COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR FOOD SECURITY STUDIES

IMPACT OF CLIMATE VARIABILITY ON HOUSEHOLD FOOD SECURITY AND COPING STRATEGIES IN YAYA GULLELE DISTRICT OF OROMIA REGION, ETHIOPIA

BY

FEYISA CHALA EFFENE

MSC THESIS SUMMITED TO CENTER FOR FOOD SECURITY STUDIES

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Declaration

I declare that this thesis is my original work and has not been presented for a degree or certification in any other Universities, institutions and that all sources of material used for the thesis have been duly acknowledged.

Signed by:

Advisor Name: _____ Signature_____ Date _____

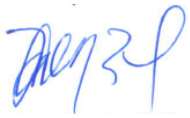
Student Name: _____ Signature_____Date _____

APPROVAL SHEET

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES

As thesis research advisor, we hereby certify that we have read and evaluate this thesis prepared under our guidance, by Feyisa Chala, entitled 'Impact of Climate Variability on Household Food Security and Coping Strategies in Yaya Gullele District of Oromia Region, Ethiopia'.

We recommend that it be accepted as fulfilling the M.Sc thesis requirements.



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Advisor Signature Date

As members of Board of Examiners of the M.Sc thesis open defense examination, we certify that we have read and evaluated the thesis prepared by Feyisa Chala, and examined the candidate. We recommended that the thesis be accepted as fulfilling the thesis requirement for the Degree of Master of Science in Food Security and Development.

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Chairperson: _____Signature _____Date _____

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Abbreviations

CC:	Climate Change
CRGE:	Climate Resilience Green Economy
CSA:	Central Statistical Agency
CSI:	Coping Strategic Index
DA:	Development Agent
DfID:	Department for International Development
DRM:	Disaster Risk Management
EPA:	Environmental Protection Agency
FDRE:	Federal Democratic Republic of Ethiopia
GHG:	Green House Gas
HFIAS:	Household Food Insecurity Access Scale
ILO:	International Labor Organization
IPCC:	Intergovernmental Panel on Climate Change
KII:	Key Informant Interview
NMA:	National Metrological Agency
NMSA:	National Meteorological Services Agency
OCSSCO:	Oromia Credit and Saving Share Company
RCM:	Regional Climate Model
S4T:	Saving For Transformation
UNFCCC:	United Nations Framework Convention on Climate Change
WVEYGAP:	World Vision Ethiopia Yaya Gullele Area Program
YGWFEDO:	Yayagulale Woreda Finance and Economic Development Office

Abstract

Ethiopia is one of the most vulnerable countries experiencing drought and floods as a result of climate variability and change. Climate change in the form of higher temperature, reduced rainfall, and increased rainfall variability reduce crop yield and threaten food security in low income and agriculture-based economies. This study investigates impact of climate variability on household food security and coping strategies in the case of Yaya Gulele District of Oromia region. Multi-staged sampling techniques were used to select the targeted area and sample household respondents. A total of 232 sampled households were selected using simple random sampling method and household survey was conduct with structured questionnaire. Key Informant Interviews and Focus Group Discussions were also conducted to complement the quantitative study. The study used both qualitative and quantitative approach and used both primary and secondary data collection methods. Various descriptive and inferential statistic techniques were applied to analyze the collected survey data. Household Food Insecurity Access Scale (HFIAS) and ordered logistic regression model were used to analyze the determinant factors which affect food security of sampled household. The result of ordered logit revealed that sex of household head, family size and distance of household from the market, education level, irrigation, market linkage, agricultural extension contact and access to saving and credit contributed significantly associated with household food security status. The result of HFIAS show that 20.26% of households were categorized as food secure, 36.21% as mildly food insecure and 30.60% as moderately food insecure and 12.93% as severely food insecure in the study area. From the result, it is possible to conclude that male headed household, having more family members and close distance to the market are more significantly affect the impact climate variability result on food security. Policy measures derived from the result include: Facilitate access to saving and credit, irrigation access, contact with of agricultural extension and create a market linkage particularly for food insecured household groups the study areas.

Keywords: *Climate change and variability, adaptation response, food security, ordered logit, HFIAS, Yaya Gulelle*

CHAPTER ONE: INTRODUCTION

1.1 Background

Climate change is predicted to have major adverse consequences for the world ecosystems and societies. Although a global phenomenon, the severity of the adverse effects of climate change is differ significantly across regions, countries and socioeconomic groups. Many believe agriculture is the most susceptible sector to climate change. This is attributed to the fact that climate change affects the two most important direct agricultural production inputs, precipitation and temperature (Deschenes & Greenstone 2007). Climate change also indirectly affects agriculture by influencing emergence and distribution of crop pests and livestock diseases, exacerbating the frequency and distribution of adverse weather conditions, reducing water supplies and irrigation; and enhancing severity of soil erosion (Watson et al. 1998; IPCC 2001). The result of climate change and variability affect everbody. Poor countries suffer more, with the poorest in the poor countries likely to suffer most. Africa is highly vulnerable to the potential impacts of climate change and Ethiopia is often cited as one of the most vulnerable and with the least capacity to respond and adapt (Thornton et al. 2006).

Analysis of historical climate data show an increase in mean annual temperature by 1.3°C between 1960 and 2006, translating into an average rate of 0.28°C per decade. The annual minimum temperature increased by about 0.37°C every decade between 1951 and 2006 (McSweeney et al. 2010). Projecting into the future, most global climate models indicate some increase in rainfall in both dry and wet seasons in Ethiopia (NMA, 2006). Studies with more detailed Regional Climate Models (RCM), however, indicate that the sign of expected rainfall change is uncertain over Ethiopia and East African highlands, and the consensus is that rainfall variability is likely to increase. Regarding temperature, IPCC‘s mid-range emission scenario results show that compared to the 1961-1990 average mean annual temperature across Ethiopia will increase by between 0.9 to 1.1°C by the year 2030, and from 1.7 to 2.1°C by the year 2050. The temperature across the country could rise by between 0.5 and 3.6°C by 2080 (NMA, 2006). The increasing temperature combined with rainfall variability will have serious consequences on ecosystems, economic sectors and communities of Ethiopia.Ethiopia National Meteorological Agency (NMA) identifies drought and flood as the major hazards in the future as well, with potential negative impacts on agriculture and food security (FDRE, 2011).

Agriculture is the mainstay of Ethiopian economy, which contributes for about 46.3% of Ethiopian GDP (Gross Domestic Product), generates more than 83.9% of the foreign exchange, and employs about 80% of the population (CSA, 2016). Agricultural production in Ethiopia is dominated by small-scale subsistence farmers, and is mainly rain-fed, thus highly exposed to climate variability and extremes. Current rainfall variability already costs the Ethiopian economy 38% of its growth potential (World Bank, 2006). Climate change is likely to worsen this already distressing situation. The major predicted impacts of climate change on Ethiopia‘s agriculture include frequent droughts and dry spells, shortened growing season, and increased incidence of pests and diseases (NMA, 2007). Without effective adaptation, there is likely to be a decrease in the total area suitable for crop production in the country. A study based on the Ricardian method predicts that a unit increase in temperature could result in reduction of the net revenue per hectare by US$177.62 in summer and US$464.71 in winter seasons (Deressa, 2007).

Climate variability is not a recent situation to Ethiopia because of the numerous and frequent droughts occurrences over the years: 1889–1892, 1972–1974, 1984– 1985, 2002–2003 and 2015–16, 2017-2018 which are due to the climate variability (Shishay. K & Dawit. G, 2018). Climate variability increases the risks of hunger in the region as it affects all four components of food security: food availability, food accessibility, food utilization and food stability. Rainfall shortage or excess hampers food production, causing food insecurity and escalation of famine in the region. Bad weather also affects people indirectly through the sequential rather than direct depletion of their assets. When drought occurs, the people cannot produce enough food to meet their needs, whereas livestock suffer from the shortage of pasture. Rural farmers, therefore, revert to coping strategies, such as livestock sale to generate income and purchase food. Livestock serves as a buffer in times of hardship, with farmers disinvesting.

It is recognized that Ethiopia is particularly vulnerable to the adverse impacts of climate change. This vulnerability has spurred much policy debate in recent years and Ethiopia is one of the few countries to have formally merged its aims of developing a green economy with building greater resilience to climate change under a single policy framework: the 2011 CRGE strategy. Before these different strategic plans for a climate-resilient green economy were launched, Ethiopia was implementing important climate compatible initiatives, particularly in terms of natural resource management and renewable energy (Zewdu *et al.,* 2014).

Considering the climate change strategies of the country, the main purpose of this study was to assess impact of climate variability on household food security and coping strategies for the study area.

1.2. Statements of the problem

Ethiopia agricultural sector is dominated by small scale farmers who are relay on low input and low production rainfed and mixed farming with traditional technologies. Government of Ethiopia has given top priority to the sector and has taken steps to enlarge productivity. However, various obstacles are grasp back the main causes of inadequate production or less than expected production due to disaster like drought, which frequently causes famine, and floods. As a result, it follows climate connected disasters makes the nation dependent on food aid. The tendency of the contribution of agriculture to total GDP of the country understandably describes the connection between the impact of climate change on agriculture and economy. After the 1991, the federal and regional government launched different types of interventions or adaptation measures to rehabilitate the degraded land and to increase agricultural productivity to enhance food secured. These involvements too happen on ground through voluntary community mobilization and productive safety net program intervention at community level and at individual farmers. After implementation of these program different studies shown that there is gradual change most of the changes are slow from the expected outcome.

About 95% annual gross total agricultural output of the country come from smallholder agriculture and only 5% commercial farms contribute to gross total agricultural output (FAO, 2016). Climate change impact differs with different land formation and the intervention also differ because it dependent on the agroe-cological and land formation of the area to bring sustainable solution for climate change impact and effect on food security local adaption mechanizes are need for proper implementation locally and current studies are needed due to variability of climate change events still excising problem. Therefore, the purpose of the study is to assess farmers' perception, adaptation strategies, and analyze determinant factors that affect smallholder farmer's choices of adaptation strategies and analyze contribution to food security in the study Woreda. Even though researches are done on climate change and variability in the country and the region, people who live in varies parts of the country/ region could not use similar adaptation strategies and face similar situation. Climate change and variability adaptation options can be very in time and places.

Because climate change adaptation is local base and control by the local environmental factors. Despite sustained economic growth and increased domestic cereal production, there has yet to be realized any substantial decrease in the size of the needy population.

Rather climatic shocks render already vulnerable population susceptible to livelihood crises that force millions of people to turn to the government for emergency assistance and safety net benefit each year to augment their own productive and coping strategies (NCCF, 2009). The country is extremely vulnerable to the least change in climate. If the rain is late, does not arrive or irregular, it immediately result in an increase in the number of people who need help because they are already living on the margins of life (Bethel, 2018).

Ethiopia is vulnerable to the impacts of climate change mainly due to poor adaptive capacity of communities and high diversity of agro ecologies, production systems and livelihood strategies (Belay et al. 2017). Ethiopia's climate is naturally both highly diverse and extremely variable, and because of this, the nature of climate of the country dramatically changing in recent years (Mokria et al. 2015). Accordingly, the phenomenon leads to experiencing the impacts of both climate variability and change as droughts and famines, flooding, expansion of desertification, loss of wetlands, loss of biodiversity, decline in agricultural production and productivity, scarcity of water, and increased incidence of pests and diseases (Craparo et al. 2015).

The North Shewa climate change and variability situation indicates higher level of rainfall variability over the last couple of decades. As the data from the National Metrological Agency (NMA) shows the yearly average rainfall deceases over time clearly depicts that between the years 1980 to 1986 the average precipitation for Belg and Mehere seasons were 107.34 milliliter and 1085.64 milliliter, respectively; while after thirty years between the years 2007 and 2011, the average rainfall decreased to 83.03 milliliter and 747.33 milliliter for Belg and Meher seasons, respectively (Gutu, et al., 2012).

Yaya Gulele woreda is frequently hit by natural hazards that greatly affect crop and animal production and productivity. Most people in Yayagulale are small-scale farmers, mainly growing staple crops such as tef (a highly valued Ethiopian staple), barley, wheat and beans. Communities in Yayagulale are seasonality-based food insecure and a marginal area that produces just enough for survival in a good year (WVEYGAP, 2018).

Food insecurity in Woreda has been increasing over recent decades, because of a complex array of factors such as land degradation, land slide, floods, deforestation and more unpredictable. Since it is among climate hot spot areas of the country, due attention should be given in thoroughly detecting trends of climatic variables with the background that the problem of one community is not very similar with others.Understanding the nature of climate change impacts, coping strategies and indigenous adaptive responses at local levels, and the national institutional responses are important for developing appropriate adaptation strategies at community and farm levels. Nevertheless, there is limited research evidence as to whether climate change is perceived as a major problem or even a reality by the Ethiopian communities, particularly by the poor and most vulnerable farmers in the rural areas. Hence, considering this knowledge gap, the research study on impact of climate variability on food security, the adaptive response and coping mechanism the local smallholder is important.

To fill this gap, this research were carried out with a focus on understanding the perceptions of people, assessing climate change adaptation strategies and identifying determinate factors, contribution on food security status of the people in Yaya Gullele Woreda.

1.3 Objectives of the study

General objectives of the study are to examine impact of climate variability and adaptation responses and coping strategies to household food security

Specific objective of the study is to**:**

- Assess household perception on extreme weather, temperature and rainfall situation.
- Identify household's adaptation responses and coping strategies to climate variability
- Analyze the role of and access to saving and credit to cope up from impacts of climate shocks
- Analyze the household food security status of study area

1.4 Significances of the study

This study enabled us to assess farmers' perceptions and climate variabilities of rainfall and temperature in the study area, the coping strategies and adaptation the smallholder are experiencing. Although this is a small-scale study, the findings from this study can complement and act as a reference point for other similar studies to be conducted in other parts of the country or the world.

This study also provides empirical data to support the perceived assertion of climate change and farmers' responses so it serves as a contribution of new knowledge about the world, at least from the perspective of the participants in this study.

1.5 Scope of the study

The scope of the study can be described in terms of methods, area of study, thematic and time dimensions. The study focused only on climate variability analysis based on the perception of farmers in the past 20 years.

1.6 Limitataion of the study

The woreda have 17 rural kebele and 2 rural town. This study focused on three rural kebeles one each from lowland, midland and highland agro-ecological zones to easily understood the climate variability of all agro-ecology of the Woreda. Due to time and financial constraints, the study was restricted to 232 samples of households in terms of size and the data collected was also restricted only within the 3 sampled kebeles.

1.7 Organization of the paper

This research thesis contains five chapters. The first chapter introduces the background, the statement of the problem, objectives, the research questions and significance and limitations of the study. The second chapter covers review of related literature that is related to the subject matter. The third chapter is about methodology, which consists of description of study area, research design, sampling techniques and procedure, data collection and analysis methods. Result and discussion parts of the study are found in chapter four including policy elements or activates that enhance food security, how small scale farmers adapting climate variability and coping the strategies in study area. Chapter five concludes the work and suggests recommendations.

1.8 Ethical considerations

The respondents for this research were not subjected to any risk that could harm them physically or mentally. Though it was the time Covid-19 epidemics, it was done with precautions. Clearance to undertake the research in the study area was taken from the relevant authorities, Addis Ababa University. The rights of respondents as participants were emphasized and observed throughout the study. The decision to participate in the study was voluntary. The respondents had the right to decide not to participate, or to stop taking part at any time without providing a reason for doing so, without any undue effects. In this study, none of the respondents refused to participate.

Individual informed consent to participate in the study was sought before each interview. This process involved the enumerators outlining the objectives and purpose of the research. The respondents were also assured that the data would be properly handled to ensure their safety and the confidentiality of respondents. They were assured that the data would only be accessed by the researcher and would be solely used for research purposes.

CHAPTER TWO: LITERATURE REVIEW

2.1 Concepts and definition

Climate variability refers to variations in the mean state and other climate statistics (standard deviations, the occurrence of extremes, etc) on all temporal and spatial scales beyond those of individual weather events (Keller et al., 2007). Variability may result from natural internal processes within the climate system (internal variability) or from variations in natural or anthropogenic external forces (external variability) (IPCC 2007).

Extreme event - the occurrence of a value of a weather variable above (or below) a threshold value near the upper (or lower) ends of the range of its observed values in specific region. Every year, disasters related to weather, climate and water hazards cause significant loss of life and set back economic and social development by years, if not decades. From 1970 to 2012; 8,835 disasters, 1.94 million deaths and US$ 2.4 trillion of economic losses were reported globally as a result of droughts, floods, windstorms, tropical cyclones, storm surges, extreme temperatures, landslides and wildfires, or by health epidemics and insect infestations directly linked to meteorological and hydrological conditions (WMO, 2014).

Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit advantageous opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC, 2001).

2.2 Overview of climate change

Over the last century (between 1906 and 2005), the average global temperature rose by about 0.7◦ c this has occurred in two phases, from 1910s to 1940s and more strongly from the 1970s to the present and causing severe problem over the world, widely accepted that climate variability is already happening and further to be anticipated (IPCC, 2007). Many studies into the detection and attribution of climate variability have found that most of the increase in average global surface temperature over the last 50 years is attributable to human activities (IPCC, 2001). It is estimated that, for the 20th century, the total global mean sea level has risen 12-22 cm, this rise has been caused by the melting of snow cover and mountain glaciers (both of which have decline on average in both hemispheres). The IPCC also notes that observations over the past century shows,

changes are occurring in the amount, intensity, frequency and types of precipitation globally (IPCC, 2007).

2.3 Theoretical review

The Intergovernmental Panel on Climate Change (IPCC, 2007) defined climate change as statistically significant variations in climate that persisted for an extended period, typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. The effects of climate variability such as rising temperature and changes in precipitation are undeniably clear with impacts already affecting ecosystems, biodiversity and people. These conditions determine the carrying capacity of the biosphere (IPCC, 2001). One of the most widespread anthropogenic challenges affecting agricultural production is climate change and climate variability (Torquebiau, 2016). Changes in mean temperature and precipitation are the main direct effect of climate change. Precipitation is particularly important, because changes in precipitation pattern may lead to floods or drought (Boko et al., 2007). Climate change with expected long-term changes in rainfall patterns and shifting temperature zones are expected to have significant negative effects on agriculture, food and water security and economic growth in Africa; and increased frequency and intensity of droughts and floods is expected to negatively affect agricultural production and food security (DfID, 2004). While many populations suffer from outcomes, climate change poses the most significant threat to vulnerable populations. Individuals living in low or middle-income countries are more likely to be affected, due to historical low levels of food supply, poor access to improved sanitation and potable water, inadequate countrywide efforts to mitigate and adapt, and large populations living on coastal regions. People living in low and middle-income countries are also more affected by climate change outcomes because of fragile health infrastructure and the poor ability of government policymakers to respond and adapt to changes in resulting health and disease patterns (Skolnik, 2016) (Tabari and Talaee, 2011) have noted that trend analysis of climatic variables has received a great deal of consideration from scholars recently. Characterization of the intra-and inter-annual spatio-temporal trend of meteorological variables in the context of a changing climate is vital to assess climate-induced changes and suggest feasible adaptation strategies and agricultural practices.

Considering the history of recurrent drought and rainfall variability in Ethiopia, for instance, conducting long term trend and variability studies with robust methods to obtain important

information on what has been changing in the past few decades has a vital contribution (Daniel, Woldeamlak and Lal, 2014). As a result, accurate estimation of the spatio-temporal distribution of rainfall; and observing its trends are crucial input parameters for securing sustainable agricultural production (Dereje et al., 2012).

Climate change mitigation and adaptation issues have become subject of intense global discussions in the past few decades. Mitigation entails all anthropogenic interventions or policies aimed towards reducing greenhouse gas (GHG) emissions or enhancing the sinks for GHGs (Chambwera and Stage, 2010; IPCC, 2001). Adaptation and mitigation measures are interlinked. According to Bruce et al. (1995), the more one succeeds in limiting climate change, the easier it will be to adapt to it. Mitigation options are options, that amongst others, strive to prevent climate change, or combat any reinforcement thereof, by reducing the net emissions of any greenhouse gases in atmosphere, either by reducing greenhouse gas emissions(source oriented measures) or by increasing the sinks for greenhouse gases (sink enhancement measures). Mitigation is regarded as a crucial long-term solution to addressing ongoing climate change and minimizing its negative impacts in the future. Adaptation, on the other hand, refers to all adjustments or moderation in natural or human systems in response to actual or expected climate change as well as taking advantage of new/arising opportunities (Adger et al., 2003; IPCC, 2001).

2.3.1 Impact of climate change and variability

Climate change is a change of climate which is attributed directly or indirectly to human activity. It alters the composition of the global and/or regional atmosphere and natural climate variability observed over comparable time periods. Climatic variability are the types of changes (temperature, rainfall, occurrence of extremes); magnitude and rate of the climate change that causes the impacts on the area of public health, agriculture, food security, forest, hydrology and water resources, coastal area, biodiversity, human settlement, energy, industry, and financial services. Changes in physical and socio-economic system have been identified in many regions (UNFCCC, 2007). According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), the global average surface temperature is likely to rise by 1.8 degrees to 4.0 degrees Celsius by 2100. The sea level may rise by 30 to 60 centimeters. Climate variability will increase almost everywhere. Northern latitudes will experience more rainfall; many subtropical regions will see less (IPCC, 2001). Detecting these changes and associating them with climate change poses

huge problems since these systems are usually subject to many stress factors other than climate change.

Vulnerability is the degree to which a system (such as a social-ecological system) is likely to be wounded or experience harm or stress in the natural or social environment. Vulnerability results from a combination of processes that shape the degrees of exposure to a hazard, sensitivity to its stress and impacts, and resilience in the face of those effects. It is also considered a characteristic of all people, ecosystems, and regions confronting environmental or socioeconomic stresses and, although the level of vulnerability varies widely, it is generally higher among poorer people (Kasperson et al., 2001). Baseline climate that was developed using historical data of temperature and precipitation from 1971-2000 for selected stations in Ethiopia showed the year-to-year variation of rainfall for the period between 1951 to 2005 over the country expressed in terms of normalized rainfall anomaly averaged for 42 stations (NMA, 2007). The country during those periods (1951 to 2005) has experienced both dry and wet years over the last 54 years. These changes in the physical environment are expected to have an adverse effect on agricultural production, including staple crops such as wheat and maize. Trend analysis of annual rainfall in Ethiopia shows that rainfall remained more or less constant when averaged over the whole country while a declining trend has been observed over the Northern and Southwestern Ethiopia (IPCC, 2007).

2.3.2 Farmers' perceptions about climate change

Perception has been defined as the process by which organisms interpret and organize sensation to produce a meaningful experience of the world (Lindsay and Norman, 1972)and that a person's perceptions are based on experiences with natural and other environmental factors that vary in the extent to which such perceptions are enabled (Hartig, Kaiser and Bowler, 2001). People experience changes in local weather patterns. These may not necessarily reflect long-term local and global trends in the climate. Nevertheless, drawing from behavioral research, many have argued that the perception of changes in the weather can play an important role in adaptation and in supporting climate policy (Howe et al., 2013; Clayton et al., 2015).

Farmers' perceptions about climate are based primarily on their sense of the reliability or variability of weather patterns— especially rainfall, temperature, and drought—in their own regions and this perception is an important determinant for adaptation decision (Piya, Maharjan and Joshi, 2013; Osbahr et al., 2011; Patt and Schro¨ter, 2008). However; as disclosed by (Amogne

et al. 2018), focusing on annual or seasonal trend alone might mislead and should be supported by variability analysis and perception of the farmers. Moreover, incorporating the experiences of farmers in trend analysis discourse which could offer important insights on the nature of meteorological processes that could not capture by the analysis of recorded data alone is very important. So farmers' perceptions of climate change governance and adaptation is pivotal for future plans aiming to deal with challenges arising as a result of CC.

Farmers who perceive potential consequences from climate change are more likely to support policies and programs that aim to address it (Niles, Lubell and Haden, 2013; Arbuckle *et al.*, 2013). However, in many parts of the world CC awareness, mitigation and adaptation mechanisms are marginally known. The spatial behavior and behavioral responses of individuals and communities are often shaped around their perceptions of problems (Getis, Getis and Fellman, 2000; Nzeadibe and Ajaero, 2010) and this urges scholars to investigate the problem of CC in the context of socioeconomic settings.

As evidenced from (Speranza, Kiteme and Opondo, (2009)) awareness and perceptions of a problem shape motivation to act or not to act on the problem related to CC. This is important because a person's response to change can be strongly influenced by their knowledge and perception (Ferguson and Bargh, 2004). It is noted that perceptions of risks by rural communities are also important in configuring the climate risk as it can shape the variety of adaptive actions taken.

As researchers also disclosed that farmers' perceptions on climate change plays a key role for appropriate adaptation and mitigation strategies related to land use and agricultural practices decision making (Adger et al., 2003; Kemausuor et al., 2011). For rural households, perceptions of local climate change help them to make decisions to change their daily practices in order to adapt to climate change risks (Ndaki, 2014)

According to (Wolf and Moser, 2011) understanding and conceptualization of climate change risks by people is greatly influenced by how they perceive other issues and relate those to climate change. (Mertz, Mbow, Reenberg and Diouf ,2009) In their research analyzed farmers' perceptions of climate change and adaptations in the savanna zone of Senegal and showed us that knowing communities' perceptions has become a prerequisite and elemental task in climate change and disaster management. Climate change perception researchers concluded that perception decides over resource allocation. Without perceiving the risk adequately, all other determinants seem to be

meaningless (Falaki, Akangbe and Ayind, 2013). Therefore, assessing households' perception of climate change could be a pre-condition for adaptation. Hence, it is important to understand the level of people's perception, its correctness, and how perception of CC motivates farmers to decide on adaptation.

2.3.3 Climate change adaptation strategies

According to (Falaki, Akangbe and Ayind, 2013) climate change effects are both complex and highly uncertain. So, adaptation strategies are to be efforts by society or ecosystems to prepare for adjusting future climate change either by proactive to minimize negative impacts of climate change or opportunistic to inspire and initiate new development practices. Although (US EPA, 2007) studies shows that people have faced and adapted to climatic changes, since its species evolved the climate change predicted for the century is far greater and faster than anything previously known in human history and prehistory. (Deressa & Hassan, 2009), due to the increasingly interdependent world, negative effects of climate change can have repercussions in every social sector and ecosystem.

In order to implement the appropriate intervention to adapt to the impacts of climate change, governments and agencies need to understand the main factors of smallholders' choices of strategy and major barriers of selected adaptation strategy (Ringler, Alemu, & Yusuf, 2009) Smallholder producers could either change their agricultural practice by altering planting dates or other methods to increase their crops resiliency or explore other income streams to increase their livelihood resiliency to climate change (Komba &Muchapondwa, 2015 & Lin, 2011). In order for smallholder producers to adapt to uncertain future climate change impacts, it is important to ensure that all aspects of their livelihood strategies are resilient to changing and unpredictable conditions via adaptation strategies. It is important to note that adaptation alone may have limitations in the face of climate change, and further mitigation strategies may be necessary to fight with climate change effect (Solomon et al. 2007). Ongoing efforts are required from governments and communities to sufficiently not only adapt to all the projected impacts of climate change, but also to mitigate its causal factors (e.g., greenhouse gas emissions) assess climate-induced changes and suggest feasible adaptation strategies and agricultural practices.

2.3.4 Climate variability and food security

Agriculture is important for food security in two ways: it produces the food people eat; and (perhaps even more important) it provides the primary source of livelihood for 36 percent of the world's total workforce. In the heavily populated countries of Asia and the Pacific, this share ranges from 40 to 50 percent, and in sub-Saharan Africa, two-thirds of the working population still make their living from agriculture (ILO, 2007). If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased.

Agriculture, forestry and fisheries are all sensitive to climate. Their production processes are therefore likely to be affected by climate change. In general, impacts are expected to be positive in temperate regions and negative in tropical ones, but there is still uncertainly about how projected changes will play out at the local level, and potential impacts may be altered by the adoption of risk management measures and adaptation strategies that strengthen preparedness and resilience.

The food security implications of changes in agricultural production patterns and performance are of two kinds: Impacts on the production of food will affect food supply at the global and local levels. Globally, higher yields in temperate regions could offset lower yields in tropical regions. However, in many low-income countries with limited financial capacity to trade and high dependence on their own production to cover food requirements, it may not be possible to offset declines in local supply without increasing reliance on food aid. Impacts on all forms of agricultural production will affect livelihoods and access to food. Producer groups that are less able to deal with climate change, such as the rural poor in developing countries, risk having their safety and welfare compromised.

2.4 Empirical literature review

It has been said that awareness or knowledge about climate change is a pre-condition for mitigating or adapting to its adverse effects (Maddison, 2006; Juana, Kahaka and Okurut, 2013).

As evidenced that farmers in South Africa have perceived increase in temperature and indicated that summer temperatures were warmer while winter temperatures were colder (Gandure, Walker and Botha, 2012). The same study also pointed out that warmer temperatures in the area are

associated with high evaporation and increased crop water requirements. The farmers also reported that there has been a perceived decrease in rainfall or precipitation. Reported that perceptions about climate change showed that a significant number of farmers believe that temperature has already increased, and that precipitation has declined for eleven African countries (Maddison, 2006). Another study conducted by (Acquah de Graft, 2011) in Ghana, indicated that 60% of the farmers reported that there has been a noticeable increase in temperature and 49% reported a decrease in rainfall. Also analyzed perceptions of climate change in western Ghana, most of the farmers in the study area perceived an increase in temperature and decrease in precipitation.

Other empirical studies also found that the temperature and humidity in Ethiopia have significantly increased over the years (Temesgen, Hassan and Ringler, 2008; Mahmud et al., 2008), (Nhemachena and Hassan, 2007) also examined farmers' adaptation strategies in South Africa, Zambia and Zimbabwe and reported that most farmers perceived long-term increase in temperature and that the region was getting drier, with changes in the timing of the rains and frequency of droughts.

2.4.1 Impact of climate change on agriculture

Agriculture is the most important sector in sub-Saharan Africa, but it is predicted to be negatively impacted by climate change. Climate change will bring about substantial welfare losses especially for smallholders whose main source of livelihood derives from agriculture (Paulos & Belay, 2018). Climate change causes the frequency and severity of weather events. Some indirect effect of climate change includes, changes in soil moisture, land and water condition, change in frequency of fire and pest infect, and the distribution of diseases. The potential for a system to sustain adverse impact on agriculture is determined by its capacity to adapt to the changes. Higher temperatures, reduced rainfall, and increased rainfall variability reduce crop productivity that would be affected food security in low income and agriculture-based economies. Thus, the impact of climate change is detrimental to countries that depend on agriculture as the main livelihood (Edwards-Jones, Plassmann, & Harris, 2009) According to study of (Deressa, 2006) for Ethiopia, both increasing temperature and decreasing precipitation are damaging Ethiopian agriculture. According to (FAO, 2011) climate change has strong impact on the agricultural sectors and forestry by modifying or degrading productive capacities and by directly and indirectly increasing the risks associated with production.

Impacts on Agriculture Ethiopia confronted many adverse impacts which are manifestations of variable climate. Yet there are indications by which these impacts will continue to influence the socio-economic activities of the community at larger scale. The northern, southern and south-eastern dry land regions of Ethiopia have repeatedly faced increased frequency of meteorological drought episodes, famines and outbreaks of diseases which are believed to be linked with climatic change. The droughts have highly impacted the agriculture of the country and brought about the loss of crops, animals and above all the loss of millions of people. Flood hazards have increased in recent decades. The food hazards which have occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996 and 2006 are such indications. These flood hazards have demanded in crop and animal destructions as well as human lives. Many studies have concluded that the agriculture sector of the country is the most affected sector by climate change. (Deressa et al., 2008) made an integrated quantitative vulnerability assessment for seven Regional States of the total eleven regions by using biophysical and social vulnerability indices of Ricardian approach. The study revealed that decline in precipitation and increase in temperature are both damaging to Ethiopian agriculture.

2.5. Conceptual framework

As indicated on the figure 2.1, because of climate variability household food securities are affected by different factors. The framework is constructed based on reading of various literatures related to climate change and variability in different time and place.The analytical framework shows that the linkage between household food security and variables assumed that affect household food security in study area. According to their nature, these variables were categorized under five categories. Demographic characteristic category includes: age, sex, educational level and family size. Socioeconomic factors involve: total livestock unit, land holding size, access to irrigation, diversified livelihood, distance from market and distance from drinking water. Instistutional and laws factors includes: Agricultural extension contact, and information of climate variability, access to saving and credit institutions. Climate variability considered the temperature and rainfall variability. Adaptation response strategies and role of saving and credit includes: soil and water conservation, agro-forestry, new crop varieties and planting trees. As it shown by arrow on figure 2.1, socio-economic factors are influenced by impact climate variability factors. The impact of climate variability, the socioeconomic factors, the democratic factors and institutional factors are addressed by working on adaptation response strategies. Finally food security status of the

household are improved by the adaptation response strategies and the accessibility of the saving and credit can improve the food security.As studies indicated in order to implement the appropriate intervention to adapt to the impacts of climate change, governments and agencies need to understand the main factors of smallholders' choices of strategy and major barriers of selected adaptation strategy (Ringler, Alemu, & Yusuf, 2010).

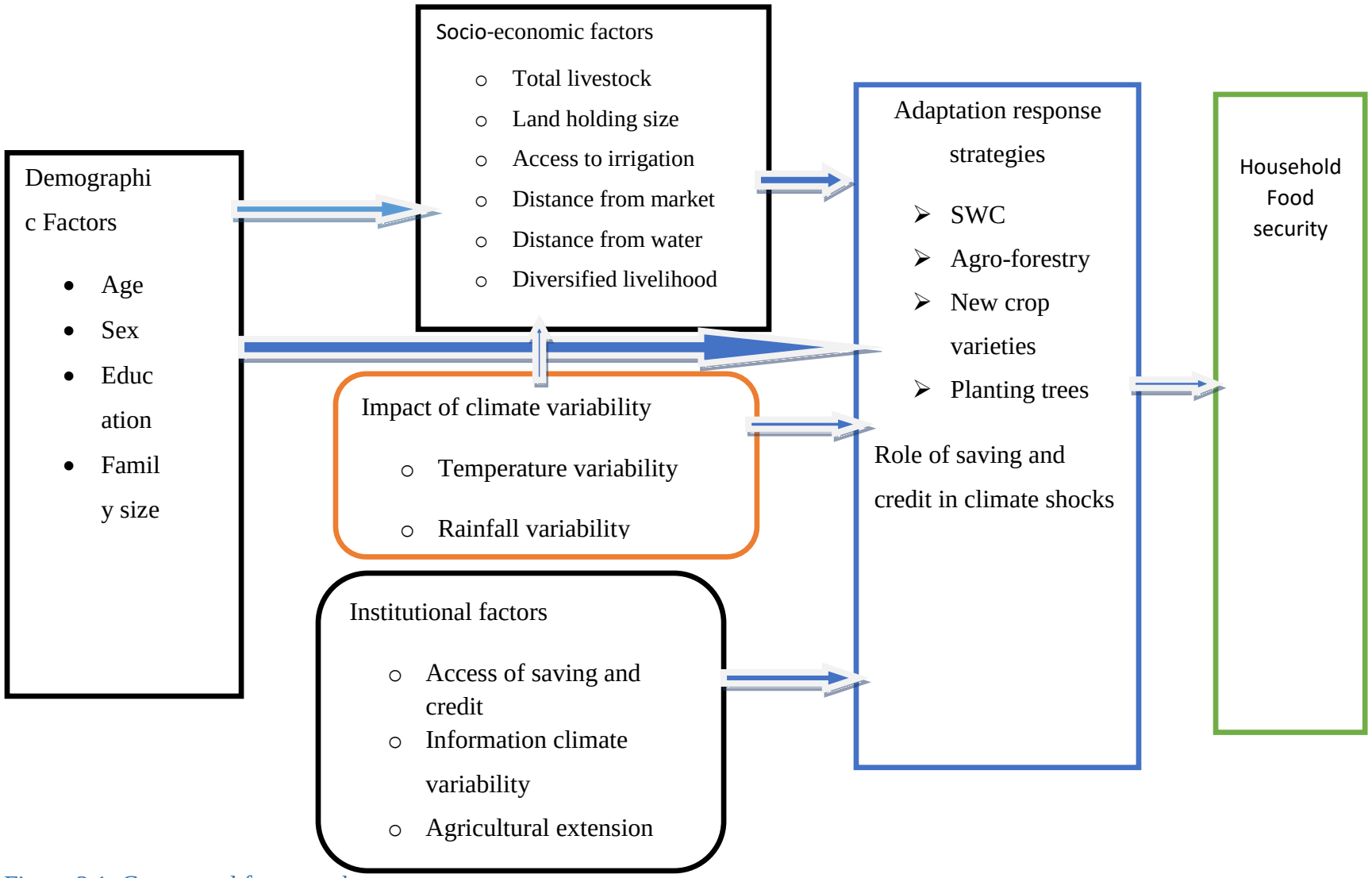

Figure 2.1: Conceptual framework.

Source: Developed based literature reviewed

CHAPTER THREE: DESCRIPTION OF THE STUDY ARAE AND METHODOLOGY OF THE STUDY

3.1. Description of study area

Yaya Gullele district is located in north Shewa zone of Oromia Regional State 114 Km away from the capital city of Ethiopia, Addis Ababa, and 26 Km from the zonal capital, Fitche. Astrological location of the District (latitude-longitude coordinate) 9◦30'N 38◦40'E (MoA, 2016).

According to the data from Yaya Gullele District Office of Finance and Economic Development (2018), the total area of the district is 369 km2. Out of this area 69 % of the woreda is possible to cultivate and 23% is covered by forest and 6.2% of land is farm land and 1.8% of land are residential areas and other as the data implies most of the land of the woreda is possible to cultivate.

The average density of the population in the woreda is 172 per km^2 in the year 2018. The population size is about 76, 014, out of which 38, 387are female. Administratively, the district is sub-divided into 17 rural villages and two rural towns and capital town of the woreda called Fittal.

Yaya Gulale District is found in the middle and at the south western part of the capital city of the Zone. It is bounded by western Shoa in the south, Degam woreda in the north- western, Girar Jarso woreda in the northern and Debra Libanos Woreda in the north eastern.

The elevation ranging from 1500-3060 meters above sea level and the agro-ecology of the area is dominated by highland, midland and lowland with the proportion of 27%, 41% and 32% respectively. The economy of the area is virtually based on agriculture specifically crop production and livestock rearing. In the woreda there are two types of season, which are belge and summer seasons

The woreda is characterize by flat, plateau, hill, and up.The major rivers in the District are Girar, Muger, Lemi, Kacama, and Aleltu. The woreda 's soil characterized by three major types: black soil 51%, red soil 21% , sand soil 11% and other soil 17%.

The vegetable cover of the woreda is rare patches of bushes and shrubs can be seen on the low lands. Eucalyptus tree are seen around homesteads and remnant of indigenous tree are found around churches. The major types of wild life animals in the woreda found at present day are fox, hyena, monkey, and rabbit.

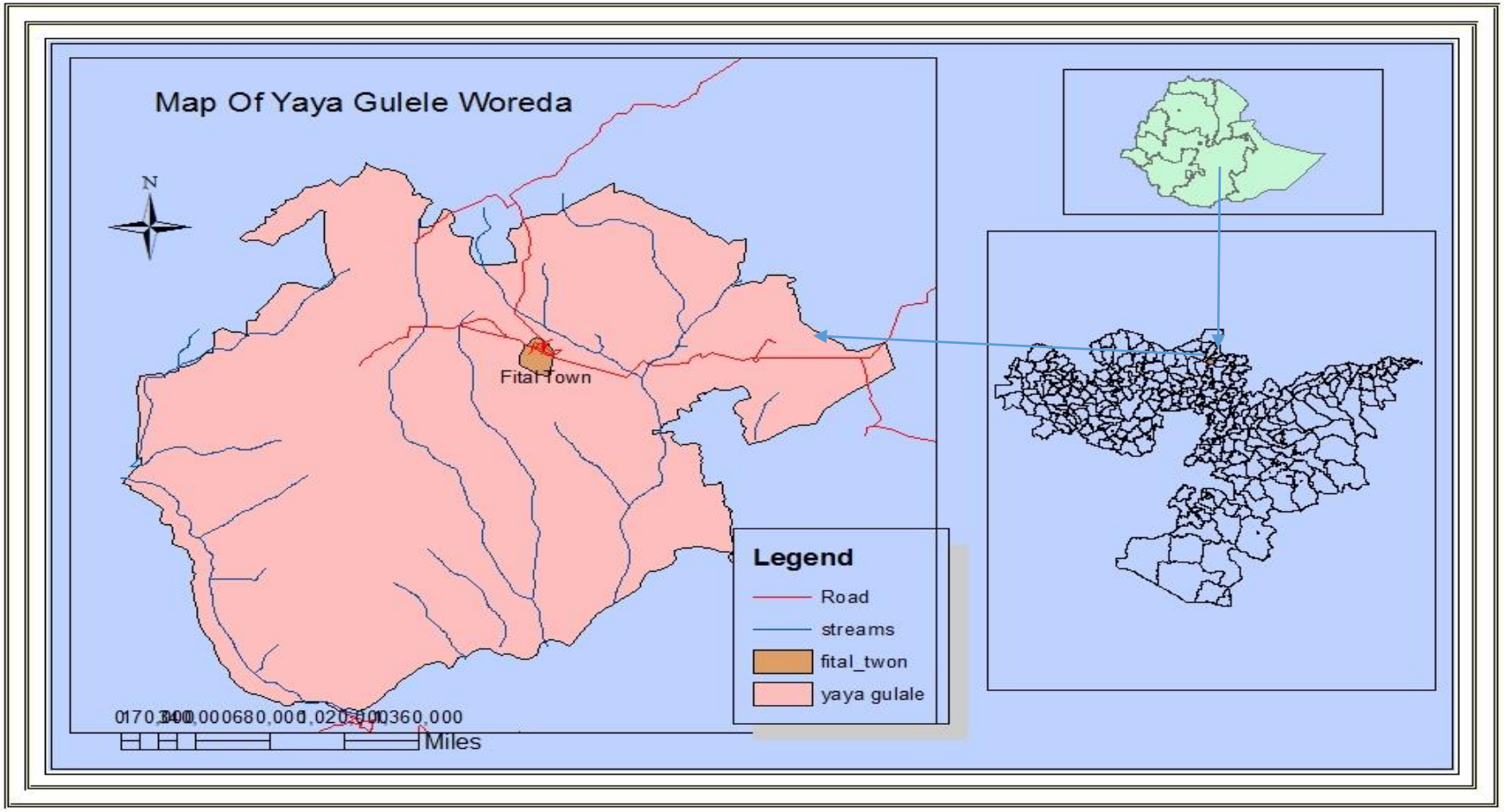

Figure 3.1: Map of study area

Source: CSA, 2007, Ethio-GIS 2015

3.2. Research design

Descriptive research design was appropriately applied in this research. Descriptive research set out to describe and to interpret the questions and looks at the study units with the aim to describe, compare, contrast, classify, analyze and interpret the entities, and the events that constitute the study. Different socio-economic, and demographic situations were described at first. Household survey and field observations as methods enabled the researcher to describe the phenomena. The regression model was used to determine the kind and magnitude of relationship among the dependent and independent variables under study. In this study, both qualitative and quantitative data analysis methods was followed to triangulate the interpretation of data and results to enhance the reliability and validity of findings. In qualitative approach in-depth Key Informants Interview (KIIs), Focus Group Discussions (FGDs), field observations were techniques for data collection. In the quantitative research method household survey on the basis of structured questionnaire interview was conducted by researcher and enumerators. These mixed approach research design thought to be appropriate to answer the research questions and then met the objectives, because it helps to identify and analyze the existing impact of climate variability on household food security and the adaptation strategies.

The research employed householdsurvey which in turn were based on multi-stage sampling procedure. Using this design, samples of the population were selected, and from these individuals, using a semi-structured questionnaire data on a number of socioeconomic, farm and household characteristics, data related to perception on climate variability,various adaptation practices, the role of saving and credit for resilient during climate shockscollected to answer the research questions. This design was selected for the advantage that the information about independent and dependent variables that was gather represent what goes on at only one point in time (Olsen and George, 2004).To obtain reliable responses on impact of climate variability information, the questionnaire administration were conducted using appropriate local terms in the common local language (Afan oromo) spoken by the people in the study area.

3.3 Research Methods

3.3.1 Sampling techniques and sample size

The study followed a multi-stage sampling technique where both probability and non-probability sampling techniques (purposive and simple random sampling) were combined to select the

woreda, kebeles and households. For primary data collection, in the first stage, Yaya Gulale was purposively selected. This was based on the availability of climate variability, frequent susceptibility to climate-related problems such as erratic rains, frequent drought, crop pests, and land slide and livestock diseases amongst others.

In the second stage, according to the data obtained from the woreda administration office, there are 17 rural kebeles and two rural towns in the woreda. The sample kebeles in the district was stratified based on their existing agro-ecological zones with the assumption that smallholder farmers within each agro-ecological system may have differences in their traditional knowledge and skills, and that this may result in different adaptive capacities in the communities (Abraham et al., 2017). Then simple random sampling technique were employed to select 3 rural kebeles one each from lowland, midland and highland from the total 17 rural kebeles in the woreda. These randomly selected kebeles are Gobolla from highland, Dedde from midland and GodaWarke from lowland area. This ensures most represent the total population and results in more reliable and detailed information.

According to the data obtained from Yayagulale Woreda Finance and Economic Development Office (YGWFEDO, 2020) the total number of households in the three sample kebeles are 1408 households. Yamane (1967) provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample size as shown below in

$$n = \frac{N}{(1 + N\ (e2))}$$ =1408/1+ (.06)2=**232**

Where, n = the desired sample size;

N = total number of target population of three kebeles and

e = the level of precision or the quality of being care full and accurate which is equal to 0.06

Table 3.1: Sampled households in selected Kebeles

Name of kebeles	Total household	Sample household	% from sample size
Gobola	513	90	38.7%

Dedde	450	74	32%
GodaWarke	445	68	29.3%
Total	**1,408**	**232**	**100%**

Source: YGWFEDO (2020)

3.3.2 Data Sources and data collection instrument

A mixed of quantitative and qualitative method approach were used. Accordingly, the combination of qualitative and quantitative research techniques was better than the use of one of them to address in order to assess the impacts of climate change and variability and easy to understand food security status. The research was employed household questionnaire survey, FGD, KIIs and field observation in primary data collection.

Household survey

Questionnaire based household surveys with 232 sample households were conducted in the study areas. Questionnaire-based survey was administered to sample farming households by using a questionnaire survey after obtaining the consent of the respondents as a research ethics. The questionnaire was translated into Afan Oromo for the purpose of simplicity and ease of communication between the enumerators and the respondents. With this technique data related to demography, socioeconomic, smallholder farmers understand of variability, access saving and credit, adaptation mechanism of household on climate change and variability and coping strategies were collected.

Focus group discussion

FGD is important in order to complement the information collection through surveys and semi-structured interviews methods. Two focus group contains both male and female household heads discussion in Woredas administration offices. The FGD was carried out before Covid-19 pandemic disease breakout. The two separate focus groups were under 50 age group (FGD 01) and the above 50 age group (FGD 02). Each groups are eight in numbers and consists of male and female headed household, both (FG01) and (FGD02s) were carried out with a mix of participants such as elders, religion leaders and DAs. The participants' were respectfully requested for their consent, time and the information. Topics related to issues of climate change and variability of the past 20 years,

adaptation practiced and challenges, their ways forward, and the existing support from the government and NGOs were addressed.

Key informant interview

The study employed key informant interviews to get information on personal thought, experience and attitude relatedwith climate change and variability. Interview is the most commonly used qualitative technique which can provide rich sources of data on people's experiences, opinions, aspirations and feelings (Kitchin and Tate, 2000).

This method was enabled the researcher to gather important information on primary data, such experience and information about the demographic change, social, economic and environmental problems as the challenges and prospects in achieving food security, coping strategies and resilience in case of shock. The key informant interview were involved locally respected person, Woreda extension workers, Health extensions, DRM office, Teachers etc. Key informants was selected based on reliability of giving information related to the study.

Field observation

In addition to the above data collection method, the field observation was carried out to validate the information provided through primary and secondary data collection tools. Observation is a qualitative method whose objective is to help researchers learn the perspectives held by study households. Data obtained through observation serve as a check against participants subjective reporting of what they believe and do (Mitchell, Fraser, 2015).

Secondary data sources

Besides the aforementioned data collection techniques and procedures, intensive desk review of published and unpublished literatures such as books, journals, articles, reports and e-resources were carried out. Documents from various Oromia bureaus, Ministry of Agriculture and Natural Resourceand Central Statistical Agency (CSA), NGOs, IPPC updated, national and local level climate change commission report werereviewed.

3.3.3 Data analysis methods

To address the objectives of this study, both descriptive statistics and econometric methods of the data analysis was employed. After coding and feeding the collected primary data into the computer, STATA version 14 was used for analysis.

Descriptive statistics

Descriptive statistics such as mean, minimum, maximum, percentages, and frequencies are applied to describe demographic, socio-economic, coping strategies and adaptation options in the study area.

Analysis of food security is supposed to measure the availability, accessibility, utilization and stability of food at the global, national household and individual levels. A state of food insecurity also expressed when the people lack of access to adequate and safe supply of food on stable basis. In other words, access to food at all times to enough food nutritionally a good quality for active and healthy life. To assess the food security status, there are a number of measurement tools available of household and it differs based on the scope and purpose of the assessment. Likewise, a combination of tools was used to generate data. In this study, the Household Food Insecurity Access Scale (HFIAS) food security measurement was applied to analyze the food security status of study households.

Household Food Insecurity Access Scale (HFIAS) which is an adaptation of the approach used to estimate the prevalence of food insecurity in the United States (U.S.) annually. The method is based on the idea that the experience of food insecurity (access) cause predictable reactions and responses that can be captured and quantified through a survey and summarized in a scale (Wehler et al., 1992; Hamilton, 1997). The HFIAS consists of two types of related questions. The first question type is called an occurrence question. There are nine occurrence questions that ask whether a specific condition associated with the experience of food insecurity ever occurred during the previous four weeks (30 days). Each severity question is followed by a frequency of occurrence question, which asks how often a reported condition occurred during the previous weeks. Each occurrence question consists of the stem (timeframe for recall), the body of question (refers to specific behavior or attitude), and two respondent options (0 = no, 1 = yes). There is also a skip codenext to each ‟no‟ respondent option. This code instructs the enumerator to skip the related frequency of occurrence followed up question whenever the respondent answers ‟no” to an occurrence question (Jennifer et al., 2007). Each HFIAS frequency of occurrence question ask the respondent how often the condition reported in the previous occurrence question happened in the previous four weeks. There are three response options representing a range of frequencies (1= rarely, 2= sometimes, 3= often). First, HFIAS score variable is calculated for each household by

summing the codes for each frequency of occurrence question. Before summing frequency of occurrence, the data analysis should code frequency of occurrence as 0 for all case where the answer to the corresponding occurrence question is “no” (i.e., if Q1=0 then Q1a=0 if Q2=0 then Q2a=0 etc.). The maximum score for household is 27 (the household response to all nine frequency of occurrence question is“often” coded response code 3); the minimum score is 0 (if the household respond“no” to all occurrence questions, frequency of occurrence questions are skipped by the interviewer, and subsequently coded as 0 by the data analysis). The higher the 32 score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity (access) a household experience (USAID, 2007).

Table 3.2 The HFIAS categories, frequency of occurance and codes

Categories	How often did this HFIAS happen for the last 4 weeks?	Code
Food secure	If the answer is "No", in the last 4 weeks	0
Mildly food insecure	If the answer is "Rarely" (once or twice) in the last 4 weeks	1
Moderately food insecure	If the answer is Sometimes" (3 to 10 times) in the last 4 weeks	2
Severely food insecure	If the answer is "Often": (more than 10 times) in the last 4 weeks	3

Source (USAID, 2007)

3.4. Definition of variable and working hypothesis

Dependent Variable of the model: The dependent variable for analysis was Household Food Security Status.The ordinal values were obtained from HFIAS model, which was used to analyze the food security status of the study households.

Independent variables: The independent variables of the model are those variables that were expected to have relationship with the climate variability and the effects on food security and the outcome variables were selected depending on available literatureand researchers’ personal experience. The following factors, which are expected to affect Household food security presented with their operationalization.

Age of the household head: A continuous variable measured in years. Age have a negative relationship with dependent variable. Age of household head plays a significant role in increasing its own productivity by exerting his/her labor and also it may affect adoption to new technologies. Household head with young age will have strong labor which can produce more and seek new technologies to improve his/her livelihood. The effect of age on rice technology adoption decisions is expected to be positive (Sisay, 2016). Older farmers may have more experience, resources, or authority that may give them more possibilities for trying a new technology. Thus, for this study, it is hypothesized that age of the farmer negatively influences the food security status of the households.

Sex of household head: It is biological difference between male and female. It refers to the sex of the household head taking a value of 1 for male and 0 for female. The gender difference is found to be one of the factors affecting food security of household.Labor supply plays a great role; due to lack of labor female headed household they are forced to rent their land. Male-headed households are in a better position to pull more labor force than the female-headed ones; sex of the household head is an important determinant of livelihood security in the study area. Male headed households could be more likely to have access to technologies and climate change information than female-headed households (Deressa et, al.2008).

Education: Education helps to increase farmer's ability to obtain, process, information relevant to coping strategies for food security at a time of climate variability. Education increase the probability of adapting climate variability strategies.It is an essential factor for diversified activities in human life. The opportunity of employment is dynamic by its nature. This is due to the continuous improvement in the research findings and technological advances. Education level could measure the household's human capital and therefore attainment of higher level of education is expected to provide higher levels of household welfare (Datt et al., 2000).

Family size: It is the total number of person living in the household working for and dependent on household for their living (Nemachena and Hassan, 2008) Mentioned that household size has mixed impacts on farmers' use of agricultural technologies. Larger family size enable farmers to take up labor intensive measures. Alternatively, a large family might be forced to diver part of its labor force in to non-farm and off farm activities to generate more income and reduce consumption demand.

Agroecology: It is categorical variables of classifying the agro-ecological zones which the household found. Its given 1 for highland 2 for midland and 3 for lowland. The types of climate variability depends on the agro-ecological zones of the area. For examples, drought mostly occurred in lowland areas.

Land size: It is positively associated with the food security status. This means that those farmers who have relatively large farm size are more likely to different adaptation strategies and then adapt CC strategies and then secure their food security. And the reverse is true for small farm size owners (Wagayehu, 2003)

Access to irrigation: It is expected to be positively associated with food security and coping mechanism for household food security. The household who have access to irrigation create opportunity produce production a time when the climate variability is difficult to gain rainfall. **Livestock unit**: It is continuous variable refers to the total number of animals possessed by the household measured in tropical livestock unit (TLU). This can be attributed to increase wealth and income based on the farm households which makes more money available in the households (Malefiya, 2017). Livestock is considered as another asset which is a security against crop failure. It is the respondent how livestock they have. These includes cattle, sheep, goat, donkey, and horse. The more livestock units, the more adapting to the climate variability and then access to food security.

Access to saving and credit: Access to saving and credit increase the probability of adapting climate change and variability. Farmers who have access to credit may overcome their financial constraints and therefore buy input and other related tools (Ngugi, 2012). Saving money at a time of gaining income has important for household when climate variability going to hit their production. Farmers who are a members of saving group are potential to cope up from any impact of climate variability than who are not a members.

Income diversification: It is a dummy variable that will take the value one if the household engaged in different income generating activities in addition to their regular agriculture income and zero otherwise. Most of farmers who has an access to off-farm employment has more adaptive from climate shocks than those who are not.According to Amha (2004) study, off-farm income opportunities is important means of securing food security. In this regard, participating in income generating activities influencing household food security status.

Extension service/contact: It refers to a contact between extension agent and the farmers. If agricultural extension contacted the farmers regularly, they will be get access information and they more likely create farmers awareness about climate and adaptation strategies. This implies that farmers with more access to information and technical assistance on agricultural activities have more awareness about the consequence of climate change. More frequent DA (Development Agent) visits, using different extension teaching methods like attending demonstrations and field day can help the farmers to adopt climate smart livestock production practices. However, all farmers may not have equal access to extension services. Some farmers visit extension agents more frequently while others visit rarely. If the farmers get better extension services, they are expected to meet food security than others (Quddus, 2012). Therefore, this variable is expected to have a positive effect on farmer‘s food security status.

Market distance: It is the location of farm household from the market to sell their product. It is a continuous variable and measured by minutes. Living far from the major market can reduce the expected profitability of a new technology and create a barrier associated with limited price information about distant marketing outlets and increased transaction costs (Abdullah and Huffman, 2005). Distance from market center was expected to affect information of climate change and new technology for their production.

Distance from water source: This is continuous variable measured in walking minutes from the residence of farm household to the water source area. We expect that the farmer whose water source is far from his residence is less likely to continuously follow up his/her livestock as compared to those whose water source nearer to their home. Thus, it is expected that farmers who live near to their water source are likely to have regular follow up of their livestock, hence motivated to respond to climate change on their livestock activities (Malefiya, 2017). Therefore, this study hypothesized that distance from home to the water source has negative relation with food security practices. The more farmers close to the drinking water the more likely to produce vegetables and fruits in their home garden and get access to food secure.

Market linkage: It is market of product the farmers produce link with buyers. It is dummy variables weather the farmers get the linkage with buyers and get profitable income from what they produce or not.

Information of climate variability: It is the dummy variables one for those who have information about climate variability and 0 for those who are not. The more the farmers having the information of climate variability, the more they likely to adapt to the change and more food secure than those who are not. If the farmers get better climate information about seasonal forecasts and climate change, they are expected to adopt different CSA technologies than others. Because the availability of better climate information helps farmers make comparative decisions among alternative food security status and hence chooses the ones that enable them to cope better with changes in climate (Abrham et al., 2017).

3.4.1 Hypothesis

Based on the scope of the study the following hypothesis was made for outcome variable.

Hi= There is no relationship between food security and explanatory variable.

Ho= There is a relationship between food security and explanatory variable.

Table 3.3 The variables and their categories, measurements and sign

Variable name	Category	Measurement	Sign
Age of household head	Continuous	Years	+/-
Sex of household	Dummy	1 or 0	+/_
Agro ecology	Categorical	1 Highland, 2 midland, 3 lowland	+/-
Educational level of household head	Continuous	Schools	+
Livestock unit	Continuous	TLU	+
Land size	Continuous	Hectare	+
Family size	Descrit	Numbers	+/_
Access to agricultural extension services	Dummy	1 or 0	+
Information of climate variability	Dummy	1 or 0	+
Market distance	Continuous	KM	-
Irrigation users	Dummy	1 or 0	+
Distance from water source	Continuous	Minutes	-
Market linkage	Dummy	1 or 0	+
Income diversification	Dummy	1 or 0	+
Access to saving and credit	Dummy	1 or 0	+

HFIAS score	Categorical		

Source: Own definition based on literature (2020)

CHAPTER FOUR: RESULTS AND DISCUSSION

This section presents and discusses the respondents' insights and understanding about climate variability and climate change, the adaptation respond they use, the household coping strategies,the role of saving and credit in case of climate shocks in the study area. From individual local perspectives of the phenomenon, climate change and variability is referring to climate change and variability specific to the area.

4.1 Demographic and socio-economic characteristics of the respondents

Descriptive analysis

This sub-section has describe the household characteristics that explain the information on demographic and socio-economic characteristics such as sex of the household head, age of household head, family size, educational level, number of livestock owned by household, land holding size, access to saving and credit, access to market linkage, information of climate variabilityand irrigationusers which were assumed that ether positive or negative influence onhousehold food security status.

The results of demographic and socio-economic information of the households presented in table 4.1 show that majority of the respondents were male headed households which is 92.24%(n=224) and female headed household 7.76%(n=18) from the total of 232 respondents. Regarding access to saving and credit, 61.21 %(n=142) were a member of saving and credit and 38.79 %(n=90) were not members. Regarding the livelihood diversification, 44.83 %(n= 104) have additional income in addition to agriculture whereas 55.17 %(n=128) have not. On irrigation users' households 28.02 %(n=65) were irrigation users whereas, 71.98 %(n=167) werenot.Agricultural extension contact with farmers in a year on information about their production in the past two years, 42.24% (n=98) responded contacted with agricultural extension service and 57.76% (n=134) were not. Regarding the household's information about climate variability 77.16% (n= 179) household responded have got information from agricultural extension service, media and training/meetings while 22.84% (n=53) have no idea about it.Regarding market linkage of the product, only 22.84% (n=53) of them got access to market and got profitable income from their product, whereas, 77.16% (n=179) were not access profitable market for their product.

Table 4.1: Demographic socio-economic characteristics HHs for dummy variables

Name of variables	Categories	Number of household(n=)	Percent %	Chi2-value (probability)

Sex of HH	Male	214	92.24%	0.37
	Female	18	7.76%	
Access to saving and credit	Yes	142	61.21%	0.000***
	No	90	38.79%	
Livelihood diversification	Yes	104	44.83%	0.000***
	No	128	55.17%	
Irrigation usage	Yes	65	28.02%	0.000***
	No	167	71.98%	
Access to agricultural extension service	Yes	98	42.24%	0.000***
	No	134	57.76%	
Information of climate variability	Yes	179	77.16%	0.046**
	No	53	22.84%	
Market linkage	Yes	53	22.84%	0.000***
	No	179	77.16%	

Source: own survey (2020)

Note: ***, **, *, show significance at p<0.01, p<0.05 and p<0.1 respectively

As it described on table 4.2, the average of age of the respondent is 50.13 years old and a minimum and the maximum was 35 and 76 years respectively. The average land size of the household was 2.35 hectare and the minimum household land size was 1 hectare and the maximum was 6 hectares.

The average family size of the study area was 5.2 which is greater than national average which is 4.8 and equal with the average family size of region which is 5.2 (CSA, 2019) and the minimum and the maximum family size of the sampled household was 2 and 9 respectively. The average number of livestock were 17.27 and 0 and 39 were a minimum and maximum in TLU respectively. This implies a mixed farming system in the study area, livestock has imperative contribution for household income and food security. The type of livestock kept by sample farmers includes cow, oxen, bull, horse, mule, donkey, calf, goat, heifer and chicken. The average formal education status of the respondent is 3.62 whereas, the minimum not grade (illiterate) to the maximum was grade 12^{th}. The average distance of market from the household is 12.3 minutes and the minimum and the maximum is 2 minutes and 25 minutes respectively. The average number of distance from the market and source of drinking water collected is 12.3 minutes and 5.28 minutes respectively and 2 and 25 minutes and 2 and 15 minutes and the minimum and the maximum respectively.

Table 4.2 Demographic and socioeconomic characteristics of study HHHs continuous variables

Name of variables	Measurements	Mean	Standard deviation	Min	Max	Chi2-value (Probability)
Age of HH	Years	50.13	10.58	35	76	0.5900
Family size	Numbers	5.2	1.41	2	9	0.188
Education	Schools	3.62	3.68	0	12	0.000***
Land size	Hectare	2.35	0.67	1	6	0.427
Livestock numbers	Numbers	17.27	9.3	0	39	0.041**
Market distance	Minutes	12.3	7.28	2	25	0.962
Distance from drinking water	Minutes	5.28	2.3	2	15	0.635

Source: Own study survey

Note: ***, **, *, show significance at p<0.01, p<0.05 and p<0.1 respectively

4.2 Smallholder farmers understand and perception of climate variability

On table 4.3 shows 21.98 % (n=51) of respondent know well about climate variability whereas, 55.6 %(n=129) replied they know and 24.14 %(n=22.42) know little about climate change and variability. Based on these, 33.19 %(n=77) heard from agricultural extension workers, 22.41 %(n=52) heard from different meetings and training given from government and non-governmental organization, 40.52 %(n=94) heard from media (radio) and 3.88 %(n=9) heard from multiple choice. This implies that most household know about climate variability from mediarather than from different agricultural extension and trainings/meetings.

Table 4.3 Smallholder farmers understanding of climate change and variability

How much Household know about climate variability	**From where they heard about climate variability**					
	Agricultural extension	Training/meetings	Media	Multiple	Total	Percent
I know well	23	11	14	3	51	21.98%

I know	42	25	58	4	129	55.6%
I know little	12	16	22	2	52	22.42%
Total	77	52	94	9	232	100.00%
Percent	33.19%	22.41%	40.52%	3.88%	100%	

Source: own survey (2020)

Smallholder farmer's perception of climate variability, focusing on temperature and rainfall climatic elements

As showed on table 4.4, the majority of respondents perceived changes on temperature and rainfall within the twenty-year period 2000 to 2020. In this regard, on the idea of temperature increasing, 16.38 %(n=38) of the respondents reported they strongly agree, 81.03 %(n=188) reported agree and 2.59 %(n=6) reportedunsure that the temperature of the area is increasing. Again regarding on the idea rainfall pattern is decreasing, 50 %(n=116) of the responded strongly agree whereas, 43.53 % (n=101) and 6.47 %(n=15) perceived agree and unsure respectively that the rainfall is decreasing. It indicated respondent mostly perceived that, the rainfall is decreasing. The studies indicates that the food security of the farmers at risk as indicated by (EdwardsJones et al. 2009) Higher temperatures, reduced rainfall and increased rainfall variability reduce crop productivity that would be affected food security in low income and agriculture-based economies. Thus, the impact of climate change is detrimental to countries that depend on agriculture as the main livelihood. Other studies by (Deressa et al., 2008) an integrated quantitative vulnerability assessment for seven Regional States of the total eleven regions by using biophysical and social vulnerability indices of Ricardian approach. The study revealed that decline in precipitation and increase in temperature are both damaging to Ethiopian agriculture.

Table 4.4 the smallholder's perception of climate variability focused on temperatures and rainfall

Climate variables	Farmers response %(n=)									
	Strongly agree		Agree		Unsure		Disagree		Strongly disagree	
	n=	%	n=	%	n=	%	n=	%	n=	%
Temperature increased	38	16.38%	188	81.03%	6	2.59%	0	0	0	0

Rainfall decreased	116	50%	101	43.53%	15	6.47%	0	0	0	0

Source own survey, (2020)

4.3 Smallholder farmers adaptation and coping strategy

According to table 4.5, the household are using the following adaptation strategies to cope up from climate change and variability. Accordingly, 16.38 %(n=38) engaging on planting trees by government and non-government facilitation on private and communal land. 33.62 %(n=78) engaging on agro-forestry works on their farm land in order to protect soil fertility and erosion. 2.16 % (n=5) responded they use diversified new crop variety that resilient for climate shocks. 21.55 %(n=50) use soil and water conservation works facilitated by government. 26.29 %(n=61) use the combination the above mentions adaptation strategies. Similar studies by (Howe et al., 2013; Clayton et al., 2015) indicated, drawing from behavioral research, many have argued that the perception of changes in the weather can play an important role in adaptation and in supporting climate policy. IPCC defines adaptation as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC Online, 2001). Smallholder producers could either change their agricultural practice by altering planting dates or other methods to increase their crops resiliency or explore other income streams to increase their livelihood resiliency to climate change (Komba &Muchapondwa, 2015 & Lin, 2011). In order for smallholder producers to adapt to uncertain future climate change impacts, it is important to ensure that all aspects of their livelihood strategies are resilient to changing and unpredictable conditions via adaptation strategies.

Table 4.5 Household's adaptation responses to climate change and variability

Adaptation strategies for climate change and variability	Frequency	Percent
Planting trees	38	16.38%
Agroforestry	78	33.62%
Diversifying new crop variety	5	2.16%
Soil and water conservation	50	21.55%
Multiple	61	26.29%
Total	232	100%

Source own survey (2020)

Analyze the role of and access to saving and credit to cope impacts of climate variability

Microfinance is a phenomenon that reflects the provision of credit and microloans to low income people in order to enable them to engage in productive economic activities that help them enhance their income (Awojobi &Bein, 2011).

Wakilo&Sakawa (2014) and Chodhury& Salleh (2017) concludes their study by confirming thatmicro credit services provide better education and health services in line with increasing income of the society. The same finding also observed from this study by Khandker (1998) and Hassan & Bhuiyan (2013) alsostudied and concluded that credit services has significant impact on smoothing consumption, operating business, generating income and enabling members and their families to attend school and develop their profession. From this studies indicated that the food secure and mildly food insecure category of the household are access to saving and credit as it described on table 4.10.

As shown ontable 4.6, from the respondent households 66.38 %(n=154) of them have access to saving and credit. From these members 58.19 %(n=135) of them a member of saving for transformation (S4T) which executed by World Vision Ethiopia and 8.19 %(n=19) are a member of Oromia Credit Saving Share Company (OCSSC).

The respondent explained the role of saving and credit used in case of climate shocks hit their production. Accordingly, from the total of 154 respondents 32.76 %(n=76) of the members said they use saving and credit in case of climate shocks hit they used for agricultural input purchase. Whereas, 15.09% (n=35) and 18.53 %(n=43) use for medication and school fee and for home consumption respectively. This implies that saving and credit support the household purchase of agricultural inputs, for medication and children schools fee and for home consumption purchase incase climate variability hit them.

Table 4.6 Name of institutions and the role of saving and credit to cope up from impact of climate variability

Role of saving and credit in climate shocks	Not a member	Name of saving and credit institutions		Percent (%)	Total
		S4T	OSCA		
Not a member	78	0	0	33.62	78
Input purchase	0	67	9	32.76%	76

Medication and school fee	0	29	6	15.09%	35
Home consumption	0	39	4	18.53%	43
Percent (%)	33.62%	58.19%	8.19%	100%	
Total	78	135	19	100%	232

Source own survey (2020)

Coping strategies during climate shocks

Indigenous people all over the world have used different strategies to respond and adapt to climate change, these include (FAO, 2007): diversified resource base (to minimize the risk due to harvest failure, they grow many different crops and varieties, and they also hunt, fish, and gather wild food plants); change in crop varieties and species; change in the timing of activities (crop harvests, wild plant gathering, hunting and fishing); change of techniques; change of location; changes in resources and/or life style(resorting to wild foods in the case of emergency situations such as droughts and floods); exchange (obtaining food and other necessities from external sources through exchange, reciprocity, barter, or markets in times of crises); and resource management (enhancing scarce and climate-sensitive resources management)

As shown on table 4.7, 19.83 %(n=46) were replied migrated some of their families members to other areas searching for jobs. 25.43 %(n=59) got support from government and non-government organization. 5.17 %(n=12) lending cash or in kind from local level money lenders with interest. 29.31 %(n=68) respondent replied they were skip a day out eating until the condition comes to the normal. 20.26 %(n=47) used multiples of the above and others options. The similar studies indicated, in Ethiopia cases, traditional and contemporary coping mechanisms to climate variability and extreme include (NAPA, 2007). Changes in cropping and planting practices, reduction of consumption levels, collection of wild foods, use of inter-household transfers and loans, increased petty commodity production, temporary and permanent migration in search of employment, grain storage, sale of assets such as livestock and agricultural tools, mortgaging of land, credit from merchants and money lenders, use of early warning system and food appeal/aid, etc.

Table 4.7 Coping strategies duringclimate variability and shocks

Coping strategies for impact climate variability	Frequency	Percent

Migration to other area	46	19.83%
Gov't and NGO support	59	25.43%
Lending from lenders	12	5.17%
Skip a day without eating	68	29.31%
Multiple and others option	47	20.26%
Total	**232**	**100%**

Source own survey (2020)

4.4 Household food insecurity status

4.4.1 HFIAS Result

According to Household Food Insecurity Access Scale (HFISA) techniques of food security measurement and analysis from all respondent 20.26 %(n=47) are food secure while 36.21 % (n=84), are mildly food insecure, 30.60 %(n=71) and 12.93 %(n=30 are, moderately food insecure and severely food insecure respectively.

Table 4.8 food security status by HFIAS measurements

Food security status(HFIAS score)	Frequency	Percent
Food secure	47	20.26%
Mild food insecure	84	36.21%
Moderately food insecure	71	30.60%
Severely food insecure	30	12.93%
Totally	232	100%

Source own survey (2020)

4.4.2 Econometrics analysis

Ordered logit result

Ordered logistic regression was a type of logistic regression analysis that when the response variable is categorized more than two with having natural order or rank. When a dependent variable has more than two categories and the values of each category have a meaningful sequential order where a value is indeed higher than the previous one, then we use ordinal logit. Order logit model of estimation used to analyze the effects of a certain category of relationship to food insecurity status of study households.

Table 4.9 Ordered logit effects of different variables on food security status of household

Food security(HFIAS)	Coef.	Std. Err.	Z	P>z	95% conf.	Interval
Sex	1.194	0.477	2.5	0.012**	0.258	2.129
Age	0.020	.014	1.45	0.146	-0.007	0.047
Agroecology	0.180	0.231	0.78	0.436	-0.272	0.633
Education	0.116	0.038	-3.02	0.003***	-0.192	-0.040
Family size	0.254	0.10	2.52	0.012**	0.056	0.451
Land size	0.011	0.188	0.06	0.953	-0.358	0.381
Total livestock	-0.011	0.014	-0.75	0.455	-0.040	0.017
Irrigation users	1.181	0.358	-3.29	0.001***	-1.885	-0.478
Market linkage	2.005	0.317	-5.49	0.000***	-2.549	-1.288
Agricultural extension	1.927	0.317	-6.07	0.000***	-2.549	-1.304
Distance from market	0.040	0.023	1.70	0.089*	-0.006	0.086
Distance from drinking water	-0.066	0.057	-1.14	0.252	-0.179	0.047
Livelihood diversification	0.279	0.278	1.00	0.317	-0.267	0.825
Information of climate change	0.212	0.331	0.64	0.521	-0.436	-0.862
Access to saving and credit	1.411	0.311	-4.54	0.000***	-2.021	0.801

Source: Author's regression result using STATA 14, 2020

Note: the sign ***, ** and* denote the coefficients are statistically significant at 1 %, 5% and10% respectively.

Gender of HH: The result of ordered logit regression model in Table 4.9shows that, sex of household has a statistically positive relationship with household food security at P<0.05 or 5% (P=0.012). It indicates that as sampled household sex is male headed household there is the more likely to be food secure for moderately and severely food insecure category. The marginal effect in

Table 4.10 shows that if the sex of household head is male headed keeping other variables constant, the probability to be food secure decreased by 16.1% and 5.95% for food secure and mildly food insecure category respectively. Whereas, theprobability to be food secure increase by 18.6% and 3.8%for moderately and severely food insecure category respectively. These shows that, those households who are food secure and mildly food insecure category male headed household are less productive and older age dependent but have more productive young members in their house. The coefficient of variation also indicates that being male headed household has increase food security status by 119.4% than being women headed households for moderately and severely food insecure household's. It is similar with studies by Deressa et al. (2008) showed that male headed households could be more likely to have access to technologies and climate change information than female headed households.

Family size: The result of ordered logit regression model in Table 4.9 shows that, family size has a statistically significant positive relationship with household food security at P<0.05 or 5% (P=0.012). Furthermore the marginal effect in Table 4.10 indicates that, as one family member increased to the household held other variables constant, there is increase food security by 4.57% and 1.22% formoderately and severely food insecure households' category. Whereas, the probability to be in the food secure decreased by 2.3% and 3.4% for food secure and mildly food insecure category respectively. It indicates that as one additional family members added in the house, the probability for moderately and severely food insecurity of the household increased by 25.4%.

Similarly studies, Mekuanit (2014) indicated most of the family member who were found in the inactive age group and that has no contribution to income-generating rather than consumption negatively related to household food security. This might be due to the fact that large household size creates more pressure on household food security status and more expenditures spent non-food items increase. On the other hand, the study by Muluken (2019) indicates that household family size has a positive relationship to household food insecurity status by 5%.

Distance from market: The result of ordered logit regression model in Table 4.9 shows that, distance from market has a statistically significant positive relationship with household food security at P<0.1 or 10% (P=0.089). As indicated on marginal effect table 4.10, as the sampled householdclose to market place held other variables constant, there is the probability to increase food security by0.7% for moderately food insecure and 0.19% for severely food insecure category.

Whereas, the probability of sampled household as close to market place by one kilometer decrease security by0.36% for food secure and 0.54% for mildly food insecure household. This implies that the better food secure are already found at place close to market. Similarly studies, a unit increase in walking hour from the home of a household to the main market would decrease the likelihood of using agronomic practice/s by 3.9% (Abayineh and Belay, 2017).It indicates that as household 1KM close to the market, the food security status is increased for moderately and severely food insecure categories by 4%.

Education: This variable has a statistically significant influence on the level of food security of household at P<0.1or 1% (P=0.003) as indicated in Table 4.9.The result indicate that household head having one additional educational level are more likely to be food secure in the food secure and mildly food insecure household category and less likely in the moderate and severely food insecure in the study area. Furthermore the marginal effect in Table 4.10 indicates thathelding other variables constant, increase one educational level increase probability to be food security status of food secure and mildly food insecurecategory household by 1.06% and 1.59% respectively while the probability to be food secure decreased by 2.09% and 0.56 in the moderate and severely food insecure category. This implies that the additional educationa level support household to be food secure. Similar studies, the level of education can enable the smallholder farmer to be open to receive, understand and implement the information relevant for the adoption of a new technology (Namara et al., 2003).

Irrigation users: This variable has a statistically significant influence on the level of food security of household at P<0.01or 1% (P=0.001) as indicated in Table 4.9. Furthermore the marginal effect in Table 4.10 indicates that, keeping other variables constant the having access to irrigation increase the probability to be food secure for food secure and mildly food insecure category by13.47% and 10.76% respectively and the probability to be food secure decreases by 19.54% and 4.70% moderate and severely food insecure category respectively. This implies that, poorer household use less production on the existing irrigations than the better off ones because they have not capital to purchase agricultural input to invest on it.

Market linkage: This variable has a statistically significant influence on the level of food security of sampled household at P<0.01or 1% (P=0.000) as indicated in Table 4.9. The result indicate that household head who have market linkage for the product are more likely to be in the food secure and mildly food insecure sampled household category and less likely in the moderate and severely

food insecure sampled category in the study area. Furthermore, the marginal effect in Table 4.10 indicates that, food security of household increased for food secure and mildly food insecure category by 28.12% and 7.74%, food security decreases by 29.18% and 6.680% the moderate and severely food insecure category.

Agricultural extension contact: This variable has a statistically significant influence on the level of food security of HHH at P<0.01or 1% (P=0.000) as indicated in Table 4.9. The result indicate that household head who have access agricultural extension service are more likely to be in the food secure and mildly food insecure HHH category and less likely in the moderate and severely food insecure HHH in the study area. Furthermore the marginal effect in Table 4.10 indicates that, get access to agricultural extension contacthelding other variables constant, the probability for food secure increased by 20.92% and 19.02% for food secure and mildly food insecure category respectively whilethe probability to be food secure decreased by 30.89% and 9.05% for moderate and severely food insecurerespectively. This indicates, the poorer household needs for access to agricultural extension service not their primary priority. Farmers have best access to institutional support (access to extension advisory services) have better opportunity to get information on climate change conditions that farmers have access to the extension services better adapter than could not have (Negash M, 2011).

Access to saving and credit: This variable has a statistically significant influence on the level of food security of HHH at P<0.01or 1% (P=0.000) as indicated in Table 4.9. The result indicate that household who have access saving and creditincrease their food security more likely for the food secure and mildly food insecure category and decreased for moderate and severely food insecure. Furthermore the marginal effect in Table 4.10 indicates that, for food secure and mildly food insecure access to saving and credit increase the probability to food secured increase by 11.86% and 20.55% respectively. Whereas, the probability food security for the moderate and severely food insecure category by 24.14% and 8.27% respectively.This implies that, the better off household get awareness of saving and credit and more likely to be a member while the poorer ones they are not a member in saving and credit.

Table 4.10: Marginal effects after ordered logit model

Variables	Marginal effect dy/dx for food secure	Marginal effect dy/dx for mild food secure	Marginal effect dy/dxformoderately food secure	Marginal effect dy/dx for severely food secure

Sex	-.1610445	-.0595837	.1826083	.0380199
Age	-.0018711	-.0027845	.0036709	.0009848
Agroecology	-.0165315	-.0246021	.0324331	.0087006
Educational	.0106919	.0159116	-.0209764	-.0056272
Family size	-.0233037	-.0346805	.0457195	.0122648
Land size	-.001022	-.0015209	.002005	.0005379
Total livestock	.0010117	.0015056	-.0019848	-.0005324
Irrigation users	.1347926	.1076676	-.195407	-.0470532
Market linkage	.2812121	.0774242	-.2918138	-.0668226
Agricultural extension	.2092084	.1902787	-.3089087	-.0905784
Distance from market	-.0036796	-.0054759	.007219	.0019366
Distance from drinking water	.0060643	.0090248	-.0118975	-.0031916
Livelihood diversification	-.0253566	-.0385633	.0502329	.013687
Information on climate variability	-.0204639	-.0272496	.0379415	.009772
Access to saving and credit	.1186439	.2055518	-.2414465	-.0827493

Source: Author's regression result using STATA 14, 2020

4.4.3 Qualitative data analysis

Focus group discussion (FGD) and key informant interview (KII)

In order to complement the information collection through surveys and semi-structured interviews methods. Two focus groups with eight each male and female household heads discussed in Woredas administration offices.

The qualitative information largely coincides with the information collected through questionnaire surveys. Most of the respondents had the view that temperatures in the study area were increasing and the rainfall decreasing at an unusual rate compared to the past 20 years.The following remarks had been given by one of the respondents:

'*…20 years ago we had been seen a jungles of forest, a wild animals, and different forest trees and gained a fresh air from it. When we cultivate a land and we produce crops on small plot of farm land we harvest many folds we gain today. There was no rainfall variability. We exactly know the time raining start and stop. We were not worry about the rainfall time with our farm time. But now, those all are changed. The rainfall sometimes rain early from a normal season and other time rain late rainfall. The temperature is becoming warmer than before and affect the production our crops by pest and it dry the body of crops. Our harvest yield decreased every year. So that we are challenged for the production of our crops.*' Siyumkebede, 48, a member of FGD01.

In Ethiopia, climate variability and change is mainly manifested through the variability and decreasing trend in rainfall and increasing trend in temperature (Zerga& Gebeyehu, 2016). This implies that the farmers know climate variability and the impact on their lives. Rising temperatures also will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria. Other studies indicated, temperature increases will potentially severely increase rates of extinction for many habitats and species (UNFCCC, 2007).

'…completely different climate variability we faced from the past 20 years ago compared with present condition. Before that we can guess when it rains with ice that affect the crops. It happened very rare. But now, even before we not know when it will rain, we seen high rainfall with ice hit the production of crops. These shows how climate variability is happening. In order balance these climate change we are planting trees and others activities that contributed to it. We informed from government and non-governmental organization teach on the ways to improve our climate." Gemechu Daba, 61, a member of FGD02. It indicates the smallholder's farmers already engaged with locally adaption strategies in order to reduce the impact climate variabilities on their lives.

Key informant asked about impact of climate change on food security status replied.

'...many farmers have an information of climate variability. It has seen on impact it produce on crop yield. We have been teaching and train our staff and farmers on the adaptation strategies in collaboration with our development partners. We have been planting trees, integrated agricultures, soil and water conservation and agroforestry and etc. Different works on these as FMNR (Farmers managed Natural Re-generation) and areaclosureare on good status. The government strategies on these is very promising. The impact of climate variability affects every

body above all, the pregnant women and children are the most vulnerable to climate impact. Mostly low land area are more affected by impact of climate change because they face more soil erosion, landslide, floods and sometimes drought. We work to reduce the impacts and capacitate our communities by diversifying their income to different off farm activities, mobilize communities' habits of saving money in collaboration with microfinance and small micro enterprise office.' Dereje, 43, Agricultural extension worker. This implies the government policy on adaptation strategies gives hope for farmers to contribute their parts and similar studies, enable effective adaptation measures, governments as well as non-government must consider integrating climate change in their planning and budgeting in all levels of decisionmaking (Mendelsohn, 2000).

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The findings of this paper suggest that farmers are aware of changes in climatic variables, especially increasing temperature and decreasing in annual rainfall and changing the seasonal patterns. The adaptation strategies of local level community has promising for future climate variability on the food security. The adaptation strategies includes: planting trees on the private and communal land, agro-forestry practice, new crop varities that are resilent to climate variability and soil and water conservation works. The role of saving and credit in case of climate variability hit their livelihood used are agricultural input purchase, medication and schools fee and home consumption purpose. The smallholders' farmers heard about climate variability from different media, government and non-governmental organization training/meetings, agriculture extension and from multiple of these. The coping strategies the sampled household during food insucured includes: migrated to other area searching for jobs, support from Gov't and NGOs, lending from lenders and skip days without eating. The HFIAS analysis result indicated that 20.26 % are food secure where as 79.74 are food insecure.

From the result ordered logistic regression indicated that, male headed household, having more family members and close distance to the market are more likely to aware and cope up from the impact climate variability are positively significantly on food security. Moreover studies result indicated by orderd logistic regression marginal effect that keeping other variables constant, the educational level, access to irrigation, market linkage, get agricultural extension contact and access to saving and credit has positive relationship with for those sampled household categorized for more food secure and mildly food insecure.

5.2 Recommendations

Based on the findings and results of the study, the following recommendation forwarded to improve farmers of Yaya Gullele impact climate variability affect on their food security status and adaptation to climate change and variability for enhancing household food security status.

- Institutional buiding should be employed by Woreda Disaster Risk Management and Agricultural and Natural Resource Office to providing updated information to assess the daily, weekly, and monthly and season weather condition of the area and report for

concerned body who can take immediate action and response for farmers. Moreover, early warning task force should be organized on kebele level by those office.

- Agricultural and Natural Resource Management office should employ professional agricultural experts who are responsible and living with farmers and provide important knowledge for farmers.
- Non-governmental organization (world vision) currently found on woreda in collaboration with Cooerative and Promotion office should organizing communities on saving groups on five kebeles from 17 kebeles only. They should be diversifying the groups on other kebeles in order to enhance the income the smallholders' farmers.
- World vision, Cooperatives and Promotion Office and Agricultural and Natural Resource Management Office should collaborate and identify and make market linkage of the potential product on the District that have not market and construct small scale irrigation for lowland areas of the communities.
- The Small and Medium Enterprise Office of the woreda should be aware and train the communities not engage only on agriculture sectors that vulnerable to climate change but diversify their income on off farm activities.

Reference

Abate Senbete (2009). Climate Change Impact on Livelihood, Vulnerability and Coping Mechanisms: A Case Study of West-Arsi Zone, Ethiopia. LUCSUS, Lund University SE- 22644, Lund, SwedeAklilu and alebachew, 2009

Abayineh Amare Woldeamanuel and Belay Simane.(2017). Assessment of Household Food Security in the Face of Climate Change and Variability in the Upper Blue-Nile of Ethiopia.

Abram, N. J., Wright, N. M., Ellis, B., Dixon, B. C., Wurtzel, J. B., England, M. H., ... & Shen, C. C. (2020). Coupling of Indo-Pacific climate variability over the last millennium. *Nature*, *579*(7799), 385-392.

Acquah-de Graft, H. (2011). Farmers' Perceptions and Adaptation to Climate Change: a willingness to pay analysis. Journal of Sustainable Development in Africa 13(5), pp. 150161.

Adger, W.N., Huq, S., Brown, K., Conway, D. and Hulme, M. (2003). Adaptation to Climate Change in the Developing World. Prog. Dev. Stud. 3(3), pp. 179–195. Kemausuor et al, 2011

Alemu, Tadesse, and Alemayehu Mengistu. "Impacts of climate change on food security in Ethiopia: adaptation and mitigation options: a review." In *Climate Change-Resilient Agriculture and Agroforestry*, pp. 397-412. Springer, Cham, 2019.

Amha, Wolday. "Managing growth of microfinance institutions (MFIs): Balancing sustainability and reaching large number of clients in Ethiopia." *Ethiopian Journal of Economics* 13, no. 2 (2004): 61-101.

Amogne Asfaw, Belay Simane, Ali Hassen and Amare Bantider (2018). Variability and Time Series Trend Analysis of Rainfall and Temperature in Northcentral Ethiopia: A case study in Woleka sub-basin. Weather and Climate Extremes 19, pp. 29–41.

Amsalu, Aklilu, and Alebachew Adem. "Assessment of climate change-induced hazards, impacts and responses in the southern lowlands of Ethiopia." Forum for Social Studies (FSS), 2009.

Arbuckle, J. G., Morton, L. W., & Hobbs, J. (2013). Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: Evidence from Iowa. *Climatic Change*, *118*(3-4), 551-563.

Paulos Asrat and Belay Simane (2018). Household and plot-level impacts of sustainable land management practices in the face of climate variability and change: empirical evidence from Dabus Sub-basin, Blue Nile River, Ethiopia, Agric Food Secur (2018) 6:6, 1DOI https://doi.org/10.1186/s40066-017-0148-y

Awojobi, O. &Bein, M.A. 2011. Micro financing for Poverty Reduction and Economic Development; a Case for Nigeria. International Research Journal of Finance and Economics, 1450-2887(72).

Ayalew, Dereje, Kindie Tesfaye, Girma Mamo, Birru Yitaferu, and Wondimu Bayu. "Variability of rainfall and its current trend in Amhara region, Ethiopia." *African Journal of Agricultural Research* 7, no. 10 (2012): 1475-1486.

Bekele, Wagayehu. "Economics of soil and water conservation Theory and Empirical application to subsistence farming in the Eastern Ethiopian highlands." PhD diss., Swedish University of Agricultural Sciences, 2003.

Belay, Abrham, John W. Recha, Teshale Woldeamanuel, and John F. Morton. "Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia." *Agriculture & Food Security* 6, no. 1 (2017): 24.

Bethel Geremew. (2018). Analysis of Meteorological Drought Using SPI and Large Scale Climate Variability (ENSO)-A case study in North Shewa Zone, Amhara Regional State, Ethiopia DebreBerhan University.

Boko M.I., Niang A, Nyong C, Vogel A, Githeko M, et al. (2007). Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: Parry M.L, Canziani, O.F, Palutikof, J.P., van der Linden, PJ., Hanson,C.E. (eds.) Cambridge University Press, Cambridge UK, pp. 433-467.

Bruce, J. P., Lee H, and Haites E.F. (1995). Climate Change 1995: Economic and social dimensions of climate change. Published by syndicate of the University of Cam

Chambwera, M. and Stage, J. (2010). Climate Change Adaptation in Developing Countries: Issues and Perspectives for Economic Analysis. International Institute for Environment and Development, 3 Endsleigh Street, London WC1H 0DD,

Chowdhury, M.A. & Salleh, M.C (2017), The Impact of Microcredit on Financial Condition and Socio-economic of Women Entrepreneurs in Bangladesh, International Journal ofAccounting, Finance and Business, 2(6), 38-49

Clayton, S., Devine-Wright, P., Stern, P.C, Whitmarsh, L., Carrico, A., Steg L, Swim, J. and Bonnes, M. (2015). Psychological Research and Global Climate Change. Nature Climate Change 5, pp. 640–46.

Craparo, A. C. W., Van Asten, P. J., Läderach, P., Jassogne, L. T., & Grab, S. W. (2015). Coffea arabica yields decline in Tanzania due to climate change: Global implications. *Agricultural and Forest Meteorology*, *207*, 1-10.

CSA. (2009). Summary and statistical reports of the population and housing census 2009

Daniel Megistu, Woldeamlak Bewket and Lal, R. (2014). Recent Spatiotemporal Temperature and Rainfall Variability and Trends over the Upper Blue Nile river Basin, Ethiopia. Int. J. Climatol. 34, pp. 2278–2292. Retrieved from: https://doi.org/10.1002/joc.3837.

Datt, G., K.Simler, Mukherjee and G. Dava. (2000). Determinants of Poverty in Mozambique: 1996-97. Food Consumption and Nutrition Division, Discussion paper No. 78, Washington, D.C., International Food Policy Research Institute.

Deschênes, O., & Greenstone, M. (2007). The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather. *American Economic Review*, *97*(1), 354-385.

DfID (2004). The Impact of Climate Change on the Vulnerability of the Poor. Global and Local Environment Team, Policy Division, Department for International Development, London, UK.

Deressa, Temesgen Tadesse. *Measuring the economic impact of climate change on Ethiopian agriculture: Ricardian approach*. The World Bank, 2007.

Deressa, Temesgen, Rashid M. Hassan, and Claudia Ringler. *Measuring Ethiopian farmers' vulnerability to climate change across regional states*. Intl Food Policy Res Inst, 2008.

Deressa, Temesgen Tadesse, Rashid M. Hassan, Claudia Ringler, Tekie Alemu, and Mahmud Yesuf. *Analysis of the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia [in Amharic]*. No. 15 (9) AMH. International Food Policy Research Institute (IFPRI), 2008.

Deressa, Temesgen Tadesse, Rashid M. Hassan, Claudia Ringler, Tekie Alemu, and Mahmud Yesuf. "Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia." *Global environmental change* 19, no. 2 (2009): 248-255.

EdwardsJones, G., MilàCanals, L., Hounsome, N., Truninger, M., Koerber, G., Hounsome, B., Cross, P., York, E. H., Hospido, A., Plassmann, K., Harris, I. M., Edwards, R. T., Day, G. A. S., Tomos, A. D., Cowell, S. J. & Jones, D. L. (2009). Testing the assertion that 'local food is best': the challenges of an evidence-based approach. *Trends in Food Science and Technology* 19, 265–274.

EPA (2011). Ethiopia's Climate-Resilient Green Economy (CRGE). Addis Ababa, Ethiopia.

EPA (2012). National Report of Ethiopia, the United Nations Conference on Sustainable Development (Rio+20). Addis Ababa: Federal Democratic Republic of Ethiopia.

Falaki, A., Akangbe, J. and Ayinde, O. (2013). Analysis of Climate Change and Rural Farmers' Perception in North Central Nigeria. Journal of Human Ecology 43, pp. 133-140

FAO (2007). Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities. Rome.

FAO (2011). Gender: Food and Agriculture ProgrammeOrganisationprogramme. http://www.fao.org/gender/genderhome/gender-programme/gender-food/en/ Date of access: 17 October. 2013.

Federal Democratic Republic of Ethiopia (FDRE) (2017). Climate Change Adaptation Programme of Action (NAPA) of Ethiopia Ministry of Water Resources and National Meteorological Agency, Addis Ababa.

Ferguson, M.J. and Bargh, J.A. (2004). How Social Perception can automatically Influence Behavior. TRENDS in Cognitive Sciences 8(1), pp. 33–39.

Gebremichael, Dawit. "Zoonotic impact and epidemiological changes of leishmaniasis in Ethiopia." *Open Veterinary Journal* 8, no. 4 (2018): 432-440.

Getis, A., Getis, J. and Fellman, J.D. (2000). Introduction to Geography, 7th edition, McGrawHill, New York.Nzeadibe and Ajaero, 2010

Gbetibouo, G. A., Hassan, R. M., & Ringler, C. (2010). Modelling farmers' adaptation strategies for climate change and variability: The case of the Limpopo Basin, South Africa. *Agrekon*, *49*(2), 217-234.

Gray, C. L., & Mueller, V. (2012). Natural disasters and population mobility in Bangladesh. *Proceedings of the National Academy of Sciences*, *109*(16), 6000-6005.

Hartig, T., Kaiser, F.G. and Bowler, P.A. (2001). Psychological Restoration in Nature as a Positive Motivation for Ecological Behavior. Environment and Behavior 33(4), pp. 590– 607.

Hassan, A. & Bhuiyan, A.B. (2013), Microcredit and Sustainable livelihood: An Empirical Study of Islamic and Conventional Credit on the Development of Human Capital of the Borrowers in Bangladesh, Journal of Economic Cooperation and Development, 34, 3, 101-128

Howe, P.D., Markowitz, E.M., Lee, T.M., Ko, C.Y. and Leiserowitz, A. (2013). Global Perceptions of Local Temperature Change. Nature Climate Change 3, pp. 352–356Clayton et al, 2015

IPCC, 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability: Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press.

IPPC, 2007. Tipping elements in the earth's climate system. Proceedings of the national academy of science 105, no.6 (2008):1786-1793.

Kasperson, R. E., Kasperson, J. X., and Dow, K. (2001). Vulnerability, equity, and global environmental change', in J. X. Kasperson and R. E. Kasperson (eds.), Global Environmental Risk, London: Earthscan

Keller, K., G. Yohe and M. Schlesinger, (2007). Managing the risk of climate thresholds: uncertainties and information needs. Climate Change, doi: 10. 1007/s10584-006-9114-6.

Khandker, S., 1998a. Micro credit programmeevaluation:A critical review1. IDS Bull., 29(4): 11-20

Lindsay, P.H., and Norman, D.A. (1972). Human Information Processing: An Introduction to Psychology. San Diego, CA, US: Academic Press, Inc.Hartig, Kaiser and Bowler, 2001

Lin BB. 2011. Agro forestry adaptation and mitigation options for smallholder farmers vulnerable to climate change. Agro ecology, ecosystems and sustainability.1st e d New York: Taylor and Francis Group. Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, Naylor RL. 2008. Prioritizing climate change adaptation needs for food security in 2030. Science 319: 607–610.

Maddison, D. (2006). The Perception of and Adaptation to Climate Change in Africa. Discussion Paper No. 10. Centre for Environmental Economics and Policy in Africa (CEEPA), University of Pretoria, South Africa

Mahmud Yesuf, Di Falco, S., Temesgen Taddese, Ringler, C. and Kohlin, G. (2008). The Impact of Climate Change and Adaptation on Food Production in Low-Income Countries: evidence from the Nile Basin, Ethiopia. IFPRI Discussion Paper 00828, pp. 1-24.

Mcsweeney, C., New, M., Lizcano, G., & Lu, X. (2010). The UNDP Climate Change Country Profiles: Improving the accessibility of observed and projected climate information for studies of climate change in developing countries. *Bulletin of the American Meteorological society*, *91*(2), 157-166.

MekuanentMuche. (2014). Determinants of Household Food Security among Southwest Ethiopia Rural Households. MSc Thesis Jimma University.

Mendelsohn R, Dinar A &Dalfelt A. (2000). Climate change impacts on African agriculture, www.ceepa.co.za/Climate_Change/pdf/. Accessed on 10, May 2015

Mertz, O., Mbow, C., Reenberg, A. and Diouf, A. (2009). Farmers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahel. Environmental Management 43, pp. 804–816.Falaki, Akangbe and Ayind, 2013

MoA. (2016). Guideline for Development Agents on Soil and Water Conservation in Ethiopia

Mokria, Mulugeta, Aster Gebrekirstos, Ermias Aynekulu, and Achim Bräuning. "Tree dieback affects climate change mitigation potential of a dry afromontane forest in northern Ethiopia." *Forest Ecology and Management* 344 (2015): 73-83.

MulukenMoges. (2019). The effect of urban productive safety net project to household food security status in Addis Ababa: a case study from Yeka sub-city woreda 08, Addis Ababa, Ethiopia Food Security and Development Studies Addis Ababa University

Namara, K. M., & Hollinger, C. (2003). Intervention-based assessment: Evaluation rates and eligibility findings. *Exceptional Children*, *69*(2), 181-193.

NAPA (2007). Climate Change, National Adaptation Programme of Action Ethiopia. Addis Ababa.

Ndaki, M.P. (2014). Climate Change Adaptation for Smallholder Farmers in Rural Communities: The Case of Mkomazi Sub-Catchment, Tanzania. PhD Thesis. University of Oldenburg, Carl Von Ossietzky. Wolf and Moser, 2011

Negash Mulatu Debalke. (2011). Determinants of farmers‟ preference for adaptation strategies to climate change: evidence from north shewa zone of Amhara region Ethiopia. MPRA Paper No. 4875: Online at http://mpra.ub.uni-muenchen.de/48753/

Nemachena, C. and Hassan, R. (2007). Micro-level Analysis of Farmers' Adaptation to Climate Change in Southern Africa. IFPRI Discussion Paper 00714, IFPRI, Washington.

Ngugi, M. W. (2012). *The impact of credit information sharing on credit risk for commercial banks in Kenya* (Doctoral dissertation).

Niles, M.T., Lubell, M. and Haden, V.R. (2013). Perceptions and Responses to Climate Policy Risks among California Farmers. Global Environ. Change 23, pp. 1752–1760.Arbuckle et al, 2013.

NMA (2006). National adaptation programme of action of Ethiopia (NAPA). Addis Ababa

NMA (National Meteorological Agency), (2007). National Meteorology Agency: Final Report on Evaluation Criteria for Identifying High Priority Adaptation Activities prepared by B and M Development Consultants for NMA. Addis Ababa, Ethiopia

Olsen, C. and George, M. (2004). Cross-Sectional Study Design and Data Analysis. College Entrance Examination Board, New York, pp.1-53.

Osbahr, H., Dorward, P., Stern, R. and Cooper, S. (2011). Supporting Agricultural Innovation in Uganda to Respond to Climate Risk: linking climate change and variability with farmers' perceptions. Expl. Agric. 47(2), pp. 293–316.

Oxfam International, (2010). The Rain Doesn't Come On Time Anymore: poverty, vulnerability, and climate variability in Ethiopia. Addis Ababa: Oxfam International- Ethiopia.UN-ISDR 2010

Patt, A.G. and Schro¨ter, D. (2008). Perceptions of Climate Risk in Mozambique: implications for the success of adaptation strategies. Global Environmental Change 18(3), pp. 458– 467.Amogne et al, 2018

Piya, L., Maharjan, K. and Joshi, N. (2013). Determinants of Adaptation Practices to Climate Change by Chepang Households in the Rural Mid-Hills of Nepal. Regional Environmental Change 13(2), pp. 437–447. Osbahr et al, 2011

Skolnik, R. (2016). Global Health 101 (3rd ed., pp. 186–187). Burlington, MA: Jones and Bartlett Learning.

Solomon, A., Goddard, L., Kumar, A., Carton, J., Deser, C., Fukumori, I., & Newman, M. (2011). Distinguishing the roles of natural and anthropogenically forced decadal climate variability: implications for prediction. *Bulletin of the American Meteorological Society*, *92*(2), 141-156.

Speranza, C.I., Kiteme, B. and Opondo, M. (2009). Adapting Public Agricultural Extension Services to Climate Change: Insights from Kenya. Paper Presented in the Amsterdam Conference on the Human Dimensions of Global Environmental Change, 2-4 December 2009. Friday December 4, 2009. Panel 9: Vulnerability and Adaptation in Agricultural and Food Systems.

Tabari, H. and Talaee, H. (2011). Analysis of Trends in Temperature Data in Arid and Semi-arid Regions of Iran. Global and Planetary Change 79(1), pp. 1-10.

Temesgen Taddese, Hassan, R.M. and Ringler, C. (2008). Measuring Ethiopian Farmers' Vulnerability to Climate Change across Regional States, IFPRI Discussion Paper 00806, International Food Policy Research Institute (IFPRI). Washington, DC, USA.

Tesso, Gutu, Bezabih Emana, and Mengistu Ketema. "Analysis of vulnerability and resilience to climate change induced shocks in North Shewa, Ethiopia." *Agricultural Sciences* 3, no. 06 (2012): 871.

Thomson, M. C., & Connor, S. J. (2001). The development of malaria early warning systems for Africa. *Trends in parasitology*, *17*(9), 438-445.

Thornton, B. R., & Toczyski, D. P. (2006). Precise destruction: an emerging picture of the APC. *Genes & development*, *20*(22), 3069-3078.

Torquebiau E. (2016). Climate Change and Agriculture Worldwide. Heidelberg: Springer, p. 373. Retrieved from: http://doi.org/10.1007/978-94-017-7462-8.

UNFCCC (2007). Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries. Retrieved from: <www.unfccc.int>.

Wakilo, K.G. &Sakwa, M. (2014). Socio-Economic Effects of Microfinance Services on Women: The Case of Rosewo Microfinance, Nakuru County, Kenya. International Journal of Academic Research inEconomics and Management Science,ISSN: 2226-3624, Vol. 3, 46-18.

Watson, R. T., Zinyowera, M. C., Moss, R. H., & Dokken, D. J. (1998). The regional impacts of climate change. *IPCC, Geneva*.

Wehler, C., R. Scott, and J. Anderson. (1992). "The community childhood hunger identification project: A model of domestic hunger -- demonstration project in Seattle, Washington." Journal of Nutrition Education 24: 29S-35S.

Wolf, J. and Moser, S.C. (2011). Individual Understandings, Perceptions, and Engagement with Climate Change: Insights from In-Depth Studies across the World. Wiley Interdisciplinary Reviews: Climate Change, 2, 547-569.

World Bank. 2006. Ethiopia: Managing Water Resources to Maximize Sustainable Growth A World Bank Water Resources Assistance Strategy for Ethiopia. Washington, DC.

YGWFEDO, (2018). Yaya GuleleFinanace and Economic Development Office, 2018

Yemane, M. (1967). Elemantary Sampling Theory, Printice-Hall Inc. *Englewood Cliffs, New Jersey, USA.*

Zerga, Belay, and Getaneh Gebeyehu. "Climate Change in Ethiopia Variability, Impact, Mitigation, and Adaptation." *Journal of Social Science and Humanities Research* 2, no. 4 (2016): 66-84.

Zewdu Eshetu, Belay Simane, Gebeyehu Tebeje, WorknehNegatu, Aklilu Amsalu, Abeje Berhanu, Bird, N., Welham, B. and Canales Trujillo, N. (2014). Climate Finance in Ethiopia. London: Overseas Development Institute; Addis Ababa: Climate Science Centre. Retrieved from: (www.odi.org/publications/8203-climatefinance-ethiopia).

Appendix

Appendix 1.1: Ordered logit food security status and food security by HFIAS

```
. ologit HFIASscore Gender Age Agroecology Educationalstatus FamilySize Landsize Totalliv
> estock Irrigationusers Marketlinkage Agriculturalextensioncontact Distancefrommarket Di
> stancefromdrinkingwater Livelihooddiversification Informationofclimatevariabili Accesst
> osavingandcredit

Iteration 0:   log likelihood = -305.81133
Iteration 1:   log likelihood = -231.81759
Iteration 2:   log likelihood = -227.20876
Iteration 3:   log likelihood = -227.14327
Iteration 4:   log likelihood = -227.14319
Iteration 5:   log likelihood = -227.14319

Ordered logistic regression                     Number of obs   =        232
                                                LR chi2(15)     =     157.34
                                                Prob > chi2     =     0.0000
Log likelihood = -227.14319                     Pseudo R2       =     0.2572
```

HFIASscore	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Gender	1.194149	.4773627	2.50	0.012	.2585349	2.129762
Age	.0204019	.0140227	1.45	0.146	-.0070821	.0478859
Agroecology	.180257	.2311929	0.78	0.436	-.2728728	.6333868
Educationalstatus	-.1165827	.0385798	-3.02	0.003	-.1921977	-.0409677
FamilySize	.2541	.1006721	2.52	0.012	.0567862	.4514138
Landsize	.0111436	.1887257	0.06	0.953	-.3587519	.3810392
Totallivestock	-.0110312	.0147806	-0.75	0.455	-.0400007	.0179383
Irrigationusers	-1.181718	.3588917	-3.29	0.001	-1.885133	-.4783029
Marketlinkage	-2.005382	.3655851	-5.49	0.000	-2.721915	-1.288848
Agriculturalextensio~t	-1.927036	.3173887	-6.07	0.000	-2.549107	-1.304966
Distancefrommarket	.0401215	.0235543	1.70	0.089	-.0060441	.0862871
Distancefromdrinking~r	-.0661239	.0577654	-1.14	0.252	-.179342	.0470942
Livelihooddiversific~n	.2792722	.2789431	1.00	0.317	-.2674462	.8259906
Informationofclimate~i	.2129937	.3316109	0.64	0.521	-.4369518	.8629392
Accesstosavingandcre~t	-1.411879	.3111901	-4.54	0.000	-2.021801	-.8019581
/cut1	-.9857545	1.159327			-3.257993	1.286484
/cut2	1.796664	1.156982			-.4709787	4.064307
/cut3	4.114479	1.186092			1.789782	6.439177

Appendix 1.2: Marginal effect after ologit

```
. mfx

Marginal effects after ologit
      y  = Pr(HFIASscore==0) (predict)
         =  .10214443
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
Gender*	-.1610445	.08714	-1.85	0.065	-.331828	.009739		.922414
Age	-.0018711	.00131	-1.42	0.154	-.004447	.000704		50.1336
Agroec~y	-.0165315	.02124	-0.78	0.436	-.058165	.025102		2.00862
Educat~s	.0106919	.00384	2.79	0.005	.003168	.018216		3.62069
Family~e	-.0233037	.00975	-2.39	0.017	-.042415	-.004192		5.20259
Landsize	-.001022	.01731	-0.06	0.953	-.034948	.032904		2.35172
Totall~k	.0010117	.00136	0.74	0.457	-.001655	.003678		17.2716
Irriga~s*	.1347926	.05147	2.62	0.009	.033907	.235679		.280172
Market~e*	.2812121	.07114	3.95	0.000	.141776	.420648		.228448
Agricu~t*	.2092084	.04588	4.56	0.000	.11928	.299137		.422414
Distan~t	-.0036796	.00223	-1.65	0.099	-.008047	.000688		12.2931
Distan~r	.0060643	.00538	1.13	0.260	-.004477	.016606		5.28448
Liveli~n*	-.0253566	.02529	-1.00	0.316	-.074933	.024219		.448276
Inform~i*	-.0204639	.0335	-0.61	0.541	-.086118	.04519		.771552
Access~t*	.1186439	.02966	4.00	0.000	.060518	.17677		.612069

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

Appendix 1.3: Logistic model test (goodness of fit and link test) for food security analysis

```
. linktest

Iteration 0:   log likelihood = -305.81133
Iteration 1:   log likelihood = -229.59822
Iteration 2:   log likelihood = -225.08095
Iteration 3:   log likelihood = -225.04211
Iteration 4:   log likelihood = -225.04209

Ordered logistic regression                     Number of obs   =        232
                                                LR chi2(2)      =     161.54
                                                Prob > chi2     =     0.0000
Log likelihood = -225.04209                     Pseudo R2       =     0.2641
```

HFIASscore	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_hat	1.19724	.1488511	8.04	0.000	.9054971	1.488983
_hatsq	-.0798684	.0405181	-1.97	0.049	-.1592824	-.0004544
/cut1	-1.165099	.2381463			-1.631858	-.6983412
/cut2	1.730116	.2399722			1.259779	2.200453
/cut3	3.944609	.3342993			3.289394	4.599824

Appendix 1.4: mfx for food security categories of households

```
. mfx, predict (outcome(0))

Marginal effects after ologit
      y  = Pr(HFIASscore==0) (predict, outcome(0))
         =  .10214443
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Gender*	-.1610445	.08714	-1.85	0.065	-.331828	.009739	.922414
Age	-.0018711	.00131	-1.42	0.154	-.004447	.000704	50.1336
Agroec~y	-.0165315	.02124	-0.78	0.436	-.058165	.025102	2.00862
Educat~s	.0106919	.00384	2.79	0.005	.003168	.018216	3.62069
Family~e	-.0233037	.00975	-2.39	0.017	-.042415	-.004192	5.20259
Landsize	-.001022	.01731	-0.06	0.953	-.034948	.032904	2.35172
Totall~k	.0010117	.00136	0.74	0.457	-.001655	.003678	17.2716
Irriga~s*	.1347926	.05147	2.62	0.009	.033907	.235679	.280172
Market~e*	.2812121	.07114	3.95	0.000	.141776	.420648	.228448
Agricu~t*	.2092084	.04588	4.56	0.000	.11928	.299137	.422414
Distan~t	-.0036796	.00223	-1.65	0.099	-.008047	.000688	12.2931
Distan~r	.0060643	.00538	1.13	0.260	-.004477	.016606	5.28448
Liveli~n*	-.0253566	.02529	-1.00	0.316	-.074933	.024219	.448276
Inform~i*	-.0204639	.0335	-0.61	0.541	-.086118	.04519	.771552
Access~t*	.1186439	.02966	4.00	0.000	.060518	.17677	.612069

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

```
. mfx, predict (outcome(1))

Marginal effects after ologit
      y  = Pr(HFIASscore==1) (predict, outcome(1))
         =  .54552195
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Gender*	-.0595837	.036	-1.66	0.098	-.130138	.01097	.922414
Age	-.0027845	.00197	-1.41	0.159	-.006655	.001086	50.1336
Agroec~y	-.0246021	.03196	-0.77	0.441	-.087237	.038033	2.00862
Educat~s	.0159116	.00593	2.68	0.007	.004281	.027543	3.62069
Family~e	-.0346805	.01505	-2.30	0.021	-.064173	-.005188	5.20259
Landsize	-.0015209	.02576	-0.06	0.953	-.052012	.04897	2.35172
Totall~k	.0015056	.00204	0.74	0.461	-.002494	.005506	17.2716
Irriga~s*	.1076676	.0328	3.28	0.001	.043389	.171947	.280172
Market~e*	.0774242	.05102	1.52	0.129	-.022575	.177424	.228448
Agricu~t*	.1902787	.04486	4.24	0.000	.102352	.278205	.422414
Distan~t	-.0054759	.00334	-1.64	0.101	-.012024	.001072	12.2931
Distan~r	.0090248	.00801	1.13	0.260	-.006682	.024732	5.28448
Liveli~n*	-.0385633	.03973	-0.97	0.332	-.116425	.039299	.448276
Inform~i*	-.0272496	.03978	-0.69	0.493	-.105213	.050714	.771552
Access~t*	.2055518	.05383	3.82	0.000	.100042	.311062	.612069

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

```
. mfx, predict (outcome(2))

Marginal effects after ologit
      y  = Pr(HFIASscore==2) (predict, outcome(2))
         =  .30148003
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Gender*	.1826083	.05958	3.06	0.002	.065836	.299381	.922414
Age	.0036709	.00255	1.44	0.149	-.001321	.008662	50.1336
Agroec~y	.0324331	.04171	0.78	0.437	-.049326	.114192	2.00862
Educat~s	-.0209764	.00717	-2.93	0.003	-.035024	-.006929	3.62069
Family~e	.0457195	.01857	2.46	0.014	.009318	.082121	5.20259
Landsize	.002005	.03396	0.06	0.953	-.064556	.068566	2.35172
Totall~k	-.0019848	.00267	-0.74	0.457	-.007215	.003245	17.2716
Irriga~s*	-.195407	.05507	-3.55	0.000	-.303347	-.087467	.280172
Market~e*	-.2918138	.04563	-6.40	0.000	-.381244	-.202384	.228448
Agricu~t*	-.3089087	.04782	-6.46	0.000	-.402632	-.215186	.422414
Distan~t	.007219	.00428	1.69	0.092	-.00117	.015608	12.2931
Distan~r	-.0118975	.01045	-1.14	0.255	-.032377	.008582	5.28448
Liveli~n*	.0502329	.05068	0.99	0.322	-.049107	.149573	.448276
Inform~i*	.0379415	.05846	0.65	0.516	-.076642	.152525	.771552
Access~t*	-.2414465	.05316	-4.54	0.000	-.345632	-.137261	.612069

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

```
. mfx, predict (outcome(3))

Marginal effects after ologit
      y  = Pr(HFIASscore==3) (predict, outcome(3))
         =  .05085359
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Gender*	.0380199	.01237	3.07	0.002	.013766	.062274	.922414
Age	.0009848	.0007	1.41	0.159	-.000386	.002355	50.1336
Agroec~y	.0087006	.01128	0.77	0.440	-.013405	.030806	2.00862
Educat~s	-.0056272	.00212	-2.66	0.008	-.00978	-.001474	3.62069
Family~e	.0122648	.00533	2.30	0.021	.001826	.022703	5.20259
Landsize	.0005379	.00911	0.06	0.953	-.017316	.018392	2.35172
Totall~k	-.0005324	.00072	-0.74	0.460	-.001945	.00088	17.2716
Irriga~s*	-.0470532	.01509	-3.12	0.002	-.076634	-.017472	.280172
Market~e*	-.0668226	.01611	-4.15	0.000	-.098395	-.035251	.228448
Agricu~t*	-.0905784	.02166	-4.18	0.000	-.133024	-.048133	.422414
Distan~t	.0019366	.00119	1.63	0.104	-.000396	.004269	12.2931
Distan~r	-.0031916	.00283	-1.13	0.260	-.008744	.002361	5.28448
Liveli~n*	.013687	.01395	0.98	0.326	-.013646	.04102	.448276
Inform~i*	.009772	.01457	0.67	0.502	-.018782	.038326	.771552
Access~t*	-.0827493	.02515	-3.29	0.001	-.132038	-.03346	.612069

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

Appendix 1.5: Odd ratio of food secured analysis

```
. ologit HFIASscore Gender Age Agroecology Educationalstatus FamilySize Landsize Totalliv
> estock Irrigationusers Marketlinkage Agriculturalextensioncontact Distancefrommarket Di
> stancefromdrinkingwater Livelihooddiversification Informationofclimatevariabili Accesst
> osavingandcredit, or

Iteration 0:   log likelihood = -305.81133
Iteration 1:   log likelihood = -231.81759
Iteration 2:   log likelihood = -227.20876
Iteration 3:   log likelihood = -227.14327
Iteration 4:   log likelihood = -227.14319
Iteration 5:   log likelihood = -227.14319

Ordered logistic regression                     Number of obs   =        232
                                                LR chi2(15)     =     157.34
                                                Prob > chi2     =     0.0000
Log likelihood = -227.14319                     Pseudo R2       =     0.2572
```

HFIASscore	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Gender	3.300747	1.575653	2.50	0.012	1.295031	8.412868
Age	1.020611	.0143117	1.45	0.146	.992943	1.049051
Agroecology	1.197525	.2768593	0.78	0.436	.7611896	1.88398
Educationalstatus	.8899565	.0343343	-3.02	0.003	.8251437	.9598601
FamilySize	1.289301	.1297967	2.52	0.012	1.05843	1.570531
Landsize	1.011206	.1908405	0.06	0.953	.6985476	1.463805
Totallivestock	.9890294	.0146185	-0.75	0.455	.9607887	1.0181
Irrigationusers	.3067514	.1100905	-3.29	0.001	.1518089	.6198344
Marketlinkage	.1346089	.049211	-5.49	0.000	.0657487	.2755881
Agriculturalextensio~t	.145579	.0462051	-6.07	0.000	.0781515	.2711818
Distancefrommarket	1.040937	.0245186	1.70	0.089	.9939742	1.090119
Distancefromdrinking~r	.9360149	.0540693	-1.14	0.252	.83582	1.048221
Livelihooddiversific~n	1.322167	.3688094	1.00	0.317	.7653315	2.284142
Informationofclimate~i	1.237377	.4103277	0.64	0.521	.6460025	2.370117
Accesstosavingandcre~t	.2436849	.0758323	-4.54	0.000	.1324168	.44845
/cut1	-.9857545	1.159327			-3.257993	1.286484
/cut2	1.796664	1.156982			-.4709787	4.064307
/cut3	4.114479	1.186092			1.789782	6.439177

Appendix 1.6: Questionnaire (English Version)

Consent Information Sheet

D*ear Study Participants:*

I would like to give you information regarding the study as follows: My study attempts to investigate 'Impact of Climate Variability on Household Food Security and Coping Strategies in the Case of Yayagulale of Oromia Region, Ethiopia.'

You are randomly selected to participate in this study. The study and its procedures have been approved by the appropriate authorities (Addis Ababa University Ethical Committee). There is a questionnaire which has four parts and to be filled by you. This questionnaire is focusing on the overall situations about Climate Variability on Food Security and Coping Strategies you adapted.

In order to obtain reliable and scientific information, it is crucial to answer as honestly as possible. No need of name, identification number, or other identifying details; hence your answers are anonymous. The information from you will be treated as confidential. This research imposes no risk and therefore no compensation will be provided for participation in this study. There are no direct benefits as a research participant. You can refuse to participate or withdraw at any time without harming you. You can ask any question concerning this research and have those questions answered before agreeing to participate in or during the study. You may contact the investigator at the phone number below. You are voluntarily making a decision whether or not to participate in this study.

Your signature certifies that you have decided to participate, having read and understood the information presented.

Consent Form

I have been explained all information and procedures that are part of this study. I understand that the research imposes no risk on me and my families.

I hereby agree to participate in this research and give my voluntary consent. I hereby also give rights to the researcher for collecting the data that are required for the study.

Agree Name of the Participant: _____ _____

Signature of the Participant: _____ _____

Date: _____ _____

Name of Investigator: Feyisa Chala, Phone number: 0913-99-64-89

Quantitative – Household Survey Questions

This research aims to investigate impact and coping strategies of smallholder farmers to climate change and variability by exploring how people perceive climate change, how vulnerable they are, and what they do to adapt to climate change. Your responses will be treated as confidential and will be used for research purposes. The results of the questionnaire will not be used in any way other than for the purpose of conducting this research.

Thank you in advance for your willingness to discuss with me. Below are my questions to you:

Basic Information Region: **Oromia Regional State**, Zone: **North Shoa**, District:**Yayagulale**,

Name of Village (Kebele):_____

Date of interview: _____ Starting time: _____ Ending time: _____

Name of enumerator: _____

Instruction: Dear enumerator, please circle the number representing respondent's answer from given alternatives and/or write their answer for the rest questions requiring quantitative and other responses.

Part I: General Household Information Village: _____

1. Gender: 1) Male 2) Female
2. Marital status: 1) Married 2) Single 3) Divorced 4) Widow
3. Religion: 1) Orthodox Christian 2) Waqefeta 3) Protestant Christian 4) Traditional belief system
4. Location**:** Agro-ecological zone (local categorization): 1) Highland 2) Midland 3) Lowland

Part II: Demographic and Socioeconomic Background

1. Age of the household head: _____
2. Formal Education: 1) None 2) Primary (grade 1-8) 3) Secondary (grade 9-12) 4) Tertiary (college, university)
3. Distance from market in KM?_____
4. Distance from water source in minutes_____
5. Distance from health institutions in KM_____
6. Size of the household: How many people are living in your household? Female: ___ Male: _____ Total: _____
   1) Below 10 years of age? M_____F_____T_____
   2) Above 10 and below 14 years of age? M_____F_____T_____
   3) Between 15-50 years? M_____F_____T_____

4) Above 50 years of age? M_____F_____T_____

7. Do you own land? If yes, what is the size of the farm land you have (owned)? Measured in: Local units ('Timad'): _____ or in hectare: _____
   1) the cultivated area: _____ or (Timad)
   2) grass and woodland: _____ or (Timad)
   3) parcels/homestead: _____ or (Timad)
8. What kind of farming do you practice? 1) Crop production 2) livestock rearing 3) both crop and livestock 4) income from forest 5) All of them
9. What kind of agriculture are you practicing? 1) Rain fed agriculture 2) Irrigated agriculture 3)Both rain fed and irrigated 4) Other, specify: _____
10. Do you own (have) livestock (like cattle, sheep, goat, etc.)? 1] Yes 2] No If yes which ones? 1) Cows and Oxen 2) Donkeys 3) Goats & Sheep 4) chickens 5) horses 6) Other, Specify:_____
11. How much money you earn from agricultures per year (approximately)? _____
12. Do you or your family member have another source of income other than agriculture? Yes/No, if yes specify _____
13. What are the major crops grown by your household last five years?

Year in EC	Cereal crop	timad)	Yield	(quintal)	Cash crops	timad)	Yield
2007							
2008							
2009							
2010							
2011							
2012							

10. In which category do you classify your agricultural land on basis of its soil fertility?

1. Infertile 2. Less fertile 3. Fertile 4. Highly fertile

11. Do you have off-farm income sources? 1. Yes 2. No

12. If yes, mention some of the major sources 1. Cattle trading 2. Apiculture3. Fattening

Part III Household Survey Questions

A. Perception of Household on Climate Change and Variability

1. Are you aware of climate variability? 1) I Know well 2)I Know 3) I Know little 4) I don't know
2. How do you characterize the weather of this area in terms of its temperature and precipitation? _____Is there any change? If yes, how? _____
3. Have you ever faced any climate related impact in your life time? If yes, what type of climatic shock? _____
4. If the answer to Q3 is yes, did it affect your cattle or/and crop? Yes/No, if yes how much? _____.
5. To what extent that has affected you and/or your family? _____
6. If the answer to Q4 is yes, how did you cope or what did you do to cope with the situation?_____
7. Who do you think is most harmed by the event? _____Why? _____
8. How do you perceive the status of climate variables in your village since 2000?

S/N	Answer code: 1=strongly agree, 2=agree, 3=Neither agree nor disagree/unsure, 4=disagree, 5=strongly disagree	Answer codes: (circle)				
1	Increasing rainfall amount during rainy season	1	2	3	4	5
2	Decreasing rainfall amount during rainy season	1	2	3	4	5
3	Increasing length of rain season	1	2	3	4	5
4	Decreasing length of rain season	1	2	3	4	5
5	Early onset of rain days	1	2	3	4	5
6	Late onset of rain days	1	2	3	4	5
7	Increase of strong winds events	1	2	3	4	5
8	Increasing temperature of the area	1	2	3	4	5
9	Decreasing temperature of the area	1	2	3	4	5
88	Other, specify: _____					

9. Have you encountered extreme/unusual weather events due to climatic variability since 2000? 1) Yes 2) No 99) I don't know/cannot remember

10. If yes, what?

1) Flooding due to heavy rainfall
2) Shortage of rain
3) Drought
4) Famine
5) Crop failure
6) Increases flood disaster
7) Poor livestock productivity
8) Loss of income

9) Loss of pasture land
10) Increase deforestation
11) Loss of agricultural land
12) High intensity wind
13) Severe soil erosion
14) Drying of vegetation
15) Shortage of water
16) I do not remember/know
17) Other, specify: _____

11. What effects did it has on you?

1) Damage to property
2) Loss in livestock
3) Loss in agricultural production
4) Loss in income
5) Health hazards
6) Lack of potable water
7) None
8) I don't know
9) Other, specify: _____

B. Indigenous knowledge practices and climate change adaptation strategies adopted at household level (What has been done to adapt with climate change?)

12. Please mention different sources of knowledge concerning climate change adaptation? (multiple response is possible!)

1) Personal experience
2) Parents/Family
3) Friends/Neighbors
4) Social groups
5) Church/mosques
6) Community gathering
7) Village leaders
8) Media
9) Extension staffs
10) NGOs
11) Others, specify: _____

13. Do you have any traditional weather prediction methods?

1) Yes
2) No
1)

16. Has climate change and variability created any good opportunities for you?

1) Yes
2) No

17. If Yes, please support your answer with explanation: _____

18. Are there any adaptation strategies you made for the change in climate (precipitation and temperature)?

1) Yes
2) No
3) I don't know

19. If yes, for Q 18, what drives you to take measure against the change? _____

21. Which of the following strategies have you/ your family adopted to reduce the loss / or adapt to climatic events or change overthe last 20 years?

a) Planting trees
b) Soil and water conservation
c) Integrated agriculture
d) Agroforestry
e) Livelihood diversification
f) Multiple

22. How did the government, GOs and NGO's responded to reduce the impact? _____

23. Which type of climatic shock is your main concern? _____

24. What are the major constraints you have that hinders your coping mechanisms? _____

C. Household Food Insecurity Access Scale (HFIAS) Measurement Tools

S/N	In the past 30 days,	Yes	No
1	In the past four weeks, did you worry that your household would not have enough food, due to climate variability impact on food security?		
1a	How often did this happen?		
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of climate variability impact on food security?		
2a	If 'yes' how many days within the month? How often did this happen?		
3	In the past four weeks**,** Did you or any household member have to eat a limited variety of foods due climate variability impacted on food security**?**		
3a	If 'yes' how many days within the month? How often did this happen?		

4	Did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food, due climate variability impacted on food security?		
4a	If 'yes' how many days within the month?		
5	Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?		
5a	If 'yes' how many days within the month?		
6	Did you or any household member have to eat fewer meals in a day because there was not enough food?		
6a	If 'yes' how many days within the month?		
7	Was there ever no food to eat of any kind in your household because of lack of resources to get food?		
7a	If 'yes' how many days within the month?		
8	Did you or any household member go to sleep at night hungry because there was not enough food?		
8a	If 'yes' how many days within the month?		
9	Did you or any household member go a whole day and night without eating anything because there was not enough food?		
9a	If 'yes' how many days within the month?		

E. Income source affected by climate change and variability

25. What are income sources highly affected by impact of climate change and variability? Is it agriculture or non- agriculture or both? Tell me agricultures ones_____

F. Saving and credit money as coping mechanism of climate change and variability

26. Are you a member of money saving and credit? A) Yes B) No If yes,

27. What are the name of saving/Credit association? _____

28. In average how many birr you save per a month? _____

29. How many loan you get from your institution? _____

30. What is the frequency you get loan? _____

31. What investment you make using your loan? _____

32. Have you used saving and credit money as a coping mechanism of climate variability? A) Yes B) No

33. How efficient the saving and credit to fight the climate shock (e.g., extreme weather, climate variability, etc)?_____

G. Institutional Factors

1. Do you get agricultural extension services in your area?
   1) Yes
   2) No
2. Do you have access to information media?
   1) Yes
   2) No
3. If your answer is yes, which medium do you possess?
   1) Radio
   2) TV
   3) Newspaper
   4) Extension agents
   5) Other, specify: _____

PartV. Guiding Questions for Focus Group Discussion (FGD) (with selected farmers representing cross section of the community, women group, youth group)

Address (location) of the village: _____

Focus group size: _____

Focus group composition: Male headed households/women headed households/youth group, kebele leaders

1. What visible changes have you observed related to rain fall, temperature, soil fertility forest vegetation, wildlife, crop productivity, livestock productivity, flow of streams, occurrence of big floods, incidence of drought, forest vegetation cover, river/stream flow etc during your life time in the village?
2. How often is the occurrence of erratic rainfall in the locality? And what are the probable causes?

3. Have you heard of “climate change”? If yes from which sources?
4. What are your traditional or local indicators to realize that there is climate change?
5. How is the trend of the rainfall and the temperature during the past 20 years? Is it increasing, decreasing, coming on time and stopping at the right time?
6. What coping and adaptation strategies have community members crafted to alleviate problems arising as a result of climatic variability/drought?
7. Do farmers have sufficient knowledge about adaptation options to climate change?
8. Are the crops you cultivate now the same as the crops your father or forefathers were growing? If no, reasons for changing the crops?
9. Are the animals you are raring now the same as the animals your father or forefathers used to rare? If no, reasons for changing the animals?
10. What customary self-help arrangements are there to support each other in your villages during the times of climatic extremes?
11. What effect has climate change caused on the food security of the local people?
12. Do you believe that it is possible to reduce or totally stop the negative impacts of climate change? if yes how?
13. Can you tell us the sowing time of common grown crops some 20 years back and what time of the year do you practice seed sowing in recent years?
14. What development interventions are carried out in the village to avert the impact of climate change? (Afforestation, water harvesting, irrigation, soil and water conservation, off farm employment, etc.)
15. Do you agree that development interventions in the village are well planned, well discussed and undertaken after consensus or lack these attributes?
16. Do you feel that farmers are happy to participate in development activities such as soil and water conservation, forestry development without payment?
17. How do you evaluate the sustainability of development interventions promoted by government and nongovernment organizations?
18. How do you evaluate the agricultural extension agents’ role in motivating and mobilizing the community to strengthen their adaptive strategies to climatic changes?
19. How do you evaluate the value of tree planting to individual households’ food security improvement and improving climate change?

20. What trainings are given to the community to reverse climatic shocks?
21. What agricultural technology and meteorological information/early warning are provided to farmers to avert climate shocks? If any by whom?
22. Do farmers have strong organizational arrangement that could enhance local development and social cohesion? Please give your opinion.
23. What are the success stories you observed in relation to coping and adaptation strategies adopted by farmers to withstand climatic shocks?
24. What should the government and the community do to avert the impact of climate change in your locality?

Part VI Guiding Questions for Government Institution Staffs (Agricultural Development Offices, Land Administration Offices, Meteorological Agency, Agricultural Research Center and NGOs representatives)

A. District Disaster Risk management Office

Name _____ Position/profession _____

1. What are the impacts of climate change on food security in your district?
2. Who is more vulnerable to the impact?
3. What is your role in prevention of socio-economic disaster caused by climate change and variability before and after the disaster? How?
4. What are your major challenges in alleviation of the problem and what should be done?

B. Agriculture and Rural Development Office officials, Development Agents andother Experts

Name _____ Position/profession_____

1. What is the agro-ecology of your district/peasant association?
2. Is there any form of climate change in your district? If your answer is yes, please can you explain?
3. If the answer to Q2 is yes, please would you like to explain the extent of climate change and variability impact on crop and livestock of your district/peasant association?
4. What is the impact of climate change and variability on the food security of the people?
5. Who is more vulnerable to the impacts? Why?
6. What are the local coping mechanisms used to reduce the impacts?
7. What is the institutions effort to reduce future impacts?
8. What are the main challenges and how do you think they can be improved?

9. What are the indictors of the occurrence of climate change?
10. How do you evaluate the climate situation in the district over the past 20 years?
11. What are the damages caused by climate change to the society?
12. Is climate change an important agenda for Agricultural Development Offices? If yes what are the development interventions introduced in the woreda (kebeles)?
13. Are the development interventions appreciated and owned by the community? Are they sustainable?
14. Do you think that farmers are aware of climate change and variability in their localities? If yes how did they acquired the awareness?
15. What coping mechanisms do farmers use in times of drought in the woreda? Also what adaptation strategies do rural households use to withstand the ill effects climate change?
16. What challenges do framers face to effectively implement coping and adaptation mechanisms?
17. How do you evaluate the impacts of climate change on rural household's livelihoods, water resources (rivers, streams, ponds), grazing lands, woodlands, farm lands?
18. Which segment of the local community more affected by climate variability/climate change? And why?
19. Is there any local level organizational arrangement made that helps farmers to overcome the damages caused by climate change/climate variability? If any, who are they?
20. How do you evaluate the role and strength of local level organization to sustain development interventions?
21. What assistances are they provided to make them empowered?
22. How integrated are government institutions working on activities that are deemed helpful to avert climate shocks?
23. Do you believe that it is possible to reduce or totally stop the negative impacts of climate change? if yes how?
24. Of the development interventions which ones are more important to reduce damages that could be caused by climate change/climate variability?
25. How does agricultural research in the region attempt to address the need for crop varieties tolerant to moisture stress and other supporting technologies to tackle climate change.

26. What are the challenges faced by the agricultural research and extension services to address climate change issues?
27. How do you evaluate the role of the NGOs contributions to coping against climate change?
28. How does the Meteorology Agency contribute to efforts to withstand climate change and variability? Does the agency have strong institutional set up to provide adequate weather information?
29. What are the success stories you observed in relation to coping and adaptation strategies adopted by farmers to withstand climatic shocks?

Part VII Qualitative – Semi-structured Interview Questions for KII Guiding Questions

1. What visible changes have you observed as related to rain fall, temperature, soil fertility, forest vegetation, wildlife, crop productivity, livestock productivity, flow of streams, occurrence of big floods, incidence of drought etc during your life time in the village?
2. How often is the occurrence of drought in the locality? And what are the probable causes?/How is the trend of the rainfall during the past 10 years? Is it increasing, decreasing, coming on time and stopping at the right time?
3. What are the status of impact of climate variability on your food security of household compare to the last 10 years ago?
4. What coping and adaptation strategies have community members practiced to alleviate problems arising as a result of climatic variability/drought?
5. Can you tell us the sowing time of common grown crops some 10 years back and what time of the year do you practice seed sowing in recent years?
6. What development interventions are carried out in the village to avert the impact of climate change? (Afforetation, water harvesting, irrigation, soil and water conservation, off farm employment, etc.)
7. What agricultural technology and meteorology information system do you access regularly and during climatic extremes?
8. Do you receive early warning information on short term variations and/or long term climate change from any sources?
9. Do you believe that it is possible to reduce or totally stop the negative impacts of climate change? if yes how?

10. What are the success stories you observed in relation to coping and adaptation strategies adopted by farmers to withstand climatic shocks?
11. What should the government and the community do together to avert the impact of climate change in the kebele?

Part VI. Suggestion and expectations for effective adaptation (KII)

1. How can vulnerability be reduced and how can adaptation are promoted? What can be done at community level and what sort of external support is needed (list current adaptation gaps in particular sector/ particular incident)
2. What do you want to recommend to local communities, Development Agencies and NGOs and State to enhance adaptation to climate change?
3. Is there anything you want to share? If so please share your issues

Thank you!

URKUND

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Sources included in the report

SA	**University of Addis Ababa / Draft research chapters_MArev KL 25 April.doc** Document Draft research chapters_MArev KL 25 April.doc (D75388890) Submitted by: lkoricho@gmail.com Receiver: meskerem.abi.aauni@analysis.urkund.com	9
W	URL: https://www.researchgate.net/publication/341070493_Small-scale_irrigation_and_its_ ... Fetched: 6/14/2020 11:22:35 PM	1
SA	**University of Addis Ababa / chapter one except the book chapter_Gemechis.docx** Document chapter one except the book chapter_Gemechis.docx (D72795578) Submitted by: engdawork.assefa@aau.edu.et Receiver: engdawork.assefa.aauni@analysis.urkund.com	2
J	**Climate variability, communities' perceptions and land management strategies in Lay Gayint Woreda, Northwest Ethiopia** URL: 125ab879-e668-471c-ac97-67b72b442523 Fetched: 10/5/2019 5:50:07 PM	2
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