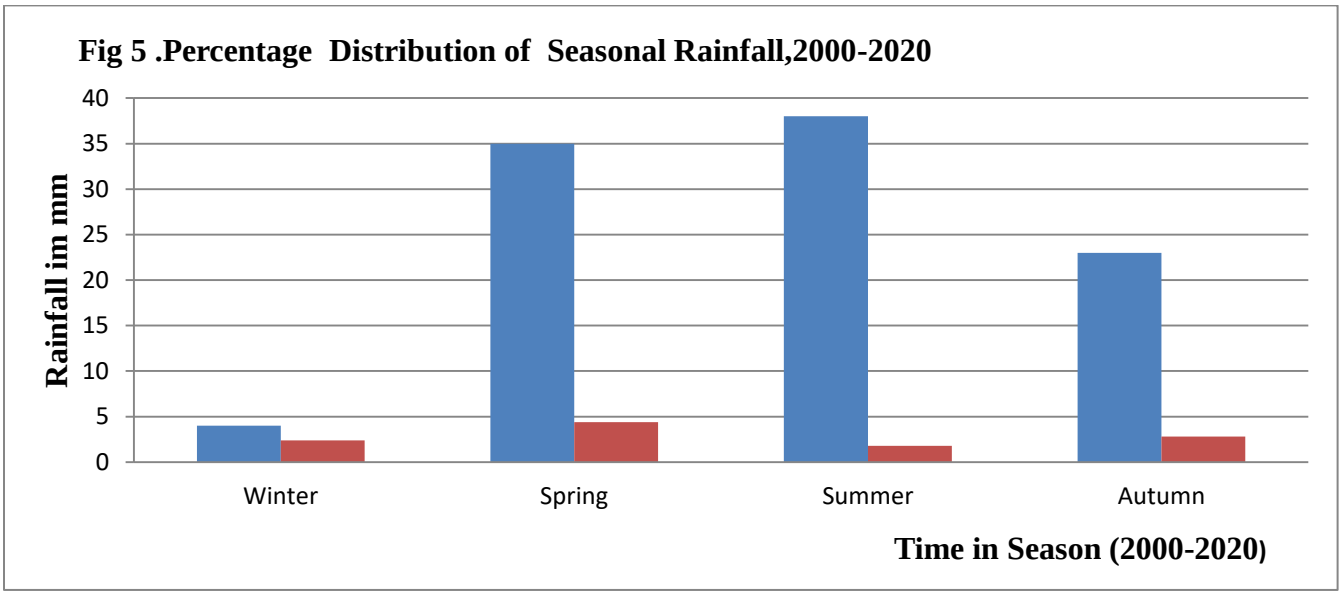



Figure 5. Percentage Distribution of Seasonal Rainfall of Chiro Woreda
**Source:** NMSA, 2021

Regarding rainfall variability, the average annual rainfall of Chiro woreda ranged between the 116.8mm (the lowest) and in 2012 to 1176.6mm in 2013 (the highest) with the difference of 895mm. There was great deviation of rainfall from decadal mean which ranged between 20.49mm (February) and 95.65mm (December). On other hand, based on Coefficient of Variation (CV), there was high variability of rainfall of months. According to COMES et al (2009), 58.3%, 25% and 8.8% of a year experienced high, medium and low rainfall variability respectively over the study period (2000-2020). This is further substantiated by observing the distribution of CV, which ranges from 0.4 (March and August) to 4.6 (December) and the yearly average was 1.2 (Figure 3).

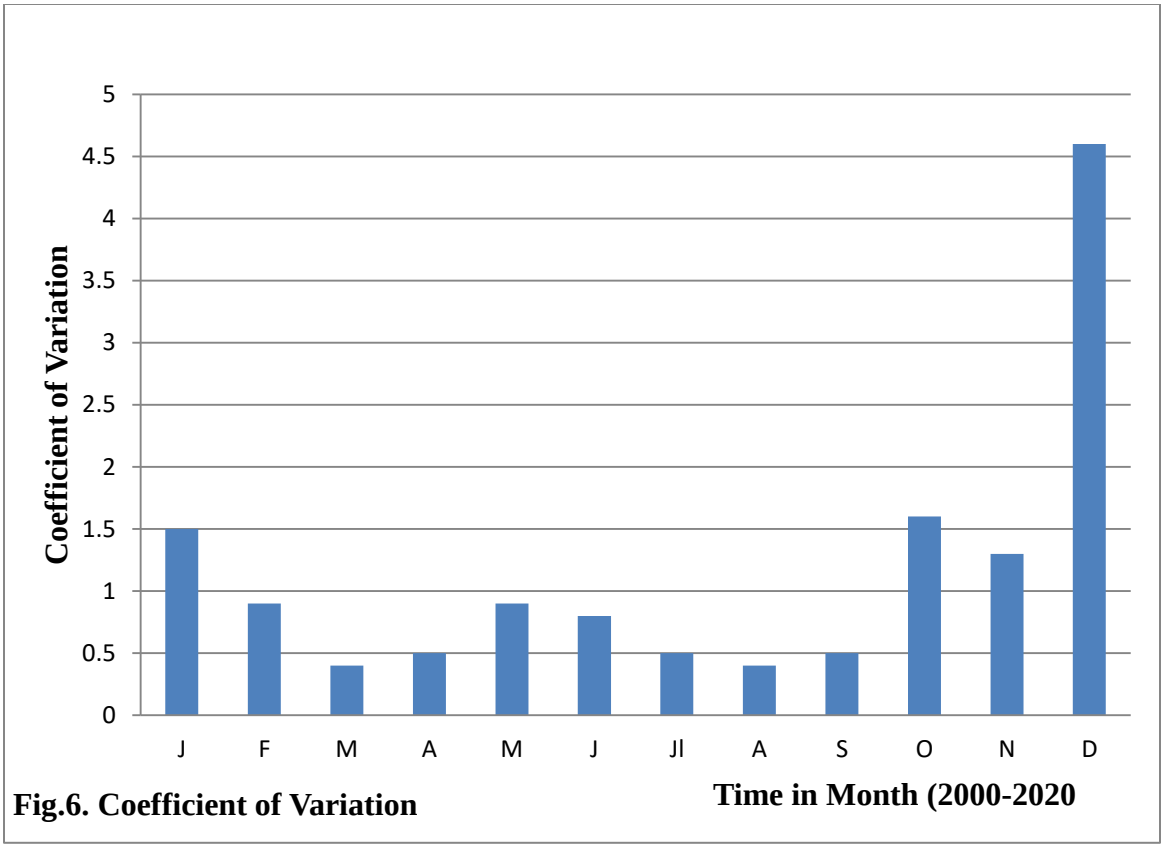



Figure 6. Monthly Coefficient of Variation of Rainfall of Chiro Woreda

**Source:** NMSA, 2021

## 4.3. Perceived Features of Climate Change and Variability by Respondents

### 4.3.1. Perception of Sample Household Heads on Extreme Events of CCV

As shown in Table 13 below, there was general consent among a great majority of sample household heads that about 88%, and 78% of them strongly agreed upon existence of drought and shortage of animal feed respectively while 95.3% and 80.7% of them agree upon occurrence of pest and disease, shrinking of lake water and pest and disease respectively. Additional information obtained from interviewees and participants of FGD also reveal that drought and shrinking of lack water were the two dominant weather events which occurred repeatedly in the study area.

Table 11. Perception of Sample Household Heads on Extreme Events of CCV

| S. N | Climatic Variable | Strongly Agree | | Agree | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Frequency | Percent |
| 1 | shrinking of lake water | - | - | 143 | 95.3 |
| 2 | Pest and disease | - | | 121 | 80.7 |
| 3 | Drought | 132 | 88 | - | - |
| 6 | Shortage of animal feed | 117 | 78 | - | - |

**Source:** Own Field Survey, 2021

### 4.3.3. Respondents' Awareness about Socio-Economic Impacts of CCV

The survey data in Table 14 below depicts that about 92% of the sample household heads reported that there was impact of climate change and variability around their living environment. In contrast, the remaining (8%) had no understanding of the change and its impacts. The result of this study goes with the finding of the World Bank (2010), i.e., Ethiopia is socio-economically vulnerable to climate change. Rapid population growth and expansion of agriculture in a potentially drier and certainly warmer climate could dramatically increase the number of people at risk. Just as the country is heterogeneous in topography and climate regime, it is also heterogeneous in social, cultural and economic factors. The degree of vulnerability of different localities and their livelihoods varies accordingly.

### 4.3.4. Economic Impacts of Climate Change and Variability

4.3.4.1. Impacts on Crops Production

As it is shown in table 15 below, a great majority of the sample household heads (90%) replied that they gained low amount of yields from crops in this year (2019/20) when compared to the past 10 years. The remaining (10%) said that the amount of the yields were medium. The reason, as they stated, was occurrence of drought which decreases in the productivity of chat plants and sorghum. Moreover, additional responses obtained from interviewees and FGD participants strengthen the analyzed results that current year was unique within 10 years in that the main livelihood of the households (chat and other crops) were destroyed by drought and made them vulnerable to aids.

Table 12. Comparison of Current Agricultural Yield with that of Past 10 Years

| **Options** | **Frequency** | **Percent** |
|---|---|---|
| Medium | 12 | 10 |
| Low | 114 | 90 |
| **Total** | **126** | **100** |

**Source:** Own Field Survey, 2021

An attempt was also made to compare the number of products in the past 10 years and the current year (2019/20). Accordingly, all respondents stated that relatively good productions were obtained from different types of crops in the past 10 years than before 10 years due to improvement of different agricultural infrastructures. But currently (2019/20) low amount of yields in all types of crops

Regarding earning, respondents were asked to compare their average income derived from crop products; as a result, they told that they had gained 12,395 and 19,710 Ethiopian birr in the past 10 years and current year respectively. This statistical data was supported by report of CWAO (2021).

Table13. Comparison on Crop Products between Past 10 Years and Current Year

| **S.N** | **Type of crop** | **Average amount in quintal** | | **F-independent test** | |
|---|---|---|---|---|---|
| | | **In the past 10 years** | **Current year (2019/20)** | **F-value** | **p-value** |
| 1 | Maize | 15 | 11 | 2.810 | 0.205** |
| 2 | Sorghum | 30 | 13 (decreased by 43%) | | |
| 3 | Chat | 52 kg | 17 kg (decreased by 67%) | | |

**Source:** CWAO and; Own Field Survey, 2021 NB** Insignificant at p>0.05

#### 4.2.3.2. Impacts on Livestock Husbandry

Regarding an average number and type of livestock reared by the sample households; field observation and record report of the Chiro woreda (CWAO, 2021) showed that the respondents reared a few numbers of livestock due to shortage of grazing land and Impact of drought.

According to responses of the respondents, an income obtained from livestock product was not free from impact of climate change particularly during dry seasons due to shortage of animal feeds.

### 4.2.4. Social Impacts of Climate Change

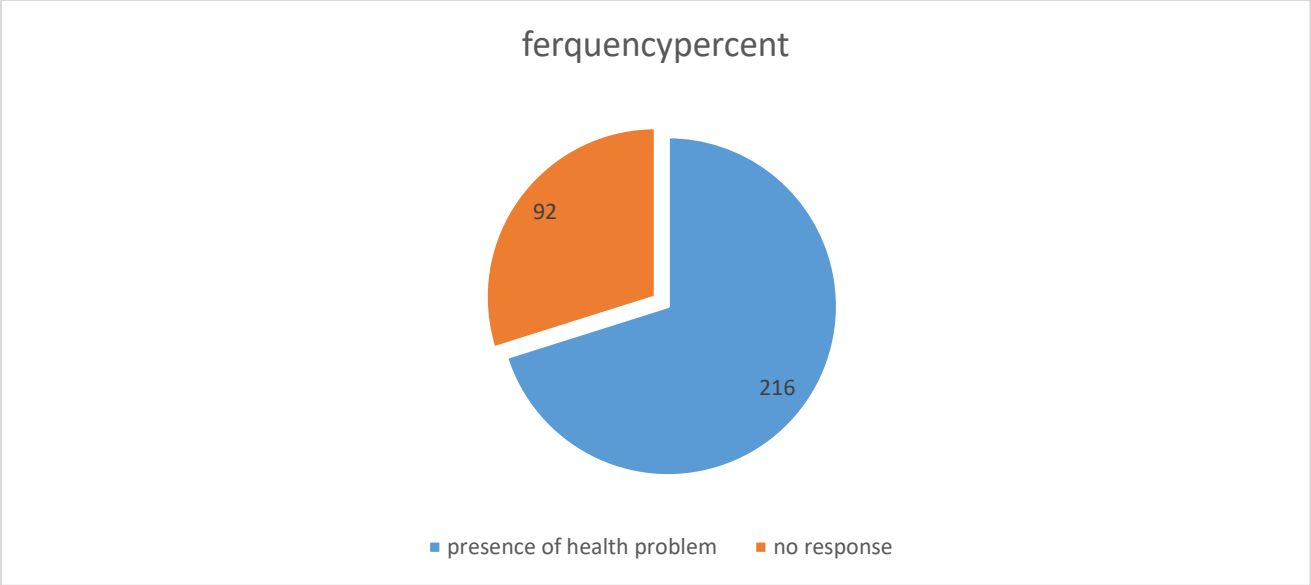
#### 4.2.4.1. Impacts on Human Health

As survey shows, out of the total, 70% of the sample respondents reported that climate change had significant impacts on their health through spearing of climate change related diseases. For instance, pneumonia and common cold were very common particularly during cooing of temperature and rainy times followed by diarrhea and asthma. Moreover, discussants said that climate change affected their health which range from bad feeling to death.

Table 14. Perception of Sample Household Heads on CCV induced Health Problems

| **Options** | **Frequency** | **Percent** |
|---|---|---|
| Presence of health problem | 88 | 70 |
| No response | 38 | 30 |
| **Total** | **126** | **100** |

**Source:** Own Field Survey, 2021




The current finding is consistence with other studies, for instance WHO (2015), stated that Ethiopia has a high incidence of climate-sensitive diseases. Roughly 70 percent of the population lives in malaria-endemic areas and outbreaks that occur every 5 to 8 years account for up to 20 percent of deaths for children under the age of 5. Increased temperatures will likely expand the range of malaria to highland areas and increased flooding which will facilitate the spread of waterborne diseases like diarrhea. More than 70,000 deaths annually are tied to indoor and outdoor air pollutants, which a hotter, more drought-prone climate will aggravate.

## 4.3. Adaptation Strategies Designed by Sample HHs

An assessment on adaptation and mitigation strategies designed by sample household heads indicates that the sample household heads have well developed experiences of applying different means of adapting and copying socio-economic impacts of climate change. Among the main strategies, about 78.2%, 63.6%, 57.8% and 49.3% were using Mixed farming, soil and water conservation, changing crop Varity, planting trees and growing short maturing crops respectively while considerable number of sample households used different methods as indicated in Table 18.

The above finding is similar with other studies, for instance, Thornton and Herrero (2014), stated that non-agriculture-based livelihoods are likely to play an increasingly important role in building resilience among agricultural populations due to climate change impacts. Diversification of farms with increased number of varieties, using mixed systems such as crop/livestock, off-farm, by getting a non-agricultural job is an important element of climate change adaptation. Farmers can adapt to

shorter and more variable growing seasons by choosing drought resistant or shorter maturing crops and varieties and adjusting planting dates (Niang et al., 2014).

Table15. Adaptation Strategies Designed by Sample Household Heads

| S.N | Adaptation Methods | Frequency | Percent |
|---|---|---|---|
| 1 | crop variety | 89 | 57.8 |
| 2 | Mixed farming (Improved crops and livestock's) | 120 | 81.2 |
| 3 | Soil and water conservation | 98 | 63.6 |
| 4 | No adaptation | 78 | 50.6 |
| 5 | Irrigation | 56 | 36.3 |

**Source:** Own Field Survey, 2021

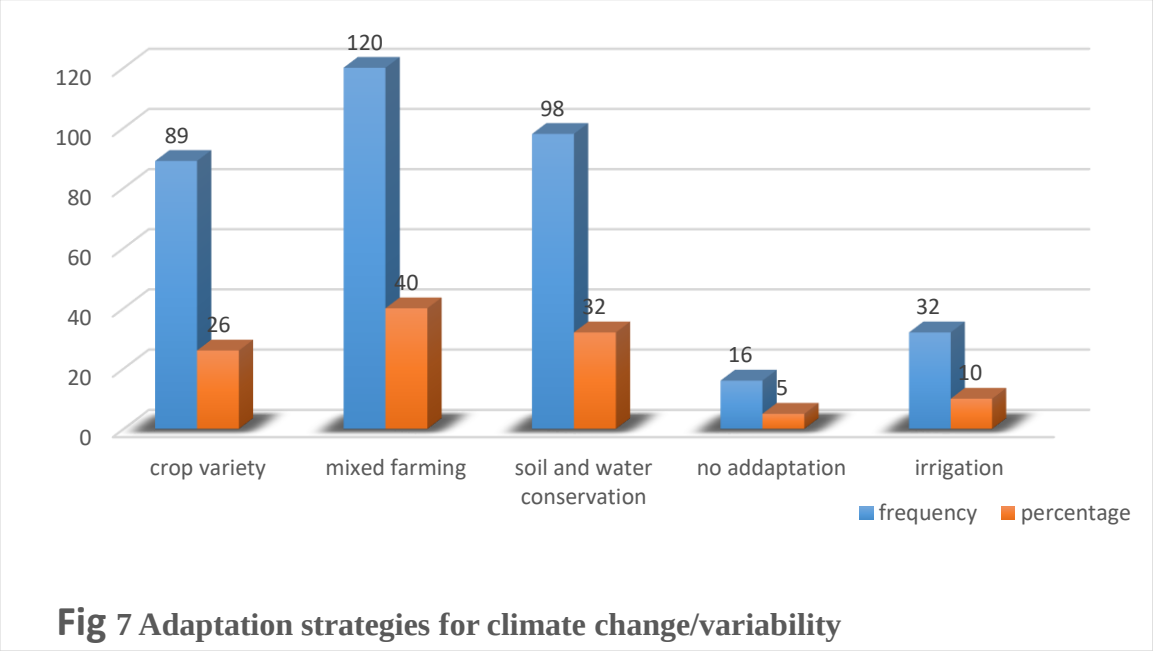



**Fig 7 Adaptation strategies for climate change/variability**

### 4.4. Determinants of Households' Choice of Adaptation Strategies to Climate Change /variability

Multi Nominal Logit (MNL) analysis was estimated to determine the factors influencing a households' choice of adaptation strategies to reduce adverse effect of climate change /variability. The estimation of the MNL, model was made by normalizing one category, which is normally referred to as the base category. In this analysis 'irrigation' was used as a base category.

The model tests assumptions of independence of irrelevant alternatives (IIA), specifically to analyze household's adaptation strategies to Climate variability in Chiro woreda. The parameter estimates of

the MNL, model provide only the direction of the effect of the independent variables on the dependent variable, they do not represent the actual magnitude of change of probability. The marginal effect of the MNL, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, were calculated.

# 5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter has two sections. The first section presents summary and conclusion of the study which briefly reflects the overall summary and conclusion of the finding and the last section forwards recommendation emanated from the finding of the study.

## 5.1. Summary

Climate change is causing the greatest environmental, social and economic threats to all of mankind and across borders in many nations. In view of this fact therefore, the main objective of this study was to assess socio-economic impacts of climate change and farmer's adaptation strategy of Chiro Woreda found in Western Hararghe zone, Oromia Regional State, Ethiopia.

The study relied Mixed Method research approach was used. Both qualitative and quantitative method of data collection and analysis used. The primary and secondary data were collected by using questionnaire, interview, Focus group discussion, field observation, reports and journals. The finding of the study showed that there was trend of increasing in average maximum and mean annual temperature in the last two decades.

Most of the sample household heads practiced mixed farming system. Particularly for crops and livestock they used rain and irrigation respectively. Chat is grown as cash crop and use as main source of family's income. On other way, the household heads rear a few numbers of livestock due to shortage of grazing land and experience of the community. From these agricultural activities, they gained relatively high amount of yields in past 5 years but the current year's products were low.

In study area, there was impact of climate change and variability in the form of drought and flooding which affected most of crops and vegetables products. For the impact, the most common adaptation and mitigation strategies designed and applied by the sample household heads include: using underground water, changing growing and harvesting time, growing short maturing crops and vegetables, diversifying agricultural production and particularly took aids from different stakeholders in this year (2013/21). Finally, conclusions and recommendations were made based on the findings of the study.

## 5.2. Conclusion

The sample household heads perceived that rainfall onsets late and ends up early. This trend caused extreme events mainly drought which had impacts on physical resources like fresh water and socio-economic activities of the surrounding communities.

As survey result and analysis on trend of climatic data shows; communities of study area have been facing impacts of climate change and variability since the last decade particularly recent five years; the impacts have become increased as there has been more climate change and variability induced events like drought as compared to the situations in the past two decades. Generally, the sample household heads in the study area were more facing repeatedly occurrence of drought which brought reduction in agricultural products and income of family.

The finding of the study reveals that climate change and variability had caused severe damage on crops and livestock productions and consequently reduced overall income of the households. In other way, the impacts were extended to human health including wide spread of malaria, pneumonia, common cold, diarrhea and asthma. Moreover, the changes in climate had negative effects on educational services like late coming and absenteeism of students in the surrounding schools and housing amenities of the sample household heads through income reduction.

Since climate change and variability has long lasting effects on socio-economic life, the sample household heads had designed adaptation strategies to the impacts and were implementing.

Among these strategies were: Mixed farming, soil and water conservation, pumping water from underground for irrigation, growing short maturing crops, mixed farming (diversifying agricultural production).

## 5.3. Recommendations

Depending on nature of the data, the finding obtained and the conclusion drawn from the study, the following recommendations are suggested adaptation methods to minimize the socio-economic impacts of climate change and variability on households around Chiro woreda of West Hararghe zone

- **Improve Agricultural Production:** The possible methods include diversifying crops, selecting appropriate variety of crops i.e. diseases resistant, early maturing and high yielding, improving the method of cultivation and agricultural technologies.

- **Build on existing people's knowledge and practices:** Reviving traditional practices and improving indigenous knowledge on how to harvest crop and diversify livelihood provide one way of coping with different climatic change. Interventions need to build on existing knowledge and adapting strategies in order to insure sustainability of their activities. Therefore, before planning interventions, a proper assessment of households available adaptations and mitigation strategies should be considered and build upon indigenous knowledge.
- **Empowering the households with information and education:** Creating and expanding awareness among the population and policy makers about climate change and variability, its impact on their livelihood, causes and consequences by providing reliable and up-to-date information to take appropriate adaptive measures.
- **Protect assets and diversify income sources:** Protect vital livestock, environmental resources like lake water in order to enhance households' adaptive capacity and resilience through awareness creation etc. Diversification of households' income sources is also necessary to minimize exposure to socio-economic impacts of climate change and variability. For this effect, the households should be encouraged to expand off-farm activities such as petty-trading and others.
- **Institutional capacity:** developing institutional capacity to generate and apply climate information at local level; that can easily be understood and utilized by target communities. Enhance the operational and technical capacity of national institutions to develop and disseminate regularly updated climate knowledge and adaptation plans.

- **Finally,** I would like to recommend similar studies to be conducted which adequately address the issue of climate change and variability, adaptation strategies by household farmers and better guide policy options for adaptation to climate change and variability.

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# APPENDEX I

## Survey Questionnaire

My name is Ketema Habtamu. I am writing a thesis entitled "Smallholder Farmers' Adaptation Practices to Climate Change in Chiro districts of west Hararghe Zone, Oromia Region, Ethiopia" in partial fulfillment for MA in Climate Change and Disaster Risk Management. The objective of this study is to identify and assess determinants farmer's perception and adaptation Practices to climate change. Confidently this research has a significant contribution in an effort to reduce the climate change relate problems of the farmers of this District especially. Therefore, your valid contribution by giving accurate information is highly valuable in achieving the objective of this research. The information we will collect from you will serve only the academic purpose and it will be kept confidential. Thus, please feel free to convey the required information honestly.

Thank you in advanced for your cooperation.

**General Direction**

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

**Part I. Supportive information**

Name of Interviewer---------- Code ----------

Date of Interview ----------/----------/--------

Time spent for interview: from-------- to ----------

Name of respondent---------- code ----------

Name of Kebele ----------

**Part II. Questions on Household Head Demographic Characteristics**

1. Gender of the household head: Male ☐ Female ☐
2. Age of the household head (in years).....
3. Marital status: a) Married: b) Single; c) divorced: d) widowed: e) Other (specify)_____
4. Educational level of household head
   A) Illiterate b) literate
5. The highest level of formal education completed , if the household head is literate ---------
6. Number of total family members: ……. male ……. Female……
7. Number of active household members aged between 15-64 years

   Male..... Female.....

8. Farm experience of household head----------

9. Dear respondent! The followings are indicators of good personal characteristics. Please tick as much as it explains your characteristics.

i. Sociability/good social interaction ☐

ii. Cooperative ☐

iii. Mediator in case there is disputes/disagreement within society ☐

iv. Positive thinkers/Open mindedness ☐

v. Other specify.....

**Part III. Questions on Household Head Socio-economic Characteristics**

10. Farming system you follow currently

i. Crop production only ☐

ii. Livestock rearing only ☐

iii. Mixed farming ☐ iv. Chat Production

11. How much income can you generate from your farming activities during last production year (i.e, Tir 1, 2012 E.C to Tahisas 30, 2013 E. C)? Please specify in Birr:

i. From crop production.....

ii. From selling livestock and livestock products.....

iii. Selling of fruits and vegetables.....

iv. Others (please specify).....

12. Do you/any members of your family has any sources of non-farm income i.e. income from Remittance, petty trade, employment in government or private enterprise, etc?

Yes ☐ No ☐

13. If yes to the above question, how much money you/your family make during last production year (i.e., Tir 1, 2012 E.C to Tahisas 30, 2013 E. C) from off-farm activity? Please specify in Birr: .....

14. How much is your total expenditure during last production year (i.e., Tir 1, 2012 E.C to Tahisas 30, 2013 E. C)? Please specify in Birr: .....

15. Total farm land operated including any grazing land (including rented land and excluding rented out land) during last production year_(in hectares)_____

Size of land rented in _____ Size of land rented out_____

16. Do you have certificate for your land? Yes ☐ No ☐

17. What are the physical characteristics of your farm, in terms of its exposure to erosion?

Susceptible to erosion ☐ moderately susceptible to erosion ☐

Not susceptible at all ☐

19. How long does it take to reach your farm from your home? In case you have more than one plots take its average distance and/or time. (Specify one way only):

Distance (in KM)..... In terms of time it takes (in min).....

20. How many quintals of yield have you harvested per hectare in 2013 E. C?

Maize..... Wheat.....

Sorghum.....

Bean/pea..... Others (specify if any).....

21. Do you have any communication devices like TV, radio, mobile phone, so on?

Yes ☐ No ☐

22. If your answer for question 21 is "Yes" what types of communication devices you have?

TV ☐ Mobile Phone ☐ Radio ☐ Others specify.....

23. Dear respondent! How many of the following types of livestock do you have? Please fill in the head count column.

| S..no | Types of livestock | Head count |
|---|---|---|
| 1 | Cow | |
| 2 | Oxen | |
| 3 | Hoarse | |
| 4 | Donkey | |
| 5 | Camels | |
| 6 | Goats | |
| 7 | Sheep | |
| 8 | poultry | |

**Part IV. Questions on Institutional Factors**

24 How far the market where you buy your agricultural inputs is (e.g. hoes, seeds, fertilizers, etc.)?

Distance in KM..... ……In terms of time it takes (in hour).....

25 How far is the market where you sell your agricultural outputs?

Distance in KM..... . In terms of time it takes (in hour).....

26. In undertaking your usual farming activities have ever faced shortage of finance? For example to purchase agricultural inputs like fertilizer, oxen, and others

Yes ☐ No ☐

27. Do you have access to any formal credits (DCSI) in time face shortage of money?

Yes ☐ No ☐

28. Do you have access to any informal credits (from neighbors, friends, relatives etc.)?

Yes ☐ No ☐

29. If yes to '26&27' where you look for credit to fill your financial constraints? More than one choice is possible. From:

Relatives ☐ Friends ☐ Non-formal money lenders ☐

Microfinance Institutes ☐

30. Do you have access to agricultural extension services in your kebele?

Yes ☐ No ☐

31.Do you receive any support from agricultural extension which could help improve your farming activities?

Yes ☐ No ☐

32. Please specify any kind services you get from them.

.....

……

33. Have you ever got any kind of formal training which helps improve your farm productivity? This might be how to (protect soil from erosion, conserve rain water, use modern agricultural inputs, reduce post-harvest loss, etc.)

Yes ☐ No ☐

34. Did you have non-formal training of the above kind from farmers or did you give training to other farmers in your locality? (Farmers-to-farmers extension services)

Yes ☐ No ☐

35. If yes to '32 & 33' how do find it in terms of its contribution to improve your farming income?

Very important ☐ Important ☐ Has no effect ☐

**Part V. Questions on Perception of Climate Change and Adaptation Methods Employed**

36. Comparing the 2009s with the recent past 5 years i.e. 2013s, have you perceive any

Changes in climate? Yes ☐ No ☐

37.Comparing the 2009s with the recent past 5 years i.e. 2013s, have you noticed any

Changes in the rainfall patterns? Yes ☐ No ☐

38. If yes, please specify the pattern of the change in rainfall you have noticed.

Increasing ☐ Decreasing ☐

39.Comparing the 2009s with the recent past 5 years i.e. 2013s, have you noticed any

Changes in temperature? Yes ☐ No ☐

40. If yes, please specify the pattern of the change in temperature you have noticed.

a) Increasing b) Decreased

41. Perceived feature of change in rain fall

a) Increasing in amount b) Increasing significantly c) Onsets on time ends up early

d) Onsets let but ends up early

42. Dear respondent please fill the following if you are experienced with it.

| No | Climate change and variability indicators | Response | |
|---|---|---|---|
| | | Yes | No |
| 1 | Drought | | |
| 2 | Flood | | |
| 3 | Off seasonal rainfall | | |
| 4 | Too much rain | | |
| 5 | Too little rain fall | | |
| 6 | Higher temperature | | |
| 7 | High winds | | |

43. Have you observed the following climate change related impacts in last decade?

| S.N | Climate change related impacts | Yes | No |
|---|---|---|---|
| 1 | Decline in crop yields | | |
| 2 | Increase in crop yields | | |
| 3 | Decline in livestock yields | | |
| 4 | Increase in livestock yields | | |

| | | | |
|---|---|---|---|
| 5 | Death of livestock because of shortage of fodder and water | | |
| 6 | Food insecurity | | |
| 7 | Decrease in water quality and quantity | | |
| 8 | Increase in communicable disease | | |
| 9 | Increase in weed and pest pressure | | |
| 10 | High risk in crop damage from drought | | |

44. Climate change Impact adaptation strategies in your farm in past decades?

| No | Climate change adaptation | Response | | If no, please specify the reason why not? |
|---|---|---|---|---|
| | | Yes | No | |
| 1 | Change in crop variety | | | |
| 2 | Mixed farming | | | |
| 3 | Temporary migration | | | |
| 4 | Planting early maturing crop | | | |
| 5 | Soil and water conservation | | | |
| 6 | Planting trees | | | |
| 7 | Irrigation | | | |
| 8 | Seeking off farm employment | | | |
| 9 | Reduce number of livestock | | | |
| 10 | Others ,if any | | | |

45. In the past two years do you received any agricultural technical support from the Government in implementing adaptation? Yes ☐ No ☐

46. If yes, what kind of technical support do you received in your effort to reduce the impacts climate change and improve your farming system? Please list

i. …….....

ii. .....

iii. ……

47. If no, what kind of support would you want to receive? Please list

i. …….....

ii. ……

47. Do you have Access to Climate Information?

Yes---------- No----------

| Option | Adaptation strategy |
|---|---|
| 1 | Using different Crop verities |
| 2 | Using improved crop seeds and livestock |
| 3 | Soil and water conservation |
| 4 | Irrigation |

If Yur answer for Question No 48 is No, please specify the reason……

……

48.. What do you suggest to be done to reduce the impacts of climate change in yours Kebele?

.....

.....

49.I have selected four climate change adaptation strategies. Thus, as stakeholders please select one adaptation strategies to climate changes which is the most comfortable for implementation in your farm.

Now using the above given adaptation strategies, please specify the best one adaptation Strategies from listed above. …….....

Thank you!