
**ADDIS ABABA UNIVERSITY**

**SCHOOLS OF GRADUATE STUDIES**

**COLLEGE OF DEVELOPMENT STUDIES**

**CENTER FOR FOOD SECURITY PROGRAMME**

# IMPACT OF CLIMATE VARIABILITY ON FOOD SECURITY IN AWABLE WOREDA, EAST GOJJAM ZONE, AMHARA REGION, ETHIOPIA

**BY**

**WALTENGUS GETACHEW**

**SEPTEMBER, 2021**

**ADDIS ABABA, ETHIOPIA**

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**BY**

**WALTENGUS GETACHEW**

**THESIS ADVISOR**

**TEMESGEN TILAHUN (PHD)**

**A THESIS SUBMITTED TO CENTRE FOR FOOD SECURITY STUDIES, COLLEGE OF DEVELOPMENT STUDIES, ADDIS ABABA UNIVERSITYIN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN FOOD SECURITY AND DEVELOPMENT**

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**CENTER FOR FOOD SECURITY STUDIES**

**DECLARATION**

This thesis is my original work and has not been presented for MA/ MSc degree in any other University and that all the sources and materials used have been properly acknowledged.

Declared by: Waltengus Getachew

Signature: _____

Date of Submission: September 2021

Supervisor's approval

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge as an advisor.

Major Advisor: Temesgen Tilahun Signature :  Date: 06September 2021

## Approval Sheet

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As advisor of the thesis, I certify that I have read and evaluated the thesis prepared by Waltengus Getachew under my guidance, entitled Impact of Climate Variability on Food Security in Awable Woreda, East Gojjam Zone, Amhara Region, Ethiopia and I recommend that for open defense as fulfilling the requirement for the degree of Master of Science in Food Security and Development Studies.

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| **Temesgen Tilahun (Phd)** | | Dec. 28, 2021 |
| (Advisor) | Signature | Date |

As members of the examining board of thesis open defense, we certify that we have read and evaluate the thesis prepared by Waltengus Getachew entitled Impact of Climate Variability on Food Security In Awable Woreda, East Gojjam Zone, Amhara Region, Ethiopia and recommend that it is acceptable as a thesis required for the degree of Master of Science in Food Security and Development Studies..

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|---|---|---|
| Name of the candidate | Signature | Date |
| Desalegn Yayeh | | 28/12/2021 |
| Name of the internal examiner | Signature | Date |
| Belay Simane | | 28/12/2021 |
| Name of the external examiner | Signature | Date |

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**ACRONYMS AND ABBREVIATIONS**

ACSI……...Amhara Credit and Saving Institutions

CCV…….Climate Change and Variability

CRGE…….**.....**Climate Resilient Green Economy

CSA……..Central Statically Agency

FAO…….**.....**Food and Agricultural Organization

FGD…….....Focus Group Discussion

GDP……..Gross Domestic Product

GHGS……Green House Gases

HHH…….Household Heads

IPCC……. Intergovernmental panel Climate Change

KII…….....Key Informant Interview

MM……....Milliliter

NMA…….National Meteorology Agency

SPSS…….Statistical Package for Social Sciences

SSA……...Sub-Saharan Africa

THC……...Thermo Hyaline Circulation

UNDP……United Nations Development Program

UNESCO……...United Nations Educational Scientific and Cultural Organizations

WFP…….**.....** World Food Program

## *ABSTRACT*

*The objective of this study is to assess the impact of climate variability on food security within the study area. to realize this objective, essential information was gathered from sample kebeles from three agro-ecological zones by using mixed research design. Both quantitative and qualitative data were collected concurrently. The quantitative data includes long-term climatic data (1974-2019) were used for analysis. Multi-stage sampling techniques were employed to pick appropriate key informants, discussants and sample households. Supported the relevant information gathered, the status of food insecurity is assessed by food insecurity indicators (HFIAS) within the household level. The result of the analysis shows that the rainfall pattern within the study area is extremely concentrated within the five years of the belg and meher season. The spring and autumn rains are found to be determinant factors to agricultural productivity within the study area. Hence, the general results of the study clearly indicates that both rainfall and temperature attributes significantly determine the annual agricultural outputs causing food insecurity in the study area additionally to socioeconomic and technological factors. The Belg rainfall shows insignificantly decreasing trend. Crop yield reduction, shortage of pasture for animals, occurrence of recent disease on crops, humans and animals, shortage of installation, flooding and erosion are the key perceived impacts of global climate change and variability. In response farmers had adopted different coping strategies like; selling fire wood and charcoal, decrease amount of meal, selling of livestock, seasonal migration and borrowing grains from relatives. The study also identified women, children, elders, disables; poor and landless are most liable tothe present effect of global climate change and variability. supported the results, this study suggests the subsequent recommendations to reduce the impacts of climate variability. Empowering peoples with education and knowledge, facilitating access to credit services, train farmers on utilization of inputs, use environmentally sound agricultural production system, use integrated adaptation & mitigation measures, solve the constraint and expand indigenous adaptation strategies.*



***Key words:*** *Food security, climate change, adaptation, households, climate variability, vulnerability*

# CHAPTER ONE

# 1. INTRODUCTION

## 1.1 Background of the Study

Climate change becomes a heavy issue throughout the globe. It's influencing the conventional processes of major ecosystems of the planet. Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, wide spread melting of snow, ice and rising global average water level. Observational evidence from all continents and most oceans shows that a lot of natural systems are being littered with climate changes, particularly temperature increases. Most of the observed increase in global average temperatures since the mid-20th century is extremely likely thanks to the observed increase in anthropogenic GHG concentrations. This increasing level of emissions of greenhouse gases has caused an increasewithin the amount of warmth from the sun trapped within the earth's atmosphere, heat that might normally be radiated into space. This has led to the atmospheric phenomenon, leading totemperature change (IPCC, 2014).

Variability of climatic elements, specially rainfall and temperature, may affect agricultural production as they influence the production elements like soil moisture and soil fertility, length of growing season and increased probability of extreme climatic conditions (McGuigan et al., 2002 cited in Leta, 2011), although with special variations. The extent of impacts of climate change varies from one agro-ecology to another. The common adverse impacts of climate change and variability, however is crop damage, lower yields, income lose, harvesting difficulties, increased pest activities and delayed seeding (Pearce, 2009) irrespective of ecological variations.

Africa is commonly identified as the region highly vulnerable to climatic variability's of the tropical rain i.e. uncertainties of commencement, termination, continuity and intensities, mainly because it is the continent which has its major areal spread within the tropics. And as a matter of fact it is the tropical land which is full of uncertainties of climatic attributes. In addition to this the social, economic, and political constraints that determine the capacity of human systems to cope with climate change and variability, and the existing burden of climate-related hazards, including high prevalence of food insecurity. Africa is also sensitive to climatic hazards, as its people are mainly dependent on natural resources for their livelihoods such as agriculture,

pastoralist and fishing. Environmental stressors, thus, place a large proportion of the population at risk of adverse outcomes (Ford et al., 2010).

Ethiopia is one of African countries, which become prone to climate change. Ethiopia is especially vulnerable to climate change because of its geographic coverage and complexity, low income and reliance on climate sensitive economic sectors particularly agriculture and pastoralist. The livelihoods of many of people in the country are critically dependent on climate. The impact of climate change in Ethiopia is highly manifested because of agriculture is pridicted to play a key role in ensuring food security and the country's economy (Aklilu&Dereje, 2010). The system of agriculture, which is mostly rain-fed, is highly affected with late onset and early offset of rainfall during the main rainy season and in most cases total failure of the Belg season. This may result in drought and famine.

According to IMF (2012), agricultural sector remains a key source of growth in Ethiopia but it continues to face major challenges. The 2006 flood in Dire Dawa city and Gambela region damaged crops and reduced productivity, washing away homes, infrastructure, significantly damaging individual assets and outbreaks of acute water diarrhea among people were the major impacts of climate change in Ethiopia. Rural livelihoods remain extremely vulnerable to climatic shocks as food production is mainly dependent of natural rainfall and irrigation supports only negligible portion of the country total cultivated land. Irrigation agriculture accounts for only 5% of the country total cultivated land (Mesfin, 2020). Thus, the amount and temporal variation of rainfall and other climatic factors during the growing season are critical to crop yield and can induce food shortage and famine. This shows that climate change and variability can have greater negative impacts on poor farm households due to high vulnerability leading to food insecurity. In turn, food insecurity has become a very important development challenge in Ethiopia (Dawit and Habtamu, 2011).

As agriculture is the main source of livelihood of the people in AwableWoreda, farmers face both agricultural drought problems and socio-economic problems. The growing population (2.9%) in the woreda increased the demand for food, resources, land and other basic needs of life, especially, during drought time the problem becomes very challenging for the community as indicated the data sourced from woreda agricultural office. No studies have been done in Arable Woreda that gives special emphasis on the impact of climate variability on food security.

Therefore, this study wants to investigate the impact of climate variability on food security with their coping and adaptation strategies at AwableWoreda, East Gojjamzone, Amhara Region.

## 1.2 Statement of the Problem

Climate change and variability adversely affect the environment, human health, food security, economic activities, resources and physical infrastructures. Although all social, economic and political sectors face the impact of climate change and variability at varying degrees, the worst hit is supposed to be the rain fed agriculture due to its high sensitivity to climate stimuli. For this reason, when this sector is impacted, it disrupts the food production system, food security status of households and domestic industries. It is also very well recognized that the consequences of climate change and irregularities vary spatially in magnitudes. For example, the countries of Sub-Saharan Africa are the most vulnerable and since many countries of this region are already food insecure; climate change and variability aggravate and worsen the problems ((Daniel, 2009 cited in Alemu, 2011).

Moreover, the World Bank (2012), states that Ethiopia is one of the countries extremely vulnerable to drought and natural disasters such as flood, heavy rain, frost and heat waves. Such extreme weather causes the losses of people and livestock and disrupts livelihoods of farmers.

The livelihoods of most of the people in East Gojjam zone depend on agriculture (both crop and livestock production) which is greatly climate sensitive in its nature and slight irregularities in climatic conditions adversely affect agricultural production and hence the livelihoods of households. Some of the signs of this effect are drought, food insecurity, failure of crop production, death of livestock, loss of biodiversity and even famine (NSZADD, 2019).

According to National Meteorological Agency (NMA, 2007) global climate change and variability affects agriculture, health, water resources and natural resources. Farmers of Arable Woreda, like farmers in the othera part of East Gojjam zone, are laid low with climate disruptions which became common natural catastrophes within the zone. In my observation and data gain from the residents, there's more erratic, unseasonal and unreliable rainfall within the rainy seasons, bringing drought, reduction in crop yields, floods, landslides and eroding. Additionally, there has been a rise in temperature which disturbs the physiology of crops and livestock, microclimate and also the soil system on which they produced.

In spite of those the AwableWoreda is characterized by heavily fragile resource base, shortage of agricultural land thanks to the growth time to time and urbanization, late coming and early withdrawal of rain fall and speedy deforestation which resulted land degradation in most low lands of the realm. Since recent past, farmers within theworedaface adverse impacts of climate variability on their livelihood more specially faced in kola agro ecology zone. As a result of this, crop and livestock production has decreased and therefore theworeda has become significantly at risk of the impacts of global climate change and variability. temperature change temperature change} and variability impact assessment research within the study area isn't conducted and available studies focused on policy responses to climate change and variability at national level, leaving out the efforts made to adapt in household and community level. Therefore, this study analyzed the impacts of climate variability on rural livelihoods food security being undertaken in Arable Woreda, an area received limited research attention up to now.

## 1.3. Objectives of the Study

The main objective of the study is to assess impacts of climate variability on rural livelihoods food security being undertaken in AwabeleWoreda, East Gojjam Zone, Amhara region, Ethiopia.

**Specific Objectives** the specific objectives of the study are:

- ✓ Assess the trends and variability of rainfall and temperature in the study area.
- ✓ Determine the status of household food security.
- ✓ Identify more vulnerable social groups to climate variability in the study area.
- ✓ Explore local adaptation and copping strategies at household level in the study area.

## 1.4. Research Questions

Based on the Objectives of the study and relevant literature, the following research questions were posed.

Research questions are;-

1. What looks like the trend of rainfall and temperature in the study area?
2. What is the status of food insecurity in the study area?
3. Who are more vulnerable to the impacts of climate variability?
4. What are the local adaptation and coping strategies to impact in the study area?

## 1.5 Significance of the Study

The study provides important information about patterns of climate variability and provides options for the impact induced to vulnerability by climate variability. It contributes a better understanding of predicted impacts of climate variability on agricultural products and food security. It also serves as base line information to facilitate and exchange of ideas among local community, researchers, policy makers, development actors etc. at different institutional level by creating awareness on how to keep up local knowledge and use it as input for further studies on the area under threat of climatic variability.

## 1.6. Scope of the Study

The study focused on assessing the impact of climatic variability on food security on selected three sample kebeles based on number of kebles that are found in the study area of AwableWoreda in East Gojjam Zone, Amhara Region. These three sample kebeles are selected from kola mizanewashatulu, from woyinadegayesenbet and from degamennda based on agro-ecological zones of the Woreda. And, Climate variability can affect all elements of livelihood resources (natural capital, human capital, physical capital, financial capital and social capital etc.) The study area is selected purposely based on the researcher's previous and current knowledge for the woreda and the sample kebeles were selected randomly.

## 1.7. Limitations of the Study

Some challenges had occurred while conducting this study. One of the main problems faced during the study was, some farmers were reluctant to give correct information on their socio economic and demographic situation, absence of the HHHs at their home during the survey and shortage of secondary data. The other challenge encountered during the survey was outbreak of corona vires pandemic 2021 (COVID 19 Pandemic), the study area and also was not stable because of regional war Tigray and Amhara regional state, so that initially some kebele officials not willing to collect data and some respondents frustrate to meet with me. However, efforts were made by the researcher and able to get the required information despite these challenges.

## 1.8. Ethical Considerations

The respondents for this research were not obligated to participate and give any response. Household survey and FGD participate in the study area were participated voluntarily, whereas for key informant interview participants by showing collaboration letter to undertake research in the woreda written by Addis Ababa University Department of FSDS, easily able to collect both primary and secondary data. The respondents had the right to decide not to participate, or to stop at any time without providing a reason for doing so. In this study, none of the respondents refused to participate.

## 1.9. Organization of the Study

This paper is organized in five chapters. The first chapter deals with the introduction part which includes the background of the study, statement of the problem, objectives, research questions, significance of the study, limitation of the study, scope of the study, ethical considerations and organization of the paper. Chapter two is all about review of related literature related with climate change and variability, its impact and adaptation .The third chapter describes research methodology and description of the study area. Chapter four presents discussion and findings of the study. And the fifth chapter deals with summary, conclusion and recommendations forwarded by the researcher.

# CHAPTER TWO

# 2. LITERATURE REVIEW

## 2.1 Definitions of Key Concepts

**Climate change:** A change within the state of the climate which will be identified by changes within the mean and/or the variability of its properties which persists for an extended period, typically decades or longer. Temperature change is also because of natural internal processes or external forcing or to persistent anthropogenic changes within the composition of the atmosphere or in land use systems (IPCC, 2001).

**Climate; -**is average state of the atmosphere observed over a protracted period of your time. It represents the buildup of daily and seasonal weather events over a protracted period of your time (Ahrens, 2007).

**Climate change:** A change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use systems (IPCC, 2001).

**Vulnerability:** The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2001).

**Impacts:** Effects on natural and human systems. It is generally refers to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. This is also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea-level rise, are a subset of impacts called physical impacts (WGII, 2014).

**Climate variability**: refers to the climatic parameter of region varying from its long-term mean. Every year in specific time period, the climate of location is different. Some years have average rainfall, some have average or above average rainfall (IPCC, 2007)

**Adaptation:** 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 (IPCC, 2007).

**Mitigation:** refers to efforts to prevent climate change. It is an action or a series of actions taken to reverse or to stop an adverse situation. It comprises conservation and, the development and employment of alternative energy sources. It consists of a component of technology and behavior change (Goodwin, 2008).

**Livelihoods:**A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conway, 1991).

**Food insecurity:** is defined as lack of access by people to enough food for an active and healthy life. It describes the phenomenon of food deficit in the household and the community level (Balcha, 2001).Risk of food insecurity and the breakdown of food systems linked to warming, drought, flooding, and precipitation variability and extremes, particularly for poorer populationsin urban and rural settings, (WGII, 2014).It also can be described clearly by concepts such as hunger, under nutrition and famine.

**Adaptive Capacity:** Adaptive capacity is defined as the potential or ability of a system, region,or community to adapt to the effects or impacts of climate change.

**Food insecurity:** is defined as lack of access by people to enough food for an energetic and healthy life. It describes the phenomenon of food deficit within the household and also the community level (Balcha, 2001). Risk of food insecurity and therefore the breakdown of food systems linked to warming, drought, flooding, and precipitation variability and extremes, particularly for poorer populations in urban and rural settings, (WGII, 2014).

## 2.2 Theoretical Framework

### 2.2.1 Relationship between Climate Change and Food Security

Climate variability and food availability are highly interlinked being climate variability may be a primary controlling factor of agricultural productivity. It is expected to negatively influence crop production, livestock rearing and water cycle. It also affects food security along with overpopulation, poor land and poor water management causing hunger and malnutrition. a major proportion of individuals within the crop dependent highlands are chronically food insecure. Moreover, temperature change places more pressure on the food security of millions by reducing crop yields, increasing land degradation, and lowering water availability (EPCC, 2015). Some 45mil people affected worldwide as a results of reduced yield of cereals, fruits, vegetables, cash crops and livestock's (GHF, 2009). So ,climate change make shrinking of yield rates, arable land shocks to natural calamity creating less favorable growth conditions. Extreme weather events under temperature change, the frequency and intensity of some disasters like droughts, floods and storms could increase, with an adverse impact on livelihoods and food security. Understanding the precise impacts of global climate change on food security is challenging because vulnerabilities are unevenly spread across the globe and ultimately rely on the power of communities and countries to deal with risks. Within the context of food security, some regions of the world might experience gains under climate change, but developing countries are likely to be negatively affected. Changes in climatic conditions have already affected the production of some staple crops, and future climate change threatens to exacerbate this higher temperatures will have an impact on yield both crop quality and quantity.

### 2.2.2. Malthusian Theory

In this theory the satisfaction of the increasing needs of the population submits the natural resources of the world to increasing pressures (FAO, 2012; Malthus, 1798). These increasing pressures put in peril the agriculture whose development is seriously threatened by the degradation and also the decrease of soils fertility in developing countries.In our country though agriculture the population it's not articulated yet round the techniques and also the methods (the most modern) for fully satisfying the requirements of the population. It becomes gradually mining and causes the quasi irreversible degradation of the lands and ecosystems within the developing countries. As population rises, demand for food, energy and income increases.

Increasing population plus land degradation aggravates challenges of crop production e.tc. Consequently, arable land per capita declines while land degradation increases through overuse of natural resources.

## 2.3. Empirical Literature

### 2.3.1. Climate Change Observation in Ethiopia

Like much of Africa, Ethiopia has become warmer over the past century and human induced climate change will bring further warming over the next century at unprecedented rates, (EPA, 2011).Various studies have their own source historical trends of climate change and variability in Ethiopia. For instance, from 0.2°C to 0.28°C rise per decade in the average annual maximum temperature between 1960 and 2006 was reported in recent studies, whereas, 0.37°C/decade increase was observed in the minimum temperature between 1951 and 2006. A projection suggests that Ethiopia will experience a 1.7°C–2.1°C increase in the mean temperature by 2050(Bewket and Conway,2007).

According to Gezahegn Abebe (2017), the mean annual temperature in Ethiopia has increased by 1.65°C between 1955 and 2015. The country's agricultural production depends heavily on local temperature and rainfall. Within the last decade, the country has been subjected to drought, floods, new insect pests, new vector-borne diseases and other problems made worse by global climate change. Ethiopia's diverse agro ecological zones are characterized by a stunning type of microclimates and corresponding weather patterns. Over centuries, its people have developed agricultural systems adapted to Ethiopia's diverse environment. However, the rapid pace of global climate change, together with increasing socioeconomic pressures, threatens to overwhelm their ability to cope (Bishaw, et al, 2013). Over the past three decades, Ethiopia has experienced countless localized drought events and 7 major droughts, five of which resulted in famines (World Bank Group, 2010).

As explained in NMA (2007), baseline climate that was developed using historical data of temperature and precipitation from 1971- 2000 for selected stations in Ethiopia, showed a really high year-to-year variation in rainfall, for the amount 1951 to 2005 over the country expressed in terms of normalized rainfall. Over those periods (1951-2000), a number of the years are dry leading to droughts and famine while others were characterized by wet conditions (NMA, 2007).

During extreme drought conditions, it is common that many farmers in the country either die due to hunger or depend on foreign food aid to sustain their lives (Temesgen., et al., 2010). The observed trend in annual rainfall, however, remained more or less constant when averaged over the full country (NMA, 2007). Studies also indicate that there has been a really hot temperature variation and alter in its trend over time. Annual minimum temperatures for the period 1951 to 2005 expressed in terms of temperature differences from the mean and averaged over 40 stations showed a very high variability (NMA, 2007). The country experienced both warm and cool years over those 55 years even though the recent years are generally warmest compared to the early periods.

According to NMA (2007) forecast, the country will experience an increasing level of temperature and precipitation within the coming decades. Using the software MAGICC/SCENGEN (Model for the Assessment of Greenhouse-gas Induced Climate Change)/ (Regional and global Climate Scenario Generator) coupled model for three periods centered around the years 2030, 2050 and 2080, NMA (2007) generated that the mean annual temperature will increase within the range of 0.9-1.1°C by 2030, in the range of 1.7-2.1°C by 2050 and in the range of 2.7-3.4°C by 2080 over Ethiopia for the IPCC mid-range emission scenario compared to the 1961-1990 normal. Consistent with the National Meteorological Agency, long-term global climate change in Ethiopia is related to changes in precipitation patterns, rainfall variability and temperature, which could increase the country's frequency of both droughts and floods. Although both developed and developing countries are plagued by global climate change, developing countries face greater challenges in overcoming its adverse consequences. Ethiopia is one in every of the smallest amount developed countries within the world; with a per capita income of but US$130 in 2006. Low economic development, inadequate infrastructure, and lack of institutional capacity all contribute to the country's vulnerability to the adverse impacts of global climate change (IFPRI, 2010).

### 2.3.2. Food Security Situation in Ethiopia

Food insecurity could be a critical challenge for rural households in Ethiopia, different studies on different parts of the country indicate that the most sources of food insecurity within the country are drought and weather related shocks and disasters. the foremost common causes of food insecurity problem in Sub-Saharan African countries which Ethiopia is that the first and other Third World countries were; drought and other extreme weather events, pests, livestock diseases and other agricultural problems, temperature change, military conflicts, lack of emergency plans, corruption, and political instability, cash crops dependence, aid and rapid increase. These factors deplete the productive assets of rural households and cause adverse effects on household's food security status and every one are endemic in Ethiopia (Shumete G., 2009).The food insecure situation in Ethiopia include: the urban unemployed, people in areas of conflict, destitute peasants, pastoralists who rely upon markets for cereal supply and also the refugees from neighboring countries, mainly from Somalia and South Sudan. Variety of studies has confirmed that there's severe food insecurity in Ethiopia covering a large range of areas and affecting an outsized number of individuals. Food security situation in Ethiopia deteriorated by intra-and-inter-state military conflict and war, different studies indicated that Ethio-Eritrea war and recurrent drought eroded the country resources which become the most causes of food security problems during 1999-2000, pastoralist community within the country acquire the conflict thanks to the control over the pasture and water resources. (Fisseha, K., 2014).

### 2.3.3. Impacts of Climate Variability on Crop Production

Food especially food crops is a fundamental requirement in our everyday life. The well-being of large populations around the world depends on access, stability and availability of food (Schmidhuber and Tubiello, 2007). This is especially true in the developing world with predominant small land holders and subsistence farmers for whom the on-farm agriculture and off-farm agricultural labor provides the main source of food and income (Ito and Kurosaki, 2009). Besides, the vulnerability of these smallholder and subsistence farmers is greatly influenced by changes in climate (Morton, 2007).Changes in climate have already decreased crop yields in several regions and are estimated to have reduced global maize production by 12 Mt a year between 1981 and 2002 (Lobell and Field, 2007). For example, in 2003, unusually high temperatures during the summer reduced food production (and killed over 50,000 people in

Europe), with cereal and fruit harvests dropping drastically in Europe, especially in Italy and France where maize production fell by more than 30% (Ciais et al., 2005).

### 2.3.4. Coping and adaptation strategies to climate change

Societies are dynamic which they use all possible strategies to chop back the vulnerability to climatic impacts. There are two kinds of responses to crisis that overlaps across the temporal scale, coping mechanisms and adaptive capacity. Coping mechanisms are the actual responses to crisis on livelihood systems within the face of unwelcome situations, and are considered as short-term responses (Berkes& Jolly 2001, as cited in Abate, 2009). Adaptation to global global climate change might be a response (processes) through which individuals reduce the adverse effects of climate on their health and well-being and advantage of the opportunities that their climatic environment provides (Burton 1992, cited in Niguse, 2011).

The people of Ethiopia are struggling against the impact of climate variations. they need been facing the impacts in various forms over millennia and have developed a variety of coping mechanisms to pander to the impacts (McKee, 2008 cited in Aklilu&Dereje, 2010). the foremost important coping mechanisms widely used include: changes in cropping and planting practices, reduction of consumption level, use of inter-household transfers and loans, collection of untamed foods, increased petty commodity production, temporary and permanent migration of individuals and animals, hidden secure grain storage, sale of assets like livestock and agricultural tools, mortgaging of land/ taking credit from merchants and money lenders, use of early warning systems and appeals for food and other varieties of aid (NMA, 2006 cited in Aklilu&Dereje, 2010). As already mentioned, for several centuries, Ethiopia has been characterized by climate variability and change; the local people have developed different Coping and adaptation strategies. These include: - farming, selling of assets, crop diversification, irrigation, off-farm activities, tree planting and soil and water conservation.

## 2.4. Conceptual Frameworks

The study aimed at examining climate variability trend, determining impact of climate variability of food security, establishing household food security status and evaluating effectiveness of coping strategies in the study area. The independent variable is climate variability (rainfall and temperature), natural and anthropogenic (human) drivers and social factor (awareness gap, skill

gap and less trend to mitigation and adaptation practice) and environmental change are dependent variables such variables assume to affect food security (food production). This can lead to seasonal crop failure and long-term production problem leading to low yields hence food insecurity. Climate variability as well can affect food access in a way that, as agricultural produce decreases, food prices shoot, and the purchasing power reduces. Environmental change in this case involves the extreme weather events such as droughts and floods. More intense and increased frequent extreme weather events and increasing abnormalities in seasonal rainfall changes are already having significant impacts on crop yields and thus food insecurity.

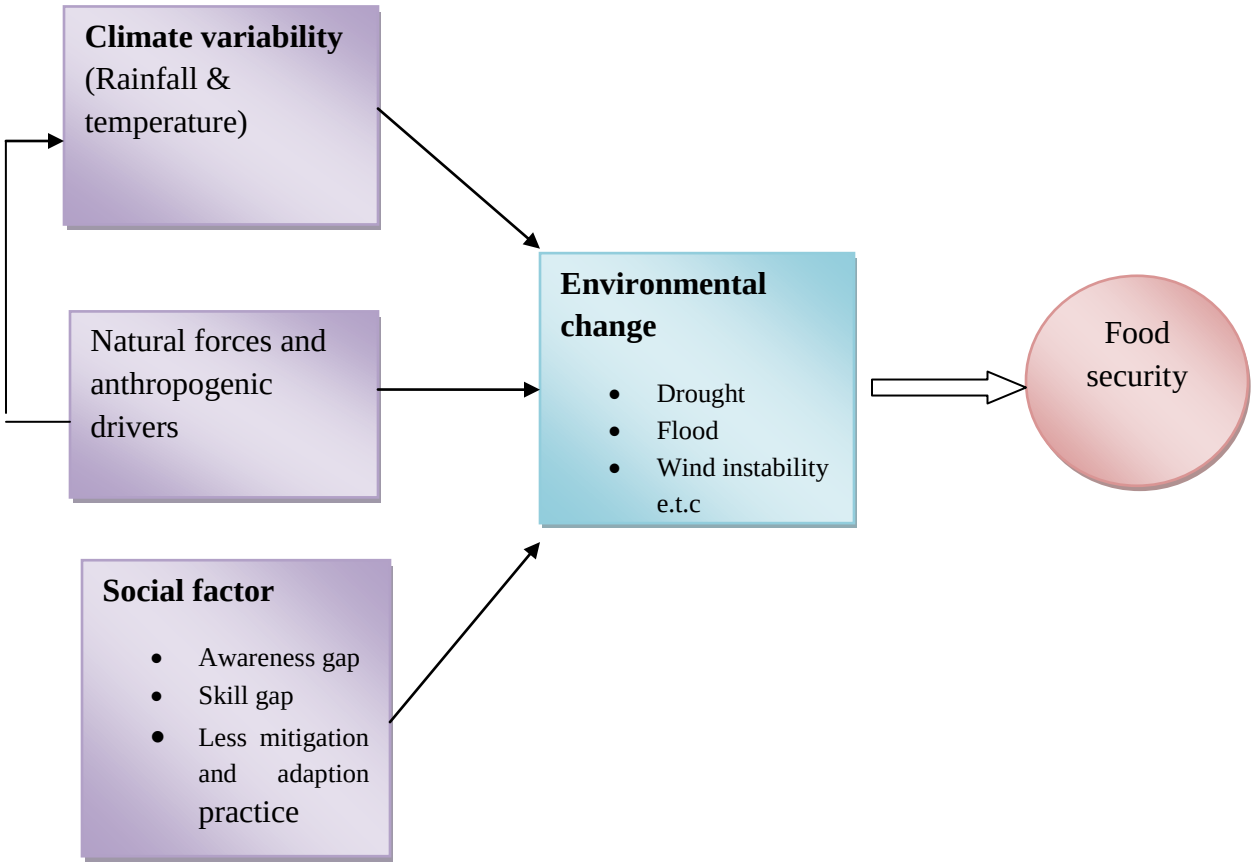



**Figure 2.1:Conceptualframeworks of climate variability and food security.**

**Source**: Adopted and modified (FAO, 2008).

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1. Study Area

The study conducted in Awable Woreda area of Lumamme County in Ethiopia. Awebal Woreda is one of the 18 Woreda's which is found in East Gojjam Zone of Amhara Regional state in Ethiopia. Geographically the Woreda is located between 10° 29' 59.99" N and 37° 44' 59.99" ˈE with an average elevation of 2435 meters above sea level. The Woreda has 3urban kebele and 28 rural Keble's. The capital of the Woreda is Lumama town which is located at 230 km distance in the Northwest of Addis Ababa and 40 km from Debre Markos. Based on the 2007 national census conducted by the Central Statistical Agency (CSA) of Ethiopia, the Woreda has a total population of 168,203, of whom 82,365 were male and 86,838 female; 23142 (13.7%) were urban inhabitants. Awabel is bordered in the north Gozamin Woreda and Debay TelateWoreda's and west by the Ameber Woreda's, in the south by Abay River which separates it from Oromia Region, in the northeast by Debay Telate Woreda, and in southeast by Dejen Woreda's.

## 3.2 Topography

The Woreda's total land coverage is 79830 hectare out of these undulating areas covers about 9%, flat plains 86%, mountainous and others 5%. The soil type of this study area is black, red and brown which account 71%, 20% and 9% respectively. The average annual rainfall of the Woreda is about 2378 mm/year. About 73% of the annual rainfall of the Woreda falls between June and September. The average annual maximum and minimum temperature of the Woreda is about 24.8 C and 11.5 C respectively. According to the woreda administration and community classification, the woreda's agro-ecology is subdivided in to kola (8%), woina dega (89%) and dega (3%).

Mixed crop-livestock agriculture is the main economic stay of the people of the study area. These agro-ecology gives an opportunity for the cultivation of range of crops like Wheat (Triticumaestivum and T. durem) and Barley (Hordeumvulgare) in the highland (dega), Teff (Eragrostistef) and Maize (Zea mays) in the midland and wetland, and Maize (Zea mays) and Sorghum (Sorhum bicolor Moench) in the lowland agro-ecosystem (kola). There are also other cereal, pulse, oilseed, and vegetables crops grown in the woreda. The farming system in the

study area dominated by cereal production that accounts for about 75% of the total cultivated area. From cereals: teff, wheat, and maize account 79.9%, 10.6%, and 1.1% respectively.

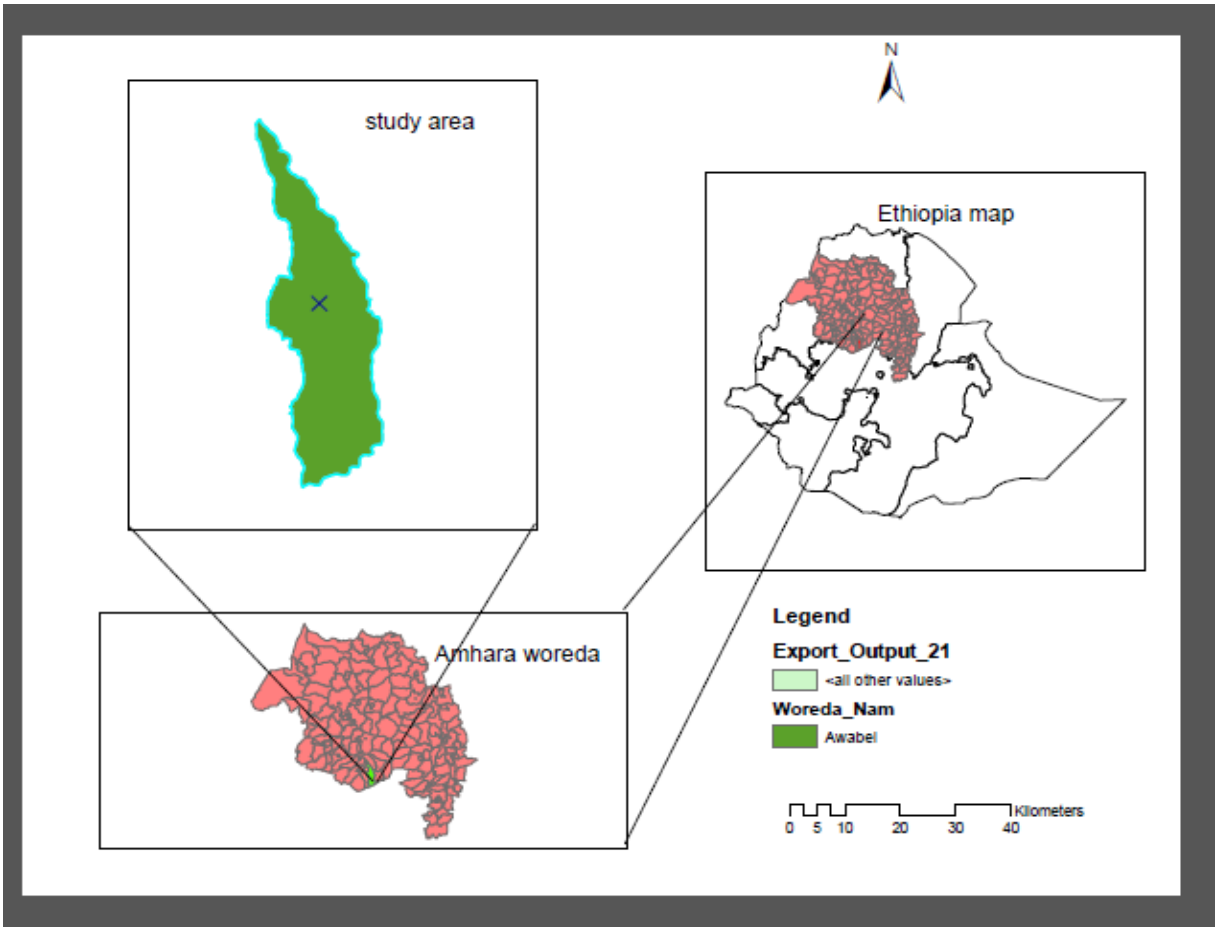



**Figure 3.1: Location Map of the Study area. (Source Ethiopia Woreda map)**

## 3.3 Research Design

This study employed cross sectional research design to assesses the overall activities of impact of climate change variability on household food security in AwableWoreda with numerous population characteristics at one specific point in time and also make inferences about a population based on the result of the sample. In the study, both qualitative and quantitative data collection method were employed. According to Degefa (2005) the use of a combination of qualitative and quantitative research techniques is better than the use of one of them to address and assess impacts and food security status.

In the quantitative aspect, household survey was used to collect relevant data from selected households. For this purpose, the questionnaire focused on household social characteristics, livelihood system, physical resources, risks and coping strategies. Most of the questions were structured and some open-ended questions were also included. Qualitative method was also applied to be identify the impact of CCV on their livelihood and to understand people response to it. In this case, key informant interview, focus group discussion and observation were employed.

## 3.4. Sample Size and Sampling Technique

Sampling technique was used to select the representative sample from the total population under the study. In order to select sample kebeles and households, multi stage sampling techniques have been employed. In the first stage, the woreda kebeles were assigned in to three distinct agro ecologic conditions such as Dega, Woyine Dega and Kola using stratified random sampling. In the second stage the three kebeles namely MendaYereberebe from Dega, Yesenbet from Woyine Dega and Mizane Washatulu from Kola were selected based on simple random sampling (lottery) method. Then from the three kebeles with a total population of 10,242 and from those populations 1,325 house holders were living in these three kebeles, because of similar characters in their livelihood, the researcher has selected 140 households through purposive sampling method from the three kebeles for questionnaire survey. The sampling procedure considered different parameters such as wealth status, male and females headed households. The sampling procedure considered different parameters such as wealth status, male and females headed households.

**Table 3.1: Distributionof sample household skebele of the study area**

| Number | Kebeles | Total households | Sex | |
|---|---|---|---|---|
| | | | Male | Female |
| 1. | Yesenbet | 415 | 260 | 155 |
| 2. | Menda | 690 | 397 | 293 |
| 3. | Mizanewashatulu | 270 | 175 | 95 |
| | Total | 1325 | | |

**Source:** FromKeble agriculture office and health extension centre

**Sample Size Determination**

The sample size will determine using the formula recommended by Yamane (1967) as follows:

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

Where n = sample size

N=population size

e =level of precision which is 0.08%

Since the study area of Awable Woreda selected kebeles had households, 1325 the formula was applied as follows:

$$n = \frac{1325}{1+1325(0.08)2} = 139.768 \approx 140$$

This gave a sample size **140**number of households was the main sample size of the study area.

Participants in focused group discussions (FGD) were selected using purposive sampling, based on age and living for a long period of time in the area. Thus, it is held with a few knowledgeable elder, religious leader and individuals of the communities. In one focus group discussion six (6) persons participated in each kebeles. The participants were one female and four male. The key informant interview were conducted with development agents (2), local leaders (3), model farmers (2) and 1 woreda agricultural development office representative, who lived in area before 5 years.

## 3.5. Data Sources

The data required for the study were obtained from both primary and secondary sources. The primary information has been collected through questionnaire, key informant interview and focused group discussion. Secondary data were collected using available sources of information such as published and unpublished documents. This includes datas from Reginal Meteorology Agency, Central Statistical Agency, Awabele Woreda agricultural office and from Arable Woreda administration office.

## 3.6. Instruments of Data Collection

To get more information from the selected sources, the researcher was used the following data collection instrument:

### 3.6.1. Questionnaire

Close ended and open ended format questions has been prepared and interviewed to the selected households to get information about the impact of CCV on their livelihood and adaptations measure practice. The questionnaire was prepared in English and translated in to Amharic language. It had been also pretested (conduct pilot survey) to test its validity and reliability. Due to this able to refine the questionnaires based on the experience gained during the pretest, and its help to avoid missing value and adjust skipping rule of the questionnaires. The closed ended format questions enabled the respondents to select one option that best meet the reviews, while the open ended question was included so as to allow opportunity to the respondents to express their perceives and feeling concerning the matter under study.

### 3.6.2. Key Informant Interview

The researcher used semi structured interview method because of its flexibility and makes clear any time when there is ambiguity. The key informant interview was conducted from kebele agriculture development agents, local leaders, model farmers and agriculture development officer, about the impact of CCV on rural livelihood and their response in the study area.

### 3.6.3. Focused Group Discussion

Focus give-and-take (FGD) helps to get data on social psychology, and allows little low group of respondents to guide by a talented moderator, to specialize in key issue of the research topic (Mwanje, 2001). The researcher selected five respondents in each kebele from different social groups and are known to own better know the way on the current and past environmental, social and economic status of the study area. At each kebele, one focus give-and-take was held. The main target group discussions were made with few knowledgeable elder, religious person and individuals of the communities. The most purpose of focus conference was to knowthe amount of perception of the people about climate variability impacts, its cause and their responses. The most important discussion topics were on the local people understanding of CCV, its impact on their livelihood, major hazards and adaptation strategies employed by the community.

### 3.6.4. Field Observation

Observation was made as supportive or supplementary technique to collect data that can complement or set in perspective the data obtained by other means (NRC, 1995). During my stay in the study area, the researcher was able to observe various environmental changes. The researcher observed changes in agro-ecology, vegetation covers, other topographic features, and development interventions and peoples response to CCV by using checklists and captured photographs as evidence.

## 3.7. Methods of Data Analysis and Interpretation

Both qualitative and quantitative data were analyzed. Quantitative data was analyzed by the use of Statistical Package for Social Scientists (SPSS) software version 26. All questionnaires were examined for completeness and consistency. The collected data was numerically coded from the questionnaires based on the objectives for easy analysis. Analysis was descriptive in nature and tables; charts and graphs were used to present the findings. To determine the actual meteorological status, a 30-year rainfall and temperature (1974-2019) data was obtained from NMA and analyzed for temperature and rainfall variability. Temperature and rainfall data were analyzed using Microsoft Office Excel to present patterns on trends in temperature and rainfall variations. Descriptive statistics (frequency, mean, standard deviation, percentages and chi-square test) and inferential statistics (binary logistic regression) were used to establish any relationships between assessed variables and all statistical tests were conducted at significance level of 0.05 %.

In the current analysis, the binary logistic regression was employed in order to investigate the major factors that determine of household food insecurity. The binary logistic regression is applied when the dependent/response variable is binary. In the current study, the dependent variable is household food security categorized as food secured and food insecure. The validity of the fitted binary logistic regression model was checked using Cox and Snell's and Nagelkerke's statistics. Both values measure the percentage of variability in data that is accounted for by the model, hence, higher is the value, better the model fit. Nagelkerke's $R^2$ is an improvement over Cox and Snell's $R^2$ that can attain a value of one when the model predicts the data perfectly. Qualitative data were analyzed by use of qualitative techniques such as establishing connection and drawing conclusions in regard to the objectives.

# CHAPTER FOUR

# 4. RESULTS AND DISCUSSION

This chapter deals with the analysis and interpretation of the collected data. An endeavor has been made to debate perception of farmers, concerning individuals and experts about the trend and pattern of temperature and rainfall, status of food insecurity, vulnerable group to climate variability and impact of climate variability on food security and investigate responses of farmers to the impact in Awable Woreda. The result and discussions consists five sections which is; general demographic characteristics of sample households, climate attributes that reveal Woreda gradual rainfall and temperature trends, the impact of climatic variability on food security in relation to different indicators and causes, the adaptive capacity of the local people and their methods to cope with the impact of worldwide temperature change and finally the foremost food insecure segment of the populations are identified and qualitative information generated from various groups of the community and anxious officials through FGDs and interviews discussed supported the results of the collected data.

## 4.1. Demographic and Socio-economic Characteristics of the Respondents

In this part, the general profile of the respondent households is presented. This includes sex, age, and marital status; educational, kebele and agro ecology, level and household size under each household were discussed.

### 4.1.1. Keble and Agro Ecology Composition of Sample Household Heads

A principal question for agro ecology is whether the large-scale adoption of ecosystem-based approaches is capable transforming agriculture's environmental externalities from negative to positive, while meeting food production needs. As shown in table 4.1 below, out of the total 140 HHHs 51(36.4%) were from Yesenbet kebele, which is situated in Dega agro-ecologic condition, 38(27.1%) of them from Mendakebele , which is Woyine-Dega and the remaining 51(36.4%) respondents were from Mizan Washatulu kebele , which has Kola agro-ecological condition.

### 4.1.2. Sex of Head of Household

The finding of the study show that, 63 (45%) were female-headed and 77 (55%) were male headed households. because the collected data indicated that within the study area most of HHHs respondents were lager in number as compare to respondents female HHHs. Relatively female headed households are at risk of climate variability risks than male headed households within the

study area because there is various burden solely perform livelihood engaging issues and to involve off-farm activity than male headed households.

Table 4.1: Socio Demographic Status of Respondents

| Socio-demographic variables | Categories | Frequency | Percentage |
|---|---|---|---|
| Kebele of the respondent | Mizan | 51 | 36.4 |
| | Menda | 38 | 27.1 |
| | Yesembet | 51 | 36.4 |
| Agro ecology of kebele | w/dega | 38 | 27.1 |
| | dega | 51 | 36.4 |
| | Kola | 51 | 36.4 |
| Sex of head of household | Female | 63 | 45 |
| | Male | 77 | 55 |
| Marital status of head of household | Single | 7 | 5 |
| | Married | 89 | 63.6 |
| | Divorced | 37 | 26.4 |
| | Widowed | 7 | 5 |
| Educational level of head of household | Illiterate | 83 | 59.3 |
| | Read and write | 53 | 37.9 |
| | Primary school | 4 | 2.9 |
| | Total | 140 | 100 |

**Source**: Field survey, (2021)

### 4.1.3. Marital Status of the Sample Household

Among the total respondents 5% of them were single, 63% married, 26.4 % divorced and 5% were widowed. This shows that majority of the household heads in the respondents were married and it indicates proportionally high figures. The number of divorced is relatively high from household respondents in the study area. The proportion of single and windowed were indicated very few and similar figure of households. Most of the females that headed houses are either widowed or divorced. In such cases, they become responsible for all works inside and outside the house. They are taking care of children, fetching water, collecting firewood and cooking food. Therefore, impacts of climate change create additional burden on women and aggravates their vulnerability because of their low adaptive capacity.

### 4.1.4. Educational Level of the Sample Household Heads

As shown on table 4.1, from the total number of respondents 59.3% illiterate, 37.9% able to read and write, and the remaining 2.9% of them able to learn primary school. This shows that

majority of the HHHs of the woreda are illiterate or able to read or write; only few of the respondents got an opportunity to learn primary school. From this, it can be concluded that there is high illiteracy rate among local people of the woreda especially among the adult and above aged people. Illiteracy has its own influence on adaptability, especially to accept new adaptation mechanisms. A number of studies (Temesgen et al, 2014) for example, reported that education increases the probability of adapting to climate change. This is because education is an indispensable tool to easily understand climate information to adjust and develop adaptive capacity to the changing climate.

### 4.1.5. Age and Family Structure of the Sample Households

As shown in table 4.2 below, the survey indicates that, age group categorization, the age of the HHHs is categorized in to two groups, maximum and minimum age group,. Based on this from the total households 56 ages are maximum, of them 29 ages are minimum, and the mean ages of households were 40.77. This entails most of surveyed HHHs are economically active; it can be assumed that they know the area and environmental problems very well. According to Ahmed (2014) categorize family size divided in to three groups, up to 4 members small, 5-8 medium and more than 8 members are large. Based on Ahmed categorization, the survey result indicated in this research maximum family size of households are 10 maximum family size, 2 minimum family size and have mean of the total family size are 6.19.

Table 4.2: Descriptive Statistics of Age of head of HH and Family size (N=140)

| | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Age of head of household | 29 | 56 | 40.77 | 6.233 |
| Family size of the household | 2 | 10 | 6.19 | 1.823 |

### 4.1.6 Means of Livelihood of the Sample Households

Household heads were also asked about their major source of livelihood, according to their response in table 4.3, the majority 48.6% of households were dependent on mixed agriculture (having both crop production and livestock husbandry), 32.9% of respondents depend on crop production only, 18.6% on livestock husbandry and the total household respondent other means

of livelihood frequency from the total 57.1 they had 42.9 they had not respectively. Land particularly is the most valuable resource and asset in the study area. However, farm lands in the area are fragmented and too small to cover the household annual consumption, expenditure patterns and leads to food insecurity. By this case most household become vulnerable to the impacts of climate change and less capacity to adapt, since the majority of farmers are own very small size of farm land and the income pattern of household owning them are highly vulnerable to the vagarious of weather and economic shocks. The survey result shows that, majority 97.9% of the total household respondent are agricultural land holder and only 2.1% landless.

### 4.1.7 Livestock Possession Households

The distribution of livestock is not uniform throughout the household. As the data on the table 4.3 shows, from the total household respondent96.4% livestock possess, while 3.6% livestock possess. The result shows that in the table 4.3 from the total respondent 3.6% had not livestock possess so, this show that means of livelihood of the respondent may have others alternate rather than livestock production. Livestock are the most important means of livelihood for households, who engaged on crop production and it provides milk and milk products that support in a season of hardship, help to petty trade and for the transportation of yields to the market center.

**Table 4.3: Sourceof household respondents**

| Economic Characteristics | Categories | Frequency | Percentage |
|---|---|---|---|
| Means of livelihood of the HH | Livestock husbandry | 46 | 32.9 |
| | Crop Production | 26 | 18.54 |
| | Mixed agriculture | 68 | 48.6 |
| Other source of means of livelihood | No | 80 | 57.1 |
| | Yes | 60 | 42.9 |
| Owner of land | No | 3 | 2.1 |
| | Yes | 137 | 97.9 |
| Do you have livestock? | No | 5 | 3.6 |
| | Yes | 135 | 96.4 |
| | Total | 140 | 100 |

**Source**: Field survey, (2021)

### 4.1.8 Economic Characteristics of Respondent Household

As the table indicated 4.4 below the total size of farm land average (mean) before 5 years was 7.5 (in timad) but the current total average household size of farm land is 6.64 (in timad).

The household survey indicates that in the study area, the average amount (mean) crop production before 5 years was 22.84 (in quntal), whereas the current amount of crop production mean is 19.12 (in quntal). As the result showed that the productivity of crop in the study area indicate decrease time to time due to fluctuations of temperature and rainfall for a period of time, crops did not get appropriate soil moisture to enable crop to absorb nutrients from the soils.

As shown in table the amount of fertilizer (urea and dap) used in the household the total average (mean)was 451.01.

Description of Livestock More importantly, HHs asked to report their livestock in number that they had before 5 years and this time. As shown table researcher asked as, how many of the following livestock did you have before 5 years and nowadays to know its trend? The distribution of livestock is not uniform throughout the household. As respondents, livestock average number before 5 years ago maximum and minimum was 87, 4 respectively and the average (mean) number of livestock was 20.42. Whereas the current number of livestock as the report indicated that the maximum and minimum livestock number was 29, 3 and the mean 12.35 respectively. As the household respondent result indicated that the total size of farm land before 5 years the standard deviation average was 2.581 the current total size of farm land standard deviation average is 2.600 this showed that the household total farm land almost similar but the household possession of livestock before 5 years in standard deviation average was 14.369 but the current is 6.441 this showed that how much the deference between household possession of livestock before and current.

### Table 4.4: Economic Characteristics of Respondents

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Total size of farm land before 5 years (in Timad) | 137 | 4 | 12 | 7.50 | 2.581 |
| Current size of farm land (in Timad) | 137 | 2 | 12 | 6.64 | 2.600 |
| Amount of crop production before 5 years (in quintal) | 137 | 6 | 55 | 22.84 | 10.618 |
| Amount of current crop production (in quintal) | 137 | 5 | 47 | 19.12 | 10.239 |
| Amount of fertilizer used (urea and dap) (in quintal) | 137 | 200 | 800 | 454.01 | 156.719 |
| How many livestock did you had before 5 yrs | 135 | 4 | 87 | 20.42 | 14.369 |
| How many livestock do you have currently | 135 | 3 | 29 | 12.35 | 6.441 |

**Source**: Field survey, (2021)

**Key: -** 1 timad means 0.25 hectare

1 kuntal means 100 k.g

## 4.2. Local Rainfall and Temperature Variability

### 4.2.1 Trends of Annual Seasonal Rainfall Trends (1974-2019)

Rainfall and temperature are important meteorological variables that determine water availability, production of crops and livestock rearing or food production processes in countries where agriculture is more dependent on rainfall, (Abebe, 2013).The average annual rain fall of Awable Woreda in the years 1974-2019, ranges from 716.9mm to 1292.3mm. The average rainfall of the Woreda is 241 mm in the past three decades.

The long term monthly average data of the rainy season in the Awable Woreda is about 1316.4 mm. In other words, this is about 73% of the total annual average rainfall of 241 mm which is occurring from June to September Figure 4.1.The rainfall distribution is mono-modal with a highest concentration from June to September. The study areas 'agriculture is highly dependent on the amount of rainfall occurring in this season, and hence, understanding the pattern and distribution of rainfall of the entire months plays a key role in making effective decision about various agriculture practices.

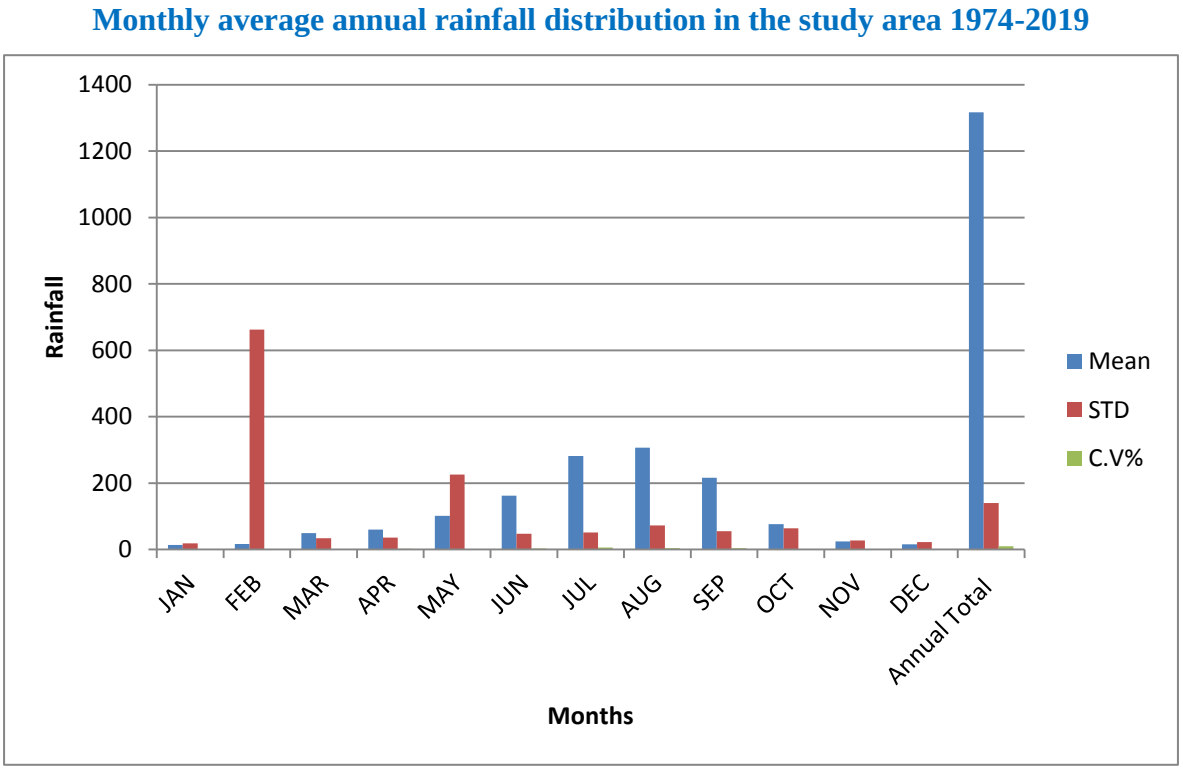



**Figure 4.1: Average monthly rainfall distribution from their means of Debre Markos meteorological Station for the period (1974-2019) Source: ENMSA (2021)**

The long-term monthly average rainfall record in Figure4.1 shows that, the highest rainfall (306.7 ± 13.2mm) was recorded in August; and the corresponding higher rains were recorded in June, July and September with estimated values of 161.9 ± 3.4 mm, 281.3 ± 5.5 mm, and 215.6 ± 3.9 mm, respectively. The greatest coefficient of variation (C.V) was observed in July (≈29%) and followed by ≈26% in August. The rainfall variations (CVs) in June and September were about 18% and 19%, respectively Figure 4.1. Hence, the past 30 years have seen a significant rise in the global mean temperature, as well as changes in precipitation patterns and more frequent and intense extreme weather events.

### 4.2.2 Temperature Trends (1988-2019)

The monthly temperature trend shows that it was only in June that the minimum temperature dropped 8.3 oc. The highest maximum temperature was between February and May. The record of maximum was 25.5 0C. The climate condition of Awable woreda analyzed for daily mean

temperature, average maximum and minimum temperatures, and the highest of maximum and lowest of minimum temperatures. Daily average temperature was estimated 22.5 ± 10.3 0C. The average maximum temperature was about 25.5 ± 18.9 0C and average minimum was estimated 12± 8.3 0C. The highest and lowest of maximum and minimum temperatures were 25.5 ± 18.9 0C and 12± 8.3 0C, respectively as shown in Figure 4.2.

Stern et al. (2006) identified that historical daily temperature and rainfall derivations were able to detect or reveal variation in a local climate. In this study, the analysis of average and extreme daily temperatures indicates the occurrence of possible climate change and a slight rise particularly in the mean and maximum temperatures. From the daily 45temperature analysis of the past 45 years (1991-2020), the highest maximum temperature reached 23 ± 0.76 0C for the period 1973 - 2009.

**Figure 4.2: Trend of average temperature 1988-2019 of AwableWoreda**

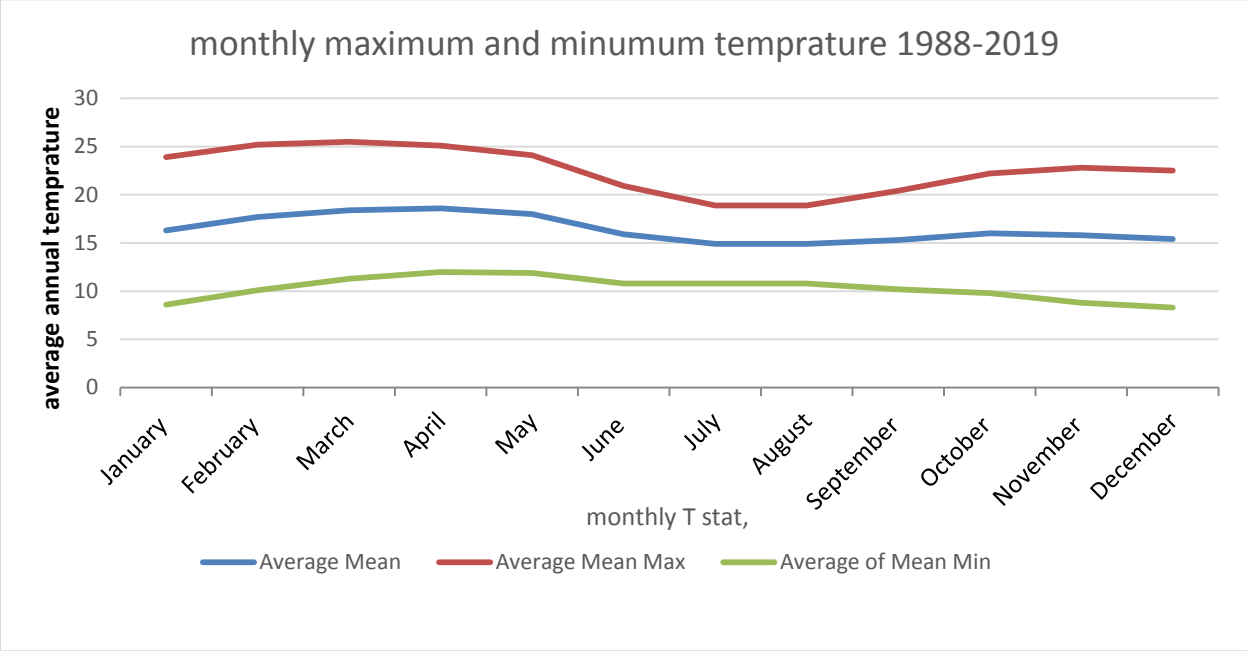



**Figure 4.3: Trend of average temperature 1988-2019 of Awable Woreda**

**Source**: ENMSA (2021)

### 4.2.3 Patterns of Climate Variability (1990-2019)

Variability of climate parameters: precipitation and temperature. The Awable woreda situation Indicates higher level of rainfall variability over the last couple of decades (table 4.5)as the data From the National Metrological Agency (NMA) Debre Markos station shows the yearly average rainfall deceases overtime. Table 4.5 clearly depicts that between the years 1990 to 1994 the average precipitation for Belg[1] and Mehere[2] seasons were 35.31 milliliter and 236.12 milliliter, respectively; while after thirty years between the years 2015 and 2019, the average rainfall increased to 39.42 milliliter and257.23 milliliter for Belg and Meher seasons, respectively.

**Table 4.5: Seasonal rainfall patterns of Awableworeda for the period of 1990-2019**

| Seasons | 1990-1994 | 1995-1999 | 2000-2004 | 2005-2009 | 2010-2014 | 2015-2019 |
|---|---|---|---|---|---|---|
| Belg rainfall | 35.31 | 46.50 | 70.80 | 40.06 | 53.53 | 39.42 |
| Meher rainfall | 236.12 | 240.24 | 235.75 | 236.71 | 254.61 | 257.43 |

Belg represents rainfall for the period February - April; Meher represents rainfall for June – September

The relatively high plateau on which Awabel is located ensures that has a temperature ranging between 8.3 and 25 oC and moderate rainfall ranging between973 to 1621 milliliter. However, rainfall is unevenly distributed throughout the year. For instance during the years, 1994, 1999, 2004, 2009 and 2014 the rainfall was 1079, 973, 1589, 1374 and 1519 milliliters respectively, on the other hand for the years 1984, 1985, 1988, 1991 and 1992, the rainfall was 1351, 1268, 1453, 1240 and 1082 milliliters respectively.

There used to be two rainy seasons; the major rainy season being from June to September and the minor rainy season being from February to mid of April. However, according to the report obtained from Woreda agriculture office, over the last few decades (from 1980 to 2011), the rainy season becomes only one. This leaves the remaining months almost dry. Hence, for most rain-fed crops, the growing season is only the major rainy season. Moreover, much of the area's socioeconomic life is dominated by the unpredicted onset and cessation of rainfall, and its

[1]Belg represents rainfall for the period February - April
[2]Meher represents rainfall for June – September

amount. For instance, within the last 10 years, there has been only two years during which the area received relatively good Belg rain that could be used for crop production. Out of the total 28 rural kebeles of the woreda, 3kebeles have already stopped Belg season cultivation. These Kebeles depend only on Meher season for crop production. During some of the years, the onset of rain was found to be too early, while during other years the rain delays unduly, thus disturbing the cropping calendar of the farmers.

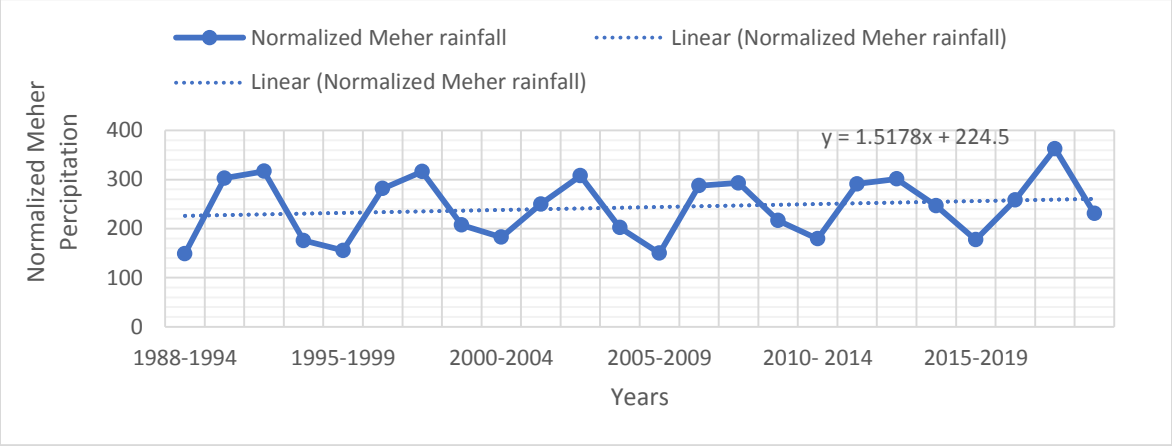



**Figure 4.4: Normalized Meher season variability of rainfall from 1988 to 2019**

In general, the amount of rainfall received each season is continually decreasing from year to year to the extent that same of the crops can no morebe adapted to the area. Fig 4.4 indicates the general trend in the decrease of the average amount rainfall received for three decades. For instance, in 1999 and 2000, there was a total failure ofBelg rain throughout the woreda; and in 2006 and 2007 there was relatively better Belg season rain.

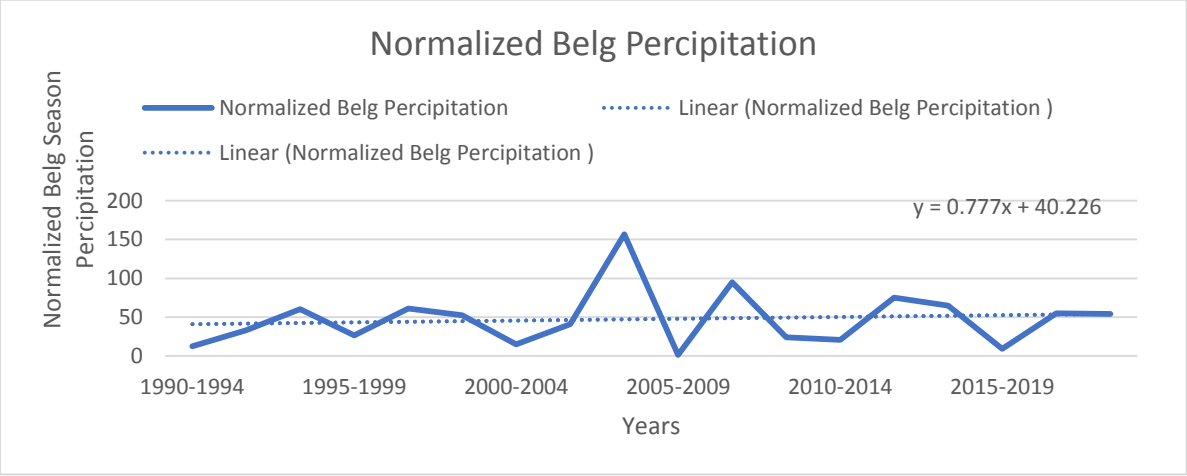


**Figure 4.5:NormalizedBelg season rainfall variability from 1990 to 2019.**

Moreover, the variability of rainfall over years has significantly increased between the year 1990 and 2019. The amount of rainfall received has become more irregular as well as the time of set on and cessation has become evenvariable. The amount of rainfall received has shown continual reduction from year to year, creating more scarcity of precipitation over years. For instance, the average amount of rainfall received before 25 years is significantly higher than the amount of rain received during the last five years.Fig 4.4shows a downward sliding in the amount of precipitation over the last 3 decades.

The lower part of the curve in fig 4.4indicates periods during which there was a complete failure of Belg season rain. According to the data from NMA and the report of Arable woreda agriculture offices, between the year2008 and 2009, there was only one good Belg season's rain received by of the woreda. With the already evidenced Belg season failure, the comparison of threat of decrease in annual precipitation between Meher land Belg seasons from the fitted linear lines fig 4.4 show higher rate of decrease for Meher, leaving the future to be more gloomy in allowing the production of current crop varieties.

When this is related to the global CC, the LaNina condition, which used to emerge every 30years, has now come to emerge every year (UNOCHA, 2012).In the area, rains have failed for three or more consecutive rainy seasons, which normally occur between March and June and between October and December every year. For instance, for the 2012 Belg season which was supposed to come in February has not come yet across every areas of Ethiopia. The Ethiopian Meteorology Agency announced the amount of seasonal rain expected from the end of February to May would be late and below the regular in distribution this season in all areas receiving Belg rain.

"As the one FGD member informed in bega season rain fall is scanty. The quality of animals was decreasing. This is due to the lack of forage and the scarcity of water and the prevalence of animal diseases resulted from high temperature variability. Thus, the quality and the quantity of animal product also deteriorated, even in the year 2015 more than 200 cattle's died, particularly larger animals are highly affected (KII &FGD,2021).

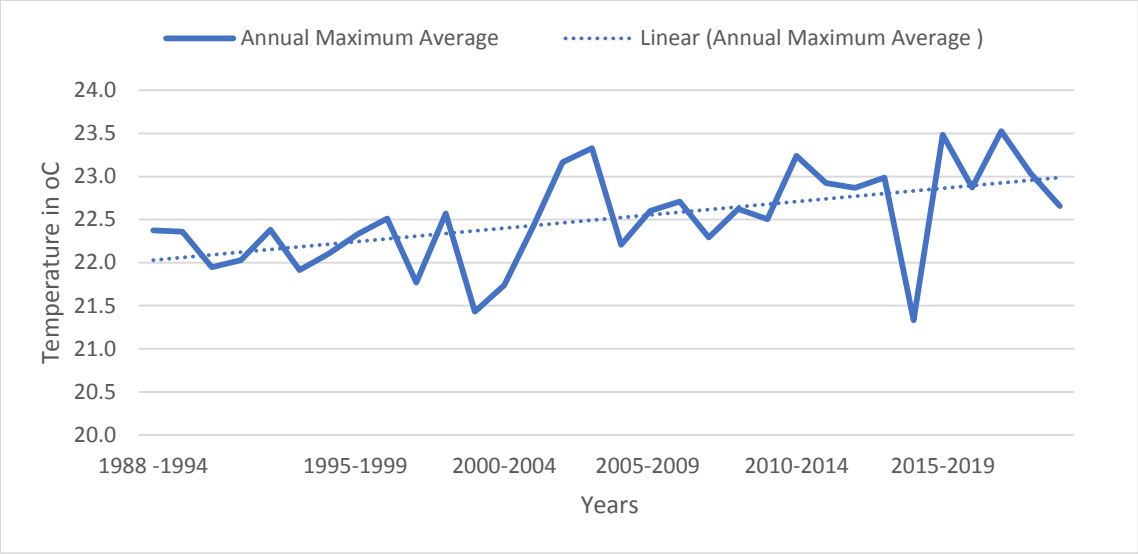



**Figure 4.6: Actual and predicted trends and variability of maximum annual temperature Arable woreda**

On the other hand, temperature variation appeared to be exhibiting significant change in the study area. Especially variability became significant over the last couple of decades (Fig 4.5). Apart from the observed high level of variability, the average temperature has continually increased over years, which has caused the shift in some of the crops from lowland to midland. Before 30 years, the average temperature ranged from 10.3 to 22.5 oC; before20 years, the average temperature ranged from8.3 to 23.5oC; while in the last 10 years alone the average temperature ranged from 10.6 to22.9oC. This clearly depicts the increasing trend in average temperature of the area. Fig4.5 and 4 clearly show increasing trends in the minimum and maximum annual temperatures over a period of more than 30 years. Generally, the maximum temperatures increased faster than the minimum temperatures. Before 30 years, the relative pattern for temperature increase was steady and continuous with lower level of variability, whereas since 2017 onwards, the rate of increase and the level of variability increased dramatically, creating difficulty among the farming communities to predict temperature levels for the next year. In general, the temperature level increased temporally as shown by the fitted straight line with positive slopes.

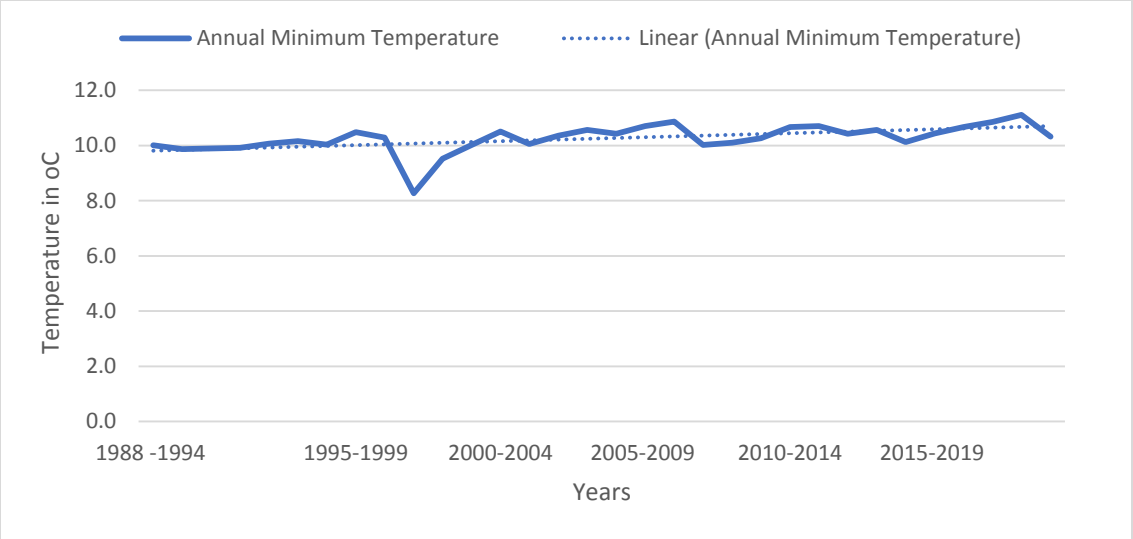



**Figure 4.7: Actual and predicted trends and variability of annual minimum temperature in Awabelworeda**

Based on the last 30 years' data, it is possible to predict the temperature level for the next 10 to 20 years. Accordingly, from the year 20221 to 2031 it can be estimated that the average minimum and maximum temperature will range between 11.5 and 28.5 oC, respectively. Similarly, for the years between 2031 and 2041, the average minimum and maximum temperature is estimated to range between 12.50 and 29.5 oC, respectively. Climate change induced shocks and crop damages Community's disaster profile for the study area indicate that the major determinant factors that make community vulnerable to shocks include economic, physical, social and ecological factors. Apart from economic factors, the poor are in general far more vulnerable than economically better off sectors of the society.

## 4.3 Local Indicators of Climate Change and Variability

According to FAO, (2011) prediction, the wet areas are expected to be wetter and the dry areas in the tropics are expected to be drier as a result of climate change. The intensity of rain storms could increase in some areas and rain becomes unreliable and unpredictable. In agreement with this prediction, most of the respondents reported that 70.7% there is climate change/variability, of them 24.3% of household respondent said the climate has not changed, the rest had not any idea about climate change and variability. In the amount and timing of rain fall in the study area and it is adversely impacting crop production. It was clear to farmers that rains are becoming more erratic and coming later going earlier in the cropping seasons. This idea supported by

majority respondents, 44.4% of the surveyed HHHs agreed that the main rainy season comes early goes late, while 33.3% of the respondents said that the rain comes and goes early. Only 22.5% of HHHs responded that the rain comes early and goes late.

The survey data reveals that 67.2% source of information heard about climate change and variability of household respondent in the study radio was the major source information. Additional the household used as source of information about climate change and variability were 19.2% television, 4%newspaper and 9.6% was government.

Table 4.6: Local indicator and source of climate change and variability of the household heads

| | Categories | Frequency | Percentage |
|---|---|---|---|
| Are you heard about climate change/variability? | No | 15 | 10.7 |
| | Yes | 125 | 89.3 |
| Source of heard information climate change | Radio | 84 | 67.2 |
| | Television | 24 | 19.2 |
| | Newspaper | 5 | 4 |
| | Government | 12 | 9.6 |
| Perception about climate change | There is climate change/variability | 99 | 70.7 |
| | The climate has not changed | 34 | 24.3 |
| | I have no idea | 70 | 5 |
| Perception about temperature in your area | Increase | 119 | 85 |
| | Decrease | 6 | 4.3 |
| | No observable change | 15 | 10.7 |
| Rain timing in your area | Comes early goes later | 48 | 44.4 |
| | Comes and goes early | 36 | 33.3 |
| | Comes late goes early | 26 | 22.5 |
| Faced climate disaster shock | No | 19 | 13.6 |
| | Yes | 121 | 86.4 |
| | Total | 140 | 100 |

**Source**: Field survey, (2021)

As shown on table 4.5 from the total household respondent 89.3% they have informed or heard information about climate change and variability, the remain 10.7% of households did not heard climate change variability. Additional from the total household heads 86.4% have exposed for climate disaster shock. The remain13.6% not faced to climate disaster shock.

The KII participants reported that:

"Rain fall pattern is disturbed and became very scares and erratic, unseasonal rain, pest infection and the fertility of the soil especially those of the cultivated land has reached to the point of infertility where it cannot become productive even farmer used agriculture inputs. The combined effect of these factors have resulted a sever crop yield reduction. Consequently, this has induced for food insecurity.

### 4.3.1 Vulnerability of Climate Change/Variability

**Table 4.7: Agro ecology, sex, marital status, educational level and means of livelihood influence on climate change and variability**

| | | Vulnerable to climate change/variability | | |
|---|---|---|---|---|
| | | No | Yes | Chi-square Test (P-value) |
| Agro-ecology | Dega | 9 | 42 | 0.171 |
| | W/dega | 4 | 34 | |
| | Kolla | 3 | 48 | |
| Sex of head of HH | Female | 8 | 55 | 0.669 |
| | Male | 8 | 69 | |
| Marital status of head of HH | Single | 0 | 7 | 0.00** |
| | Married | 6 | 83 | |
| | Divorced | 5 | 32 | |
| | Widowed | 5 | 2 | |
| Educational level of head of HH | Illiterate | 10 | 73 | 0.035* |
| | Capable to read & write | 4 | 49 | |
| | Primary school | 2 | 2 | |
| Means of livelihood of HH | Livestock husbandry | 11 | 35 | 0.00** |
| | Crop production | 0 | 68 | |
| | Mixed agriculture | 10 | 16 | |

**Note**: ***** significant at 0.05 level of significance, ****** significant at 0.01 level of significance

The findings of this study revealed that majority of household respondent said to vulnerable to climate change and variability. The results showed that the all categorical agro ecology zones 124 household respondent were vulnerable to climate change and variability This could be due to the fact that majority of the household heads affected by variability of climate. However, Chi-square test results proved that agro ecology of the study area had significance effect on

household food security on vulnerable climate change and variability. Further, gender had no influence on vulnerability of climate change/variability in the study area, though a look at the results showed that Male (n=69) adapted to vulnerable. This could be attributed to the fact that male headed households were more that female headed in the study area. Additionally, the level of education had significant positive influence on vulnerable to climate change and variability in the study area. The results shows that households heads with illiterate (n=73), able to read and write (n=49) and primary school (n=2). This means that household heads with high education levels are likely to tolerate and education increases the probability of resist to climate change/variability.

**Table 4.8:Vulnerablegroup of household with family size**

| Group Statistics | | | | | |
|---|---|---|---|---|---|
| | Are you vulnerable about climate variability like health, price e.t.c | N | Mean | Std. Deviation | Std. Error Mean |
| Family size of the household | Yes | 124 | 6.33 | 1.869 | .168 |
| | No | 16 | 5.13 | .885 | .221 |

**Source**: Field survey, (2021)

### 4.3.2. Perceived Impact of Climate Change and Variability on Rural Livelihood

Most people follow traditional cultivation practices that rely on seasonal rain water. Erratic rainfall patterns and hailstorm contributing to soil erosion, soil fertility loss and crop damage are having an adverse impact on livelihoods of most of these communities, thus increase food insecurity. Climate change and variability had serious impacts on livestock and crop production in Awable Woreda. Climate change and variability is likely to impact on crop productivity directly through changes in the growing environment, but also indirectly through prevalence of agricultural pests and diseases, associated impacts on soil fertility and biological function. The rain fed yield changes are driven by both precipitation and temperature changes. As IPCC (2014) concluded, slight warming decreases yields in seasonally dry and low-latitude regions. Climate variability affects virtually all aspects of agricultural and other water-intensive activities and has impact on a large proportion of households, with far-reaching consequences throughout the economy. Like in most rural parts of Ethiopia, the source of livelihood in the study area (Awable woreda), is agriculture. Therefore, unreliable and erratic rainfall during the

rainy season results in loss of upper most and fertile soil, decrease soil fertility through soil erosion and this eventually leads to decrease in crop yield and food insecurity.

FGD and key informant interview participant reported that:

There is CCV in our woreda from past one decade onwards. Some of the indicators were increase in temperature, rainfall variability, outbreak of new pests, weeds and crop diseases, and amount of spring water decrement observed in the area. In FGD participant said repeatedly that Some years before, the Belg rainy season start drop in March, but now there is no Belg rain around ten years left and also the main rainy( Meher) season rain comes late(end week of July) and goes early around first week of September".

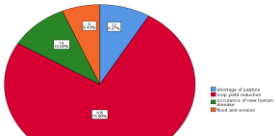


**Figure 4.8:Climatechange and variability challenge on rural livelihood.**

**Source**: Field survey, (2020).

In Fig 4.1 as the survey result shows 75% respondent's crop yield reduction is the major challenge of CCV, whereas 10% result shows occurrence of new crop, animal and human disease, and 8.57 shortage of pasture. The rest6.4% of respondents responds that flooding with erosion of farm and irrigable lands affect their live when the summer season comes because of CCV affect their livelihood.

### 4.3.3 Participant Household's Respondent to Climate Change/Variability

As the survey result reveals that from the total 72.9% households have participated to overcome climate change/variability in the study area. Whereas 27.1% households impossible to participate in the impact of climate hazards.

**Table 4.9:Measureand participants of household on climate change and variability**

| | Categories | Frequency | Percentage |
|---|---|---|---|
| Participate to overcome climate change and variability | No | 38 | 27.1 |
| | Yes | 102 | 72.9 |
| Measures you used to overcome climate change/variability | Planting trees | 39 | 30.5 |
| | Tracing | 27 | 26 |
| | Water harvest | 24 | 23.1 |
| | Reforestation | 14 | 13.5 |
| | Total | 140 | 100 |

**Source**: field survey (2021)

### 4.3.4 Measure Used Household Respondent to Overcome Climate Change/Variability

The finding of the study show that on the table, such measures include that planting tree, traditional tracing, water harvest and reforestation was found to be practiced in the study area. Of the 140respondents interviewed in 30.5%, indicated tree planting as an adaptation strategy to the impact of climate variability as well as to climate change. Another locally based technology that is used by local communities in the study area is traditional terracing that was reported by 26% of the respondents measure to adapt impact to climate change and variability. This practice increases soil water holding capacity when applied in the field as reported in Shemdoe at el 2009b.Whereas water harvest and reforestation used as a measure of climate change and variability in the study area of the 140 interviewed 23.1%, 13.5 respectively.

### 4.3.5 Vulnerable society group for climate change and variability

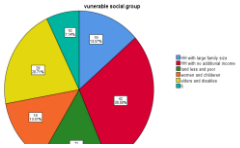


**Figure 4.9: Groupof society vulnerable to climate impacts**

**Source**: Field survey, (2021)

From the total household respondent indicated that the most vulnerable social group in the community 30% sample respondent household with no additional income.

According to World Bank, (2012) stats that the poor, landless, women's, children, disables and elders are among the most vulnerable social groups in the community due to lack of access to resources mobility, decision making etc. In view of this, about 20.71% of sampled respondents said that elders and disable peoples are more vulnerable to the impact of CCV, land less and poor people was 15% from respondent because they don't have enough farm land and livestock's. Whereas 13% of respondents said that, women's and children's and large family size are the most affected social groups in the community. , households with large family were vulnerable to the adverse effects of CCV, because of limited adaptive capacity.

## 4.4Analysis of Household Food Security

FAO, 2010 describes household food security as "having both physical, social and economic access to sufficient, safe and nutritious food at all times for a healthy life". Categorical designations of household food security status were based on whether the household was food secure, mildly food insecure, moderate food insecure and severely food insecure as shown in figure 4.9.

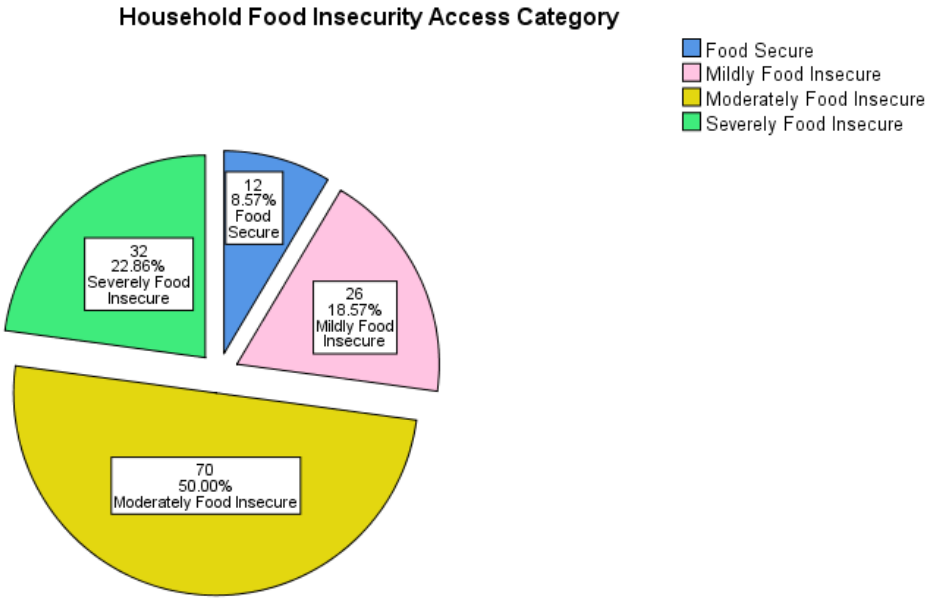



**Figure 4.10: household food insecure category**

**Source:** Field survey, (2021)

Distribution of respondents according to food security status in the study area

| Food Secured | Frequency | Percent |
|---|---|---|
| \No (0) | 102 | 72.9 |
| Yes (1) | 38 | 27.1 |
| Total | 140 | 100.0 |

**Logistic Regression**

In the current study the binary logistic regression was employed in order to investigate determinants of household food security in the study area. The dependent variable household security is measured as a binary variable based on the status of food security of each household. The main component of logistic regression output is the summary of model variables. This summary presents several statistics i.e., S.E, Wald, df, significance, Exp (**β**), for each variable included in the model as well as the constant. **β** represents the un standardized regression

coefficient and represents the effect of the predictor variable has on the dependent variable and Exp(**β**) is the calculated odds ratio for each variable (if it is continuous) or each category (if it is categorical). The odds ratio represents the increase (or decrease if Exp (**β**) is less than 1) in odds of being classified in a category when the predictor variable increases by 1.

**Table 4.10: Parameter estimates of the binary logistic regression model on food security and its determinants**

| Variables | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Sex of head of household (1) | 2.832 | .779 | 13.231 | 1 | **.000**** | 16.980 |
| Family size of the household | -.491 | .155 | 10.100 | 1 | **.001**** | .612 |
| Educational level of head of household | | | 19.107 | 2 | **.000**** | |
| Educational level of head of household (1) | 3.278 | .750 | 19.107 | 1 | **.000**** | 26.511 |
| Educational level of head of household (2) | 3.34 | .721 | 21.812 | 1 | **.001*** | 28.219 |
| Means of livelihood of the household | | | 5.788 | 2 | **.085** | |
| Means of livelihood of the household (1) | -2.066 | 3.941 | 4.814 | 1 | **.068** | .127 |
| Means of livelihood of the household (2) | -1.715 | 2.763 | 5.046 | 1 | **.065** | .180 |
| Do you think to adapt climate variability hazards? (1) | 0.512 | .176 | .312 | 1 | **.017*** | 1.67 |
| Did you participate on climate change variability overcome? (1) | .267 | .709 | .142 | 1 | **.706** | 1.306 |
| Constant | .156 | 1.159 | .018 | 1 | **.893** | 1.168 |

***Significant at 0.05 level of significance, ****significant at 0.01 level of significance*.

According to the final model, Sex of head of household, family size, educational level of head of household and perception of house hold head to adopt climate variability hazards were found 0.05 level of significance.

The model summery statistics has been employed in order to examine the goodness of fit the final model before interpretation. As shown in table below, the Cox and Snell $R^2$ was 0.378and Nagelkergke's$R^2$was 0.548. This indicated that the final model, with four explanatory variables, explained about 54.8% of the total variation in the data and it signifies that the model is good.

**Table 4.11: Summaryof logistic regression analysis**

| Model Summary | | | |
|---|---|---|---|
| Step | -2 Log likelihood | Cox & Snell R Square | Nagelkerke R Square |
| 1 | 97.272[a] | .378 | .548 |

**Interpretation and Discussion of Binary Logistic Regression Analysis**

As seen in table 11 the final model results four significant variables which have the potential to determine the status of food security of households. Now, the contribution of each covariate has been discussed by interpreting the coefficients as well as the odds ratio values.

The first significant predictor that affects the status of food security of households is sex of head of household. According to the current analysis households lead by males were found 17 times more likely to secure food in their family than households lead by females (i.e.,$Sig.value = 0.000, \beta = 2.832, Odds\ Ratio\ (OR) = 16.980$).

The second significant variable in the final model was family size of households. According to the logistic regression output, family size was negatively associated with food security of households in the study area. More specifically, as family size increase by one, a household become 38.8% less likely to achieve food security (i.e.$Sig.value = 0.001, \beta = -.491, Odds\ Ratio\ (OR) = .612$).The third significant predictor is educational level which had three categories with the first category (i.e., illiterate)was used as reference. Based on the current analysis, as the educational level of heads of household gets better, the chance of households achieving food security will increase. The last predictor found significant was household head perception towards adopting climate variability hazards. The current analysis asserts that household heads who believe it is possible to adopt climate variability hazards were 67% more likely to achieve food security in their household than household heads perceive climate variability hazards can't be adopted(i.e., $Sig.value = 0.017, \beta = 0.512, Odds\ Ratio(OR) = 0.599$)

## 4.5 Adaptation and Copping Strategies

As climate variability has been common, farmers in the study area were practicing different adaptation and copping strategies. According to Negatu, (2016), in developed and developing countries all over the world, farmers and indigenous and local communities have traditional knowledge, expertise, skills, and practices related to food security, agricultural production, diversity and adaptation. Adaptation strategies are methods that local people used to adjust themselves with the existing change to minimize and adapt the impact of climate change.

Of the respondents, 17.5% and 14.4% of households respectively responded as controlling and increasing of grazing land as better choice.

### 4.5.1 Farmers' Adaptation Strategies to Climate Change and Variability

Studies have confirmed that climate change is happening, and societies must take the necessary adaptation strategies to the impacts of CCV. For poor countries like most African nations, adaptation is not an option rather it is a necessity (IPCC, 2014). Adaptation strategies are methods that the local people used to adjust themselves with the existing change. In order to this, the local people on the woreda made different changes and adjustments in different sectors. These includes growing short maturing crops, wise storage of crop grains (saving), changing livestock type, intensive irrigation, decreasing the number of livestock, rain water harvesting, crop diversification and inter- cropping system.


**Figure 4.11: Community adaptation to climate hazards**

**Source**: Own survey, (2021)

Since, climate change is a real phenomenon and affecting the entire world, people are working to minimize the influence through adapting and coping mechanisms. However, the capacity differs from country to country, from region to region and even from woreda to woreda. This is because of the nature of the area and development. So far, in Arable woreda as one of the exposed areas for climate change, there are different local and institutional adaptive and coping mechanisms. However, increased frequency and intensity of climate change impacts have reduced the capacity of local people to adaptation and cope with the problems.

The household survey indicates that 87.86% of respondents said, it is possible to adapt with some of the impacts of climate change induced-hazards. While about 12.14% of the respondents confirmed that it is impossible to adapt climate change related problem.

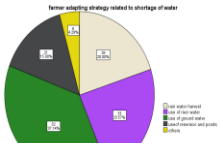


**Figure 4.12: Adaptationstrategy for shortage of water**

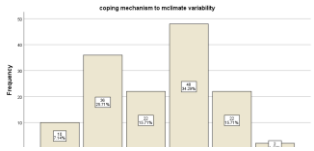
As shown fig 4.11 farmers have been taken different types of adapting strategies for scarcity of water used as the first measure 37.14% use of ground water, 23.57% use of river water as adapting strategy. Whereas 20% Rain water harvesting, 15% use of reservoir and ponds and 4.29% use of other source as adapting strategy. Rain water harvest is basically the diversion, collecting, storage and usage of rainwater for various purposes for instance collecting rainwater from roof tops. Rain water harvesting was the third adopted coping strategy in the study area.

### 4.5.2. Farmers' Coping Mechanisms to Climate Variability

Coping mechanisms employed by different rural households are many reckoning onthe provision of resources they need. Respondents replied. It's not uncommon to experience different coping strategies during food shortage to attenuate or avert the prevalence of asset depletion and other catastrophic impact. Results of the analysis discloses (figure) that, the local communities are already undertaking various coping mechanisms in response to the adverse impacts of CCV. Thus, to assess the categories of coping strategies they're using, the surveyed household heads told the farmers use the subsequent coping mechanisms;

**Selling of livestock:** from the total samples 34.29% of them cope the climate impact problems through selling of sheep's, goats, cows, hens and even the problem is more sever forced to sell farming ox.

**Selling fire wood and charcoal:** Selling fuel wood and charcoal is another coping mechanism which is used by farmers to cope up with incoming impact of drought and rain fall variability. From the total respondents 25.71% respond that by selling fire wood, animal muck and charcoal to cope up the existing climate variability related problems. In the study area mostly poor people cover their house consumption by selling fire woods, muck and charcoals to the urban dwellers.




**Renting of land:** to pass bad time 15.71% respondents were forced to rent their lands for 3 up to 5 years in cash or in kind. But there is frustration in this way, some renter not willing to leave at the end of the year.

**Borrowing grains from relatives:** about 15.71% of the respondents are borrowing grains from relatives to cope the impacts of climate variability are the main coping mechanisms. When get surplus product they return the borrowed grains or compensate through helping daily works.

**Reduce number of meal:** According to the individual interview reports 7.14% of the respondents reduce the mile size and frequencies of eating during shortage of food occurs. This system is implemented on adult household members commonly eat two times per day even they forced to eat ripen grains (in Amharic said to be Nifiro or Kolo), whereas children are commonly eating three times with low nutrition level. In other way, during the serious food scarcity periods the community has confirmed that the size of meal and frequency will be decreased for all household members.

**Seasonal migration:** One of people's adaptation options to cope the climate variability impacts are migration. Especially peoples in Kola and Woyina Dega kebeles chooses migrate to Debre markose, Bahirdar, and others towns and surrounding rural areas to get works as a daily laborer or farming of contract lands from other nations. As indicated on figure 4.12, around 1.43.1% of the smallest in number from total respondents say's migration is their coping mechanisms to the impacts of climate variability. Most of the time peoples who migrate are above the age of 30 to get jobs. By doing this they reduce vulnerability of their family and after they get some money they back to their home.

**Access to credit services**: - The sample house hold heads were asked access to institutional credit during occurrence of climate related hazards. According to the survey data, majority 82.9% respondents said "**NO**" because of heavy criteria and high interest rate they are not able to fit and also that much not have credit provider institute in the study area. From total respondents only 17.1% of the respondents said „**Yes**", they get credit from ACSI (Amhara credit and saving institute) with many guaranty criteria to get the money and also with high interest rate. Even if there is an effort made by the government, but clearly shows that farmers" adaptation to the changing climatic is being constrained by not easily access to credit because of complex criteria and high interest rate of credit institution in the woreda.

**Table 4.12: Access to credit and early warning information of HH respondents**

| | Categories | Frequency | Percentage |
|---|---|---|---|
| Access to credit from institute during climate related hazards | No | 116 | 82.9 |
| | Yes | 24 | 17.1 |
| Early warning information before climate related shock | No | 114 | 81.4 |
| | Yes | 26 | 18.6 |

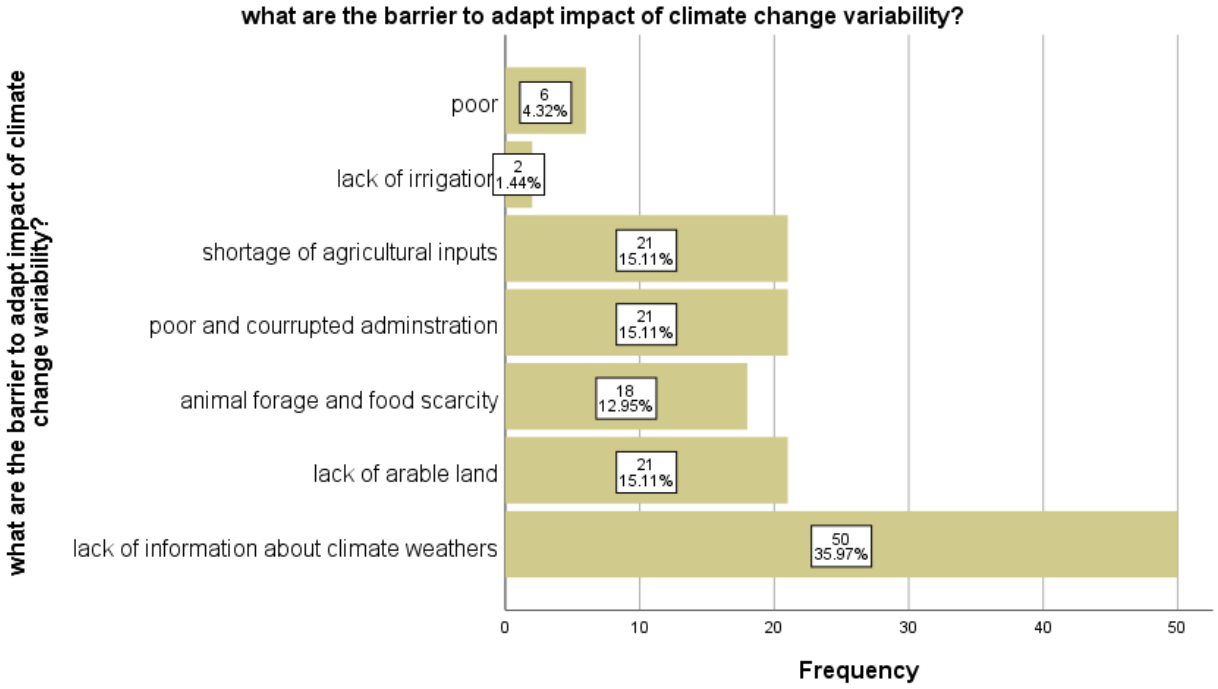
**Source**: Field survey, (2021)

**Disaster preparedness, prevention and information**

Most respondent households of the study area 81.4% reported that not get adequate early warning information before the occurrence of climate related shock, even after occurrence government responses to the impacts of climate hazards were not effective. FGD participants and key informants indicated that they are not satisfied with preparation and responses of the government particularly against climate variability, human and animal disease, crop pest invasion and diseases, flooding, hailstorm and landslide which affected the livelihood of the people in the area. In fact, Agricultural development office carried out disaster prevention and preparedness programs to reduce the vulnerability of the communities to climate change caused disasters. But, most of these activities were not effective due to lack of modern weather forecasts material and skilled man power to predict the future climate condition.

### 4.5.3 Barriers to Climate Change Adaptation

A study conducted by Bewket (2010) in choke mountain, East Gojjam, identified lack of access to land ,water, market, information, and knowledge about the appropriate adaptations as barriers to adaptation climate change in Ethiopia. This study supports the findings of such survey results.



### Figure 4.13: Barriersto adapt climate hazards

This survey assessed local people's barriers to use various adaptation options. Survey results obtained from household respondents, FGDs and key informants on barriers to taking up adaptation options includes; lack of irrigation land, poverty, lack of enough arable land, Poor and corrupted administration, lack of information on climate and weather variability, forage and feed scarcity, shortage of agricultural inputs were major constraints of adaptation for many peoples in the study area

**Lack of information on climate and weather variability**

Lack of information is one of the barriers to adapt impacts of CCV in the study area. The total 35.97% respondents and FGD participants found in the area declared that lack of access to timely meteorological reports (information) is one most pressing constraint for making adjustment to erratic or reduced rainfall to adjust planting dates. Weather forecasts related with onset and/or offset of rains have never been communicated. They also said that the weather information that rarely delivered to farmers for pre-harvest is very general and lack specificity. This adversely affects the accuracy and acceptability of meteorological reports.

**Lack of enough arable land: -**another major constraint of adaptation to impacts of climate change noted by 15.11% respondents was land scarcity. Many household heads indicated that very small (fragmented) land holding size was reported as the main cause. For crop diversification and crop rotation the small plots of land not adequate. Farmers explained that a decrease in their respective land holdings size and farm fragmentation leads economically poor.

**Shortage of agricultural inputs: -**from the total number of respondents 15.11% considered lack of adequate agricultural inputs, since the lands adapt fertilizers, the soil became infertile and erode, so that its fertilizer consumption increase from year to year but the supply is low. Even when the farmer needed such chemicals and fertilizers the government not supply timely. Sometimes chemical fertilizer supplied at late July, after farming finished. Whereas the price of fertilizer, pesticide, herbicide and insecticides increased yearly, this also constraint to resist climate related problems.

**Poor and corrupted administration: -** The survey results showed 15.11% respondents that, Poor and corrupted administration were hindrances to adapt climate change, the farmer exposed for additional and unnecessary expense because of the presence of corrupted administration both at kebele and woreda level. For instance the chemical fertilizer that comes for farmers sold for merchants, and then merchants sold for farmer with expensive cost. Prohibiting food aid by saying the farmers are food secure to the government and non-governmental organization for political purpose. Impose unnecessary expenses on farmers, like expense for sport, Red Cross and for different associations obliged by solders. Increase annual rent of unproductive farm land, unemployment of educated youths and local government assigned enclosure area near to our residence and farm land, it becomes home for wild animals, such as monkey, fox, wild cat, snake and hyena. Wild animals eat our crops, fruits, sheep's, hens and goats. So we forced to displace from the area and it also source of conflict in use of resource inside was some of the problems reported by the respondents.

**Lack of irrigation land: - Lack** of irrigable land was the main constraint for peoples who live in Dega agro ecology of Awable woreda. The majority of sample respondents in Dega kebele respond that absence of river and springs in the area not able to practice irrigation, that‟s help during crop failure, whereas in Kola and Woyina Dega some respondents reported that lack of irrigable land considered as the main barriers to adapt CCV induced hazards.

**Poverty** Adaptation comes at a cost. Hence, poor households have low adaptive capacity. The people in the area indicated poverty as a major constraint for not taking up the following adaptation options: changing crop pattern, to use agricultural inputs, rainwater harvesting and adopting non-farm activities. For instance, to engage with petty trade availability of money to start petty trade were main constraint.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.1. Summary

The international consensus of the scientific society led by IPCC, agreed that the global temperature is increasing and the main cause of this is the accumulation of CO2 and other GHGs. The negative effects of CCV are threatening to reverse development strives in many parts of the world, especially in developing countries. In the coming decades, global CCV will have a serious threat on food and water security. Ethiopia's agricultural sector is heavily dependent on natural rain fall (rain fed agriculture).Though agriculture is the back bone of Ethiopia's economy; it has been adversely impacted by various extreme weather events.

This study intended to assess the impacts of CCV on rural livelihood and their adaptation methods in three kebeles of Awable woreda found in East Gojjam Zone, Amhara region, Ethiopia. It relied on both qualitative and quantitative methods of data collection and analysis. The primary data were collected by using data gathering tools such as household survey, FGDs, key informant interviews and observation. The study also used meteorology data of rainfall and temperature from 1974 to 2019 to examine the trend of climate variability. The finding of the study showed that maximum temperature had significantly increasing through time and expected to continue increasing in the future. On the contrary, annual and seasonal rainfall had decreased and showed fluctuation. Local people also perceived, rainfall variability with increasing temperature, occurrence of new crop pests, weeds and diseases, recurrent drought and grow of new plant species, dry up of river and streams, prevalence of new human and animal disease as major indicators of CCV.

Crop yield reduction, shortage of pasture, shortage of water supply, occurrence new disease on crops, humans and animals, flooding and erosion are mentioned as the most frequently impacts of CCV on rural livelihood. According to the survey data, erratic rain fall with flooding, drought and others like lightning, snake etc. are main vulnerability of the community to climate shocks. Deforestation, low fertility of agricultural land, land use land cover change and absence of sustainable agricultural practice were the main cause of climate change in the study area. The study attain that, landless and poor, women and children, households with large family size and

no additional income, elders and disables were more vulnerable social groups to the adverse effects of CCV, because of limited adaptive capacity.

According to the finding of the study, the most common adaptation options include: use of ground water, intensive irrigation, diversification of income, changing livestock type and rain water harvesting were the main adaptation strategies for crop production/animal husbandry and water supply problem through adjust themselves with the existing change. And also the farmer cope the immediate crises through selling fire wood and charcoal, seasonal migration, reducing number of meals, sells of livestock, borrowing grains from relatives and renting of land were short term responses for crop failure, whereas use of river water for household consumption and decreasing the number of livestock were coping mechanisms for problems with water and animal. Analysis reveals that level of education; sex and martial states of HHH have significant effects on perception to adapt, hearing about CCV and food security status.

Mobilizing community for mitigation measures (natural resource conservation), introducing new agricultural technologies, access to credit services and disaster preparedness, prevention and information were some of local government initiated actions. But the analysis results indicate that some of the mitigation and adaptation measures were not integrated and mutually reinforcing. Lack of information on climate and weather variability, animal forage and feed scarcity, lack of enough arable land, poor and corrupted administration, shortage of agricultural inputs, lack of irrigation land and poverty are considered as the major constraints of farmer's adaptation to impact of CCV.

## 5.2. Conclusion

The household survey result reveals that, temperature increment and rainfall variability is a major driver of vulnerability in the woreda. Synonymously the scientific data also indicate that the amount and timing of the rain fall in the area is very variable and decreasing trend in all seasons. While the trend of maximum temperature consistently increasing from year to year. This is affecting agricultural practices (both crop production and livestock husbandry) which are very sensitive to CCV. Crop yield reduction, shortage of pasture, occurrence of new disease on crops, humans and animals, flooding and erosion were some of the livelihood problem in the study area, which was exacerbated by shortage of agricultural land, low soil fertility, shortage of grazing land, water scarcity lead high poverty of the communities.

For many years, the local people of the study area have struggled against the impacts of different types of natural hazards. In order to minimize the impact of climate change hazards, the households and local communities have applied different adaptation strategies. However, increased frequency and intensity of climate change impacts have reduced the capacity of local people to adaptation and cope with the problems. Especially poor and landless, women and children, elders and disables, household no additional incomes and large family size were more vulnerable households among the society.

The current coping and adaptation strategies that the local people used and the government mitigation measures are not planned, coordinated and not sufficient, such as charcoal making and fuel wood selling are not only suitable but would also cause forest resource degradation and even leads desertification. Assigning enclosure area near to residence and farm land leads displace the community form their area and harvested rain water create favorable condition for malaria breeding. So that it could not fully support the local people to sustain their life. Even though the woreda governmental administration are trying to take some seasonal intervention measures, it faces several short comings like institutional inter- connectedness, commitment, equity, efficiency etc. Therefore it is not as such efficient to overcome the existing climate related problem in the area.

## 5.3. Recommendations

Based on the finding of the study, the following intervention measures are recommended to minimize the impacts of CCV on rural livelihood communities of Awable WoredaThese measures include:-

- ✓ Empowering peoples with education and information; youth education program should be continued that stopped before five years ago and give training on impact of climate change and its adaptation strategies in addition to modern farming and inputs utilization. Create awareness about climate change, its impact on rural livelihood and providing reliable and early warning weather information for farmers help to take appropriate copping and adaptive measures. And also build the capacity of women in all decision making process, women's both household headed or others should be informed and participated in governmental or social group meeting, to be aware in all aspect equal to men's.

- ✓ Access to credit is considered as one of the several factors that can affect adaptive capacity of households. Thus, to minimize the effects of CCV, the local government should facilitate long term credit service with low interest rate for landless, poor, women and young to invest in farm and off farm activities.
- ✓ Government officials specifically woreda agricultural office should train farmers on utilization of inputs, farmers use inputs traditionally, not know the dose for hectare, its leads reduce natural soil fertility and soil decomposition through misuse of scarce and expensive inputs.
- ✓ To minimize the impact of CCV in the study area, the local government administration and non-governmental organization should support, expand and solve the constraint of indigenous adaptation strategies; conduct experience sharing among farmer's which employed effective adaptation strategies, such as growing short maturing crops, crop diversification, diversifying income sources and irrigation to bring sustainable development in the area.
- ✓ Adaptation & mitigation strategies should be complimentary, integrated and mutually reinforcing, the local government planned equally without contradict each other since both of them were important to reduce the adverse impact of CCV.
- ✓ Finally, this study recommend similar studies to be conducted in the study area and adequately identify the impact of CCV, its adaptation mechanisms and existing challenges to adapt and provide more options to policy formulation and enhance livelihood sustainability of the rural community.

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# APPENDIX

## Appendix I: Introduction

My name is Waltengus Getachew. I am a master's student in Addis Ababa University studying college of development studies (Specialization in MSC in Food security and Development study). I am doing my thesis on: the Impacts of climate variability on household food security in Awableworeda, East Gojjam Zone, Amhara region, Ethiopia.

Thus, I would like to express my appreciation in advance for your cooperation in giving your time and being committed for the success of this work. The information from respondents will keep confidential and will not affect any body in any way. So you are kindly requested to give your honest opinion

Thank you in advance

## Part I. General characteristics of respondents

### 1. General

1.1. Name of the kebele----------

1.2 Farmer's name ---------- (Not compulsory)

1.3. Date of interview----------

1.4. Enumerator's name ---------- signature----------

Checked by ----------signature ----------

**2. Socio-economic and demographic characteristics**

2.1. Sex of household: A. Male B. Female

2.2. Age of the household head in years……

2.3. Family size, Male…….. Female……. Total……..

2.4. Marital status: A. Single B. Married C. Divorced D. widowed

2.5. What is your educational level?

A. Illiterate B. Capable to read and write C. Primary School D. Secondary School E. Higher education

**3.** What is your means of livelihood or how do you get your livelihood? (Multiple responses is possible)

A. Livestock husbandry B. Crop production C. Renting out land

D. Mixed agriculture E. petty trade F. Other (specify)……..

**4.** Do you have another source of livelihood other than Agriculture (off farm activity)? A. Yes

B. No (skip toQNo6)

**5.** If answer to **Q No 4 is 'yes',** what could be that activity, Please specify A. Bee keeping

B. Petty trade C. working as labor D. working hand crafts E. others (specify)…….

**6.** Do you hold land? A. Yes B. No (skip toQNo12)

**7.** If your answer for **Q No 6 is** 'yes', how much is the total size of your land? Before 5 years in Timad …….. Currently in Timad…….

**8.** Crop production/year in quintal before 5 years ago is……

**9.** Crop production/year in quintal currently……

**10.** How many kilograms of chemical fertilizer you use on your total farm land for 2012/2013 meher season? (Both DAP and Urea)…….

**11.** What are the major crops grown by your household last year?

| Cereal crop | Average (timad) | Yield (quintal) | From previous Years decrease or increase | Reason for decrement or increment |
|---|---|---|---|---|
| Teff | | | | |
| Sorghum | | | | |
| Wheat | | | | |
| Barley | | | | |
| Maize | | | | |
| Bean | | | | |
| Pea | | | | |
| Others | | | | |
| Total | | | | |

**12.** Do you have livestock? A, Yes B, No (skip toQNo14)

**13.** If yes on question number 12 how many livestock do you have?

| Animal type | Number of animals | | Reason for decrement or increment |
|---|---|---|---|
| | No of Animals before 10 years | No of Animals right now | |
| Oxen | | | |
| Cow | | | |
| Horse | | | |
| Donkey | | | |
| sheep | | | |
| Goat | | | |
| Hen | | | |
| Beehives | | | |
| total | | | |

**Part two**

**A. Assessment of the impact of climate change /variability and community vulnerability**

**14.** Are you heard about climate change /variability before? A. Yes B. No (skip toQNo16)

**15.** If your answer to **QNo 14** is yes, from which source you heard about climate change/variability?

A. Radio B. Television C. Newspaper

D. Government Organization E. Non-government Organization

**16.** What is your perception about climate change/ variability of your kebele?

A. There is climate variability B. The climate has changed

C. The climate has not changed (it is stagnant) D. I have no idea

**17.** If your answer to **Q No 16 is, "the climate has changed/ show variability"** what are the local indicators of the observed climate change? (Multiple answers is possible) A. Rain fall variability B. Increase in temperature C. Recurrent drought and grow of new plant species D. Occurrence of new crop pests, weeds and diseases E. Dry up of river and streams F. Prevalence of newly introduced human and animal disease G. Others (specify)……...

**18.** What are the major challenges that climate change/ variability posed on your livelihood?

A. Shortage of pasture B. Crop yield reduction C. Occurrence new human disease

E. Shortage of water supply D. Flooding and erosion F. Others (specify)……..

**19.** How do you perceive the temperature pattern of your locality or Village?

A. Increased B. decreased C. No observable change D, Other specify.

**20.** Is there a change in the timing of rain in your area? A. Yes B. No (skip toQNo23)

**21.** If your answer is **'Yes',** how do you characterize it?

A. comes early and goes late. B. Comes and goes early C. Comes late and goes early

**22.** If your answer for **Q No 21 is, comes late and goes early,** what changes have you observed in crop production?

A. decrease in crop yield B. Increase in crop yield

C. No change in production D. Decrease of long cycle crops E. Others

**23.** Are you vulnerable to such problems like economic shocks, health, price fluctuations A. Yes B. No (skip toQNo25)

**24.** If yes, which one of the following affects your life? (You can select one more)

A. Loss of livestock B. Price fluctuations for agricultural products C. Food inadequacy D. Disease E. Flood and landslide F. Shortage of water supply

G. Other (specify)……..

**25.** Do household get sufficient water in the whole year? A. Yes B. No

**26.** What is the source of water for your household?

A. Rivers (Stream) B. Protected springs C. pounds

D. Unprotected springs E. pipe lines F. Dams

**27.** Do you think that livestock production has increased or decreased in your village or locality?
A. Increased (skip toQNo29) B. Decreased

**28.** If your answer for **Q No27 is decreased,** what do you think is the reason?

A. Livestock disease B. lack of grazing land C. shortage of water for animal's D. lack of fodder for animals E. others, (specify) ……

**29.** Have you ever faced any climate related disaster over the last 5 years?

A. Yes B. No (skip toQNo32)

**30.** If your answer for **QNo 29, is 'yes',** what type of climate shock is your concern?

A. Recurrent drought B. Erratic rain fall with flooding

C. Crop pests, weeds and diseases D. Rain fall variability E. others

**31.** What do you think is the main cause for the climate change related problem that you specified in Q NO, 30?

A. Deforestation B. Change in land use and land cover C. low fertility of land D. Absence of sustainable farming system E. Others (specify)…….

**32.** Which group of the society is most impacted by and vulnerable to climate change and variability?

A. Households with large family size B. Households with no additional income

C. Land less and the poor D. Women and children

E. Elders and disables

**B. Adaptive and Copping methods to impacts of climate change and variability**

**33.** Do you think that it is possible to adapt the impacts of climate variability induced-hazards?

A. Yes B. No

**34.** Who is responsible to adaptation practice? (Multiple answers is possible)

A. Government Organization B. Non-government Organization

C. Local community D. Interested group

**35.** Did you participate in any community based measure to overcome the observed climate change/ variability impacts?

A. Yes B. No (skip toQNo37)

**36.** If yes, what is that measure you have participated to overcome climate variability problem?

A. planting trees (a forestation) B. Terracing

C. Rain water harvesting D. Reforestation

**37.** What are major coping strategies you used to overcome climate change / variability impacts on livestock production?

A. Changing livestock type B. Seasonal migration with your cattle in search of pasture & water

C. Sale of weak and old animals before the dry season. D. Decreasing the number of livestock

E. Others (specify)……..

**38.** Adaptation strategies, you used to overcome climate change / variability impacts related with crop production?

A. Receiving aid from safety net B. Growing short maturing crops

C. Crop diversification and inter- cropping system D. wise storage of crops (saving).

E. Intensive irrigation F. Others (specify)……..

**39.** Adaptation related with shortage of water?

A. Rain water harvesting B. Use of river waters

C. Use of ground water D. Use of reservoirs and ponds

E. Others (specify)……...

**40.** How do you manage to cope with some of your problems related with vulnerability?

A. Reducing number of meals B. Selling fire wood and charcoal

C. Borrowing grains from relatives D. Sells of livestock

E. Renting of land F. Seasonal migration

G. By getting aid H. Others (specify) ……

**41.** Do you have access to get credits from institutions during climate related hazards?
A. Yes B. NO

**42.** Do you get early warning information before the occurrence of climate related shock?

A. Yes (skip toQNo44) B. NO

**43.** If No, who is responsible in disseminating information before the occurrence of hazards?

A. local institutions, ( Idir, debo). B. NGOs

C. Local government institutions D. Medias such us TV, Radios

E. Others (specify)……

**44.** What are the barriers to adapt the impact of climate change and variability?

A. Lack of information on climate and weather variability B. Lack of enough arable land

C. Animal forage and feed scarcity D. Poor and corrupted administration

E. Shortage of agricultural inputs F. Lack of irrigation land

G. Poverty

**45.** What do you think the locally feasible coping mechanisms that should be adopted to reduce climate change / variability impacts on livelihoods? ----------
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**Food security status of household**

1. In the past four weeks, did you worry that your household would not have enough food?

   A = No (skip to Q2) B=Yes

2. If answer to **Q No 1 is 'yes',** how often did this happen?

A = rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

3. In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?

   A = No (skip to Q4) B=Yes

4. If answer to **Q No 3 is 'yes',** how often did this happen?

   A = Rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

5. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?

   A= No (skip to Q6) B = Yes

6. If answer to **Q No 5 is 'yes',** how often did this happen?

   A = Rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

7. In the past four weeks, 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?

   A = No (skip to Q8) B = Yes

8. If answer to **Q No 7 is 'yes',** how often did this happen?

   A = rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

9. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?

   A = No (skip to Q10) B = Yes

10. If answer to **Q No 9 is 'yes',** how often did this happen?

    A = rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

11. In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?

    A = No (skip to Q12) B = Yes

12. If answer to **Q No 11 is 'yes',** how often did this happen?

A = rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

13. In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?

    A= No (skip to Q14) B = Yes

14. If answer to **Q No 13 is 'yes',** how often did this happen?

A = rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

15. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?

    A = No (skip to Q16) B = Yes

16. If answer to **Q No 15 is 'yes',** how often did this happen?

A = rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

17. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

    A = No (questionnaire is finished) B= Yes

18. If answer to **Q No 17 is 'yes',** how often did this happen?

A = rarely (once or twice in the past four weeks) B = Sometimes (three to ten times in the past four weeks) C = Often (more than ten times in the past four weeks)

**Appendix, II**

**Interview questions for focus group discussions (FGD)**

1. What do you think are the local indicators of Climate variability or change in your kebele?

2. Do you think climate change or variability posed negative effects on your livelihood? If Yes, Please explain it.

3. What are the more vulnerable livelihood sectors in your Keble (peasant association)?

4. Is there any change on water, grazing land, the quality of pasture and arable land over the past years in your village? Please

5. Who is responsible to give response to the variability of climate?

6. What are the main impacts of climate variability on the community, on the livestock and the environment? List down

7. How do you perceive your crop production? A. Increasing B. Decreasing

8. What are the local peoples coping mechanisms used to reduce the impacts?

9. Have there been climate extremes (drought and flooding) in the last 10 years?

10. Have you ever been participated in community based environmental participation in your Keble?

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

12. What is the role of traditional institutions in coping the problem?

**Appendix III**

**Check list for key informant interviews**

1. Is there any form of climate change or variability in your woreda/district? If „Yes" what are the observed indicators of climate change/ variability?

2. What do you think is the impacts of climate variability on the livelihoods of farmers?

3. Who are more vulnerable to the adverse impacts of climate change and variability?

4. What are the local peoples coping mechanisms used to reduce the impacts?

5. What do you think the causes of climate change/ variability?

6. Do local communities take part in making decisions with regard to adaptation mechanisms and how to implement in woreda level? If, yes, how? If not why Please explain it?

7. What are the major impacts of climate variability induced-hazards up on the people's health, livestock and environment?

8. What do you think the possible ways to minimize the impacts of climate variability?

9. What is the role of institutions like GOs, NGOs, in facilitating adaptation to climate change in your woreda?

**APPENDIX V**

**Check list for field observation**

1. Impacts of climate change and variability

2. Communities" natural resource conservation activities

3. Government activities on environmental conservation

4. Farmers coping and adaptation strategies

5. Farmers additional incomes (off farm activities)

## ANNEX

Annex. 1. Monthly and annual total rainfall stats (mean STD, C.V%) for the period 1974- 2019

DebreMarkose Station Rainfall

| Years | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1974 | 5.6 | 32.3 | 37.7 | 83 | 40.1 | 208.1 | 254.6 | 347.3 | 152.2 | 40.2 | 10.6 | 0 | 1212 |
| 1975 | 0 | 0 | 99.7 | 12.9 | 89 | 129 | 353.8 | 226.7 | 242.7 | 107.8 | 79.7 | 0.3 | 1342 |
| 1976 | 3 | 33.6 | 24.3 | 50.5 | 70.9 | 251.5 | 255.3 | 316.5 | 226.6 | 73.6 | 13.4 | 17.5 | 1337 |
| 1977 | 60.1 | 39.3 | 159.6 | 62.8 | 119.8 | 159.4 | 231.6 | 314 | 159.1 | 18.6 | 5.6 | 2.5 | 1332 |
| 1978 | 30.0 | 34.8 | 57.0 | 27.0 | 29.4 | 90.5 | 322.5 | 371.0 | 288.1 | 128.9 | 0.0 | 0.0 | 1379 |
| 1979 | 29.3 | 0.0 | 23.7 | 20.1 | 75.7 | 229.7 | 279.6 | 365.4 | 201.2 | 128.3 | 90.8 | 20.4 | 1464 |
| 1980 | 9.6 | 13.0 | 19.1 | 92.5 | 109.9 | 109.0 | 243.4 | 279.7 | 237.4 | 21.9 | 14.6 | 0.3 | 1150 |
| 1981 | 0.7 | 0.5 | 7.2 | 81.2 | 149.0 | 138.0 | 252.4 | 274.5 | 197.1 | 111.8 | 6.0 | 30.9 | 1249 |
| 1982 | 1.1 | 8.5 | 73.7 | 14.1 | 125.3 | 169.9 | 285.8 | 263.4 | 306.2 | 62.1 | 0.0 | 0.0 | 1310 |
| 1983 | 15.0 | 58.8 | 44.4 | 20.5 | 78.1 | 171.4 | 337.6 | 266.4 | 279.2 | 35.7 | 10.0 | 13.5 | 1331 |
| 1984 | 18.3 | 30.1 | 57.5 | 55.1 | 173.3 | 113.0 | 286.5 | 293.8 | 210.8 | 12.0 | 91.1 | 9.4 | 1351 |
| 1985 | 13.1 | 30.7 | 52.3 | 0.4 | 175.7 | 156.7 | 284.2 | 188.8 | 182.1 | 164.5 | 10.8 | 9.1 | 1268 |
| 1986 | 2.1 | 0.0 | 21.7 | 37.9 | 30.1 | 128.9 | 232.7 | 236.3 | 219.0 | 98.3 | 13.2 | 37.1 | 1057 |
| 1987 | 30.9 | 38.0 | 29.2 | 14.5 | 104.3 | 125.0 | 352.9 | 238.2 | 265.9 | 57.3 | 0.2 | 1.4 | 1258 |
| 1988 | 17.8 | 26.3 | 33.9 | 98.0 | 169.3 | 168.4 | 343.3 | 342.8 | 168.6 | 75.4 | 9.1 | 0.0 | 1453 |
| 1989 | 13.2 | 1.9 | 41.4 | 90.8 | 77.6 | 103.3 | 356.3 | 315.9 | 137.1 | 14.0 | 0.6 | 0.0 | 1152 |
| 1990 | 32.6 | 13.3 | 59.8 | 33.7 | 88.7 | 124.2 | 246.2 | 328.5 | 222.2 | 169.7 | 41.3 | 6.3 | 1367 |
| 1991 | 0.0 | 14.7 | 43.7 | 47.3 | 114.4 | 68.2 | 202.8 | 360.0 | 226.6 | 114.0 | 47.8 | 0.0 | 1240 |
| 1992 | 3.7 | 0.0 | 25.4 | 13.4 | 103.7 | 237.6 | 340.6 | 162.6 | 159.4 | 0.0 | 13.8 | 21.4 | 1082 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | 5.3 | 0.0 | 16.8 | 45.8 | 129.4 | 146.5 | 363.5 | 441.4 | 182.9 | 29.5 | 27.8 | 15.3 | 1404 |
| 1994 | 0.0 | 31.2 | 10.3 | 93.9 | 28.2 | 193.8 | 267.8 | 267.9 | 133.2 | 53.1 | 0.0 | 0.0 | 1079 |
| 1995 | 0.0 | 26.0 | 109.2 | 53.9 | 188.9 | 178.8 | 219.9 | 258.2 | 128.1 | 87.2 | 6.1 | 17.1 | 1273 |
| 1996 | 14.4 | 60.2 | 0.7 | 52.3 | 31.7 | 173.8 | 295.6 | 335.8 | 261.1 | 95.4 | 1.5 | 0.0 | 1323 |
| 1997 | 6.5 | 22.8 | 142.5 | 91.0 | 25.0 | 163.1 | 355.4 | 330.7 | 204.4 | 10.4 | 7.7 | 85.9 | 1445 |
| 1998 | 4.8 | 18.9 | 52.1 | 64.2 | 32.6 | 148.8 | 315.1 | 344.3 | 275.8 | 11.3 | 21.8 | 0.0 | 1290 |
| 1999 | 8.8 | 3.8 | * | * | * | 113.9 | 222.3 | 311.8 | 168.0 | 60.8 | 32.5 | 51.0 | 973 |
| 2000 | 28.6 | 36.6 | 37.3 | 113.9 | 86.7 | 138.9 | 164.9 | 307.9 | 168.7 | 94.6 | 72.7 | 5.5 | 1256 |
| 2001 | 8.0 | 27.4 | 37.8 | 120.3 | 181.7 | 209.0 | 305.8 | 253.0 | 322.1 | 150.1 | 5.5 | 0.0 | 1621 |
| 2002 | 9.3 | 5.0 | 35.2 | 42.7 | 139.6 | 147.6 | 281.2 | 301.0 | 218.1 | 7.4 | 13.2 | 0.5 | 1201 |
| 2003 | 0.0 | 1.0 | 20.5 | 90.4 | 146.6 | 126.4 | 246.1 | 317.4 | 151.2 | 14.4 | 6.4 | 95.5 | 1216 |
| 2004 | 27.6 | 4.6 | 74.1 | 108.0 | 228.0 | 291.7 | 252.3 | 360.5 | 151.1 | 33.1 | 35.0 | 23.2 | 1589 |
| 2005 | 14.3 | 0.0 | 29.6 | 99.2 | 123.2 | 153.0 | 288.8 | 338.8 | 205.8 | 183.5 | 86.0 | 6.9 | 1529 |
| 2006 | 3.1 | 2.2 | 26.0 | 4.4 | 152.4 | 86.0 | 203.2 | 252.6 | 270.7 | 200.8 | 6.9 | 0.0 | 1208 |
| 2007 | 72.6 | 0.0 | 2.8 | 43.2 | 50.4 | 180.7 | 251.8 | 340.3 | 164.3 | 210.5 | 2.5 | 28.3 | 1347 |
| 2008 | 0.0 | 0.0 | 3.2 | 110.5 | 29.5 | 174.9 | 328.7 | 211.1 | 271.0 | 265.9 | 32.7 | 12.3 | 1440 |
| 2009 | 0.4 | 3.7 | 58.1 | 101.2 | 129.6 | 154.7 | 365.2 | 322.3 | 170.3 | 66.1 | 0.0 | 2.2 | 1374 |
| 2010 | 57.0 | 16.3 | 92.8 | 75.2 | 11.2 | 155.9 | 276.3 | 335.9 | 234.6 | 3.9 | 2.2 | 61.5 | 1323 |
| 2011 | 3.6 | 57.4 | 70.6 | 19.2 | 5.3 | 212.0 | 205.5 | 351.6 | 256.8 | 10.7 | 1.1 | 18.8 | 1213 |
| 2012 | 4.1 | 7.6 | 13.8 | 120.1 | 19.8 | 195.0 | 286.6 | 317.7 | 205.2 | 87.5 | 37.7 | 23.2 | 1318 |
| 2013 | 2.3 | 0.6 | 110.6 | 42.9 | 43.7 | 142.9 | 323.0 | 220.5 | 235.1 | 90.2 | 41.5 | 0.0 | 1253 |
| 2014 | 3.5 | 20.7 | 87.8 | 67.4 | 104.5 | 190.9 | 364.1 | 281.1 | 301.5 | 43.4 | 30.7 | 23.5 | 1519 |
| 2015 | 19.9 | 0.5 | 77.5 | 71.0 | 152.9 | 188.0 | 250.6 | 325.9 | 256.9 | 37.9 | 0.4 | 0.0 | 1382 |
| 2016 | 0.0 | 0.0 | 0.0 | 15.8 | 169.9 | 290.3 | 287.5 | 289.4 | 200.1 | 71.2 | 38.8 | 21.9 | 1385 |
| 2017 | 11.7 | 21.1 | 43.0 | 23.0 | 17.0 | 115.2 | 283.2 | 620.3 | 106.9 | 103.0 | 10.9 | 16.8 | 1372 |
| 2018 | 15.6 | 21.8 | 42.9 | 92.3 | 175.3 | 151.2 | 240.5 | 290.2 | 307.0 | 18.1 | 16.7 | 5.0 | 1377 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 0.0 | 3.1 | 110.4 | 68.9 | 237.8 | 143.0 | 231.1 | 288.3 | 282.9 | 37.9 | 97.3 | 11.5 | 1512 |
| **Mean** | 13.2 | 16.7 | 49.3 | 59.7 | 101.4 | 161.9 | 281.3 | 306.7 | 215.6 | 76.3 | 23.8 | 15.1 | 1316.4 |
| **STD** | 18.8 | 662.1 | 33.6 | 35.4 | 225.5 | 47.2 | 50.8 | 72.0 | 54.9 | 63.9 | 27.4 | 21.9 | 140.0 |
| **C.V%** | 0.7 | 0.0 | 1.5 | 1.7 | 0.4 | 3.4 | 5.5 | 4.3 | 3.9 | 1.2 | 0.9 | 0.7 | 9.4 |

STD=standard deviation, C.V% coefficient of variation (relative variability across months)

Annex.2. Monthly temperature stats (mean minimum, maximum temperature values for the period 1988-2019 (temperature in 0C)

| Months | Average Mean | Average Mean Max | Average of Mean Min |
|---|---|---|---|
| January | 16.3 | 23.9 | 8.6 |
| February | 17.7 | 25.2 | 10.1 |
| March | 18.4 | 25.5 | 11.3 |
| April | 18.6 | 25.1 | 12.0 |
| May | 18.0 | 24.1 | 11.9 |
| June | 15.9 | 20.9 | 10.8 |
| July | 14.9 | 18.9 | 10.8 |
| August | 14.9 | 18.9 | 10.8 |
| September | 15.3 | 20.4 | 10.2 |
| October | 16.0 | 22.2 | 9.8 |
| November | 15.8 | 22.8 | 8.8 |
| December | 15.4 | 22.5 | 8.3 |

Annex.3. Normalized Meher season variability of rainfall from 1988 to 2019

| | 1980-1986 | | | | 1987-1991 | | | | 1992-1996 | | | | 1997-2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seasons | JUN | JUL | AUG | SEP | JUN | JUL | AUG | SEP | JUN | JUL | AUG | SEP | JUN | JUL | AUG |
| | 168.4 | 343.3 | 342.8 | 168.6 | 178.8 | 219.9 | 258.2 | 128.1 | 139 | 164.9 | 307.9 | 168.7 | 153 | 288.8 | 338.8 |
| | 103.3 | 356.3 | 315.9 | 137.1 | 173.8 | 295.6 | 335.8 | 261.1 | 209 | 305.8 | 253 | 322.1 | 86 | 203.2 | 252.6 |
| | 124.2 | 246.2 | 328.5 | 222.2 | 163.1 | 355.4 | 330.7 | 204.4 | 148 | 281.2 | 301 | 218.1 | 180.7 | 251.8 | 340.3 |
| Meher | 68.2 | 202.8 | 360 | 226.6 | 148.8 | 315.1 | 344.3 | 275.8 | 126 | 246.1 | 317.4 | 151.2 | 174.9 | 328.7 | 211.1 |
| rainfall | 237.6 | 340.6 | 162.6 | 159.4 | 113.9 | 222.3 | 311.8 | 168 | 292 | 252.3 | 360.5 | 151.1 | 154.7 | 365.2 | 322.3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 146.5 | 363.5 | 441.4 | 182.9 | | | | | | | | | | | |
| | 193.8 | 267.8 | 267.9 | 133.2 | | | | | | | | | | | |
| Years | 1990-1994 | | | | 1995-1999 | | | | 2000-2004 | | | | 2005-2009 | | |
| Average RF | 148.9 | 302.93 | 317 | 175.71 | 155.7 | 281.7 | 316.2 | 207.5 | 183 | 250.1 | 307.96 | 202.24 | 149.9 | 287.5 | 293 |

Annex.4. Normalized Belg season rainfall variability from 1990 to 2019.

| Seasons | 1980-1986 | | | *1987-1991* | | | 1992-1996 | | | 1997-2001 | | | 2002-2006 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FEB | MAR | APR | *FEB* | *MAR* | *APA* | FEB | MAR | APA | FEB | MAR | APR | FEB | MAR | APR |
| Belg rainfall | 26.3 | 33.9 | 98.0 | *26.0* | *109.2* | *53.9* | 36.6 | 37.3 | 86.7 | 0.0 | 113.9 | 29.6 | 16.3 | 92.8 | 75.2 |
| | 1.9 | 41.4 | 90.8 | *60.2* | *0.7* | *52.3* | 27.4 | 37.8 | 181.7 | 2.2 | 120.3 | 26.0 | 57.4 | 70.6 | 19.2 |
| | 13.3 | 59.8 | 33.7 | *22.8* | *142.5* | *91.0* | 5.0 | 35.2 | 139.6 | 0.0 | 42.7 | 2.8 | 7.6 | 13.8 | 120.1 |
| | 14.7 | 43.7 | 47.3 | *18.9* | *52.1* | *64.2* | 1.0 | 20.5 | 146.6 | 0.0 | 90.4 | 3.2 | 0.6 | 110.6 | 42.9 |
| | 0.0 | 25.4 | 13.4 | *3.8* | *0.0* | *0.0* | 4.6 | 74.1 | 228.0 | 3.7 | 108.0 | 58.1 | 20.7 | 87.8 | 67.4 |
| Years | 1990-1994 | | | *1995-1999* | | | 2000-2004 | | | 2005-2009 | | | 2010-2014 | | |
| Average RF | 12.49 | 33.0429 | 60.4 | *26.34* | *60.9* | *52.28* | 14.92 | 41 | 156.5 | 1.18 | 95.06 | 23.94 | 20.52 | 75.12 | 65 |

Annex.5. Actual and predicted trends and variability of maximum annual temperature Awabel

| | |
|---|---|
| **1988 -1994** | 22.4 |
| | 22.4 |
| | 21.9 |
| | 22.0 |
| | 22.4 |
| | 21.9 |
| | 22.1 |
| **1995-1999** | 22.3 |
| | 22.5 |
| | 21.8 |
| | 22.6 |
| | 21.4 |
| **2000-2004** | 21.7 |
| | 22.4 |
| | 23.2 |
| | 23.3 |
| | 22.2 |
| **2005-2009** | 22.6 |

| | |
|---|---|
| | 22.7 |
| | 22.3 |
| | 22.6 |
| | 22.5 |
| **2010-2014** | 23.2 |
| | 22.9 |
| | 22.9 |
| | 23.0 |
| | 21.3 |
| **2015-2019** | 23.5 |
| | 22.9 |
| | 23.5 |
| | 23.0 |
| | 22.7 |

Annex.6. Actual and predicted trends and variability of annual minimum temperature in Awabelworeda

| | |
|---|---|
| **1988 - 1994** | 10.0 |
| | 9.9 |
| | 9.9 |
| | 9.9 |
| | 10.1 |
| | 10.2 |
| | 10.0 |
| **1995-1999** | 10.5 |
| | 10.3 |
| | 8.3 |
| | 9.5 |
| | 10.0 |
| **2000-2004** | 10.5 |
| | 10.1 |
| | 10.4 |
| | 10.6 |
| | 10.4 |
| **2005-2009** | 10.7 |
| | 10.9 |
| | 10.0 |

| | |
|---|---|
| | 10.1 |
| | 10.3 |
| **2010-2014** | 10.7 |
| | 10.7 |
| | 10.4 |
| | 10.6 |
| | 10.1 |
| **2015-2019** | 10.4 |
| | 10.7 |
| | 10.9 |
| | 11.1 |
| | 10.3 |
| | |

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