MADDA WALABU UNIVERSITY

COLLEGE OF SOCIAL SCIENCES AND HUMANITIES

DEPARTMENTOF GEOGRAPHY AND ENVIRONMENTAL STUDIES

CLIMATE CHANGE ADAPTATION AND MITIGATION STRATEGIE PRACTICED: THE CASE OF BERBERE DISTRICT OF BALE ZONE, SOUTHEAST ETHIOPIA

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January, 2022

Robe, Ethiopia

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A Thesis Submitted to School of Graduate Studies Department of Geography and Environmental Studies, MaddaWalabu University in Partial Fulfillment of the Requirements for the Degree of Masters of Art in Geography and Environmental studies

By

WogayehuKebebe

Robe, Ethiopia

January, 2022

DECLARATION SHEET

I, Wogayehu Kebebe, hereby declare that this research thesis is my original work and that all sources have been duly acknowledged. This document has not previously been submitted, in its entirety or in part, at any other university in order to obtain an academic qualification. I have carried out the present study independently with the guidance and support of the research advisor, Haji Kedir (PhD).

By: Wogayehu Kebebe

Signature _____

Date _____

Advisor's Approval Sheet

This is to certify that Wogayehu Kebebe has carried out her research work on the topic entitled: "the Climate Change Adaptation and Mitigation Strategies: Case of Berbere District of Bale Zone, Southeast Ethiopia has been carried out entirely by the candidate under my direct supervision and guidance. Therefore, I recommended that the student has fulfilled the requirements and hence can submit the thesis to the department.

By: Advisor: Haji Kedir (PhD)

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Date _____

Examiner's Approval Sheet

We, the under signed, members of the Board of examiners of the final open defense by Wogayehu Kebebe have read and evaluated the thesis entitled" the Climate Change Adaptation and Mitigation Strategies: Case of Berbere District of Bale Zone. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the Degree of Master of Arts in Geography and Environmental Studies.

Name of the Chair person signature Date

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Name of major advisor signature Date

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Name of Internal examiner signature Date

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Acronyms and Abbreviation

CRGE	Climate Resilient Green Economy
CSA	Central statistical Authority
CRGE	Ethiopia's Climate-Resilient Green Economy
EEPC	Ethiopian Electric Power Corporation.
EPA	Ethiopia Plan of Action
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
LPG	Liquid Petroleum Gas
MoA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
NAPA	National Adaptation Plan of Action
NAMAs	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programs of Action
ND-GAIN	Notre Dame Global Adaptation Initiative
OECD	Organization for Economic cooperation and Development
ORS	Oromia Regional State
PASDEP	Plan for Accelerated and sustainable Development to end poverty.
PSNP	participatory safety net program
REFDD+	Reducing Emissions From Deforestation and Degradation
SDP	Sustainable Development Progarm
SLM	Sustainable Land Management
UNFCC	United Nations Framework Convention on Climate Change
UNDP	United Nation Development Program

Abstract

The general objective of the study is to assess the Climate Change Mitigation and Adaptation strategies in Case of Berbere District of Bale Zone, Southeast Ethiopia. The data were collected from 283 households, 3 leaders of each sample kebele, 5 experts of forest management, 6 elders and 6 knowledgeable peoples, who have long years, 3 development agents and 2 technical forestry supervisors of Oromia Forest and Wild life Enterprise(OFWE) offices Barbere branch. Both primary and secondary data collection instruments were used to collect the necessary data. Questionnaires along with interviews were used for the purpose of data collection. The selections of the households carried out by using systematic sampling techniques to avoided bias and also ensuredthe representative data. The quantitative data analyzed with the frequency, percentages and regression. The study found that the sample kebele identified as averagely vulnerable area to climate variability and change, and is frequently faced with climate-related hazards, commonly drought and floods. The study indicated that adaptation strategies had small effect on the trend of climate changes. Based on the findings of this study, the following recommendations are made for consideration to improve the practice. The study recommends that government should enforce the policy on afforestation as a mitigation measure against climate change. In addition, there is need for government at all levels to engage extension agents who should teach farmers climate friendly practices that mitigate climate and enable effective adaptation. In addition, there is need for government at all levels to arrange access to credit that enable them effective adaptation.

Keywords: Adaptation Strategies, Mitigation Strategies and Climate Change

CHAPTER ONE

1. INTRODUCTION

1.1. Back ground of the Study

The Earth's climate is rapidly changing as a result of increases in the concentrations of greenhouse gases (GHGs) in the atmosphere mainly caused by human activities, particularly burning of fossil fuels, agriculture and deforestation (Zegeye, 2013). Electricity and heat production account for 25% of the GHG emissions; agriculture, forestry and other land uses (AFOLU) 24%; industry 21%; transport 14%; buildings 6.4%; and other energy 9.6% (IPCC, 2014).

In this regard Ethiopia emits a very small proportion of global greenhouse gases (GHGs) and yet is highly vulnerable to the impacts of climate change, which have grave implications for the achievement of its development goals. It has been estimated that climate change could reduce the country's GDP by up to 10% by 2045 compared with a 2011 baseline scenario (Ministry of Environment, Forest and Climate Change, 2015).

Climate variability and changes such as the increased intensity of severe weather events (particularly droughts), prolonged intra-sessional dry spells, and flash flooding stemming from rising temperatures and increasing rainfall variability, have impeded the country's efforts to realize its vision of inclusion and prosperity(Mokria, 2017).

Ethiopia's climate is naturally both highly diverse and highly variable. However, the climate is dramatically changing in recent years (Mokria, 2017). Both climate variability and change have been occurring in Ethiopia. The temperature (maximum, minimum, mean) is increasing, but the rainfall does not show any definite trend– it shows high variability (Mokria, 2017).

Ethiopia's pastoral and agro-pastoral communities, as well as smallholder farmers, are particularly vulnerable to climate change. The impact is highly pronounced on developing countries that have low adaptive capacity because of low income, technology and their reliance on climate sensitive economic sectors like agriculture. It has been projected that in Africa, 75 – 250 million people exposed to increased water stress due to climate change by 2020 (Mokria, 2017).

This exposure requires a concerted focus on adaptation to reduce poverty and build resilience. Adaptation activities in agriculture could cut climate shock-related losses by half (International Center for Tropical Agriculture, 2017). Information on how to adapt natural ecosystems to the anticipated effects of climate change is rapidly growing as increasing numbers of land managers engage with the topic (International Center for Tropical Agriculture, 2017). Much of this information, however, remains broadly applicable across ecosystem types without regard to geographic setting and does not provide sufficient detail for forest managers to identify specific response actions.

However, the concept of mitigation is relatively new concept, and it mainly focus on limiting the emission of greenhouse gases. To address these challenges, there is a need for stronger climate change adaptation policies, programs and implementation capacity, across sectors, levels of intervention and actors (MoA 2015). Climate change, poverty reduction, and economic development are inextricably linked; consequently, climate change adaptation and mitigation must be mainstreamed in development planning, projects, and programs (MEFCC, 2015). Therefore, this paper aims to give an overview on adaptation and mitigation measures undertaking in Berbereworeda in response to climate change.

1.2. Statement of the Problem

World Economic Forum (2020) ranked climate change and related environmental issues as the top five global risks likely to occur within the next ten years. Ethiopia is one of the least developed countries vulnerable to the impacts of climate change and the unpredictability of climate variability.

Ethiopia is among the countries that are most vulnerable to climate change in East Africa, and the phenomenon is expected to negatively impact progress in sectors such as agriculture, transportation, energy, and health. Ethiopia's pastoral and agro-pastoral communities, as well as smallholder farmers, are particularly vulnerable to climate change (MEFCC, 2015).

The Government of Ethiopia has made efforts to recognize climate change as a risk in sectoral policies on agriculture, health, and energy. The majority of national and international programming efforts concentrate on the agricultural sector, including pastoralism, as well as disaster risk management and capacity building for government officials and civil society. The country's Growth and Transformation Plan, Programme of

Adaptation to Climate Change, and Climate Resilient Green Economy Strategy are key national roadmaps that guide these efforts (GTP II, 2020). However, there are gaps in adaptation action.

The country's adaptive capacity is constrained by limited livelihood options for the majority of the population, inadequate ability to withstand or absorb disasters and the prevailing biophysical shocks it faces.

Studies have predicted that the current rate of environmental degradation and climate change in Ethiopia contribute to a faster rise in temperature in the 21st century and that this will affect food security due to the poor resilience of small-scale farmers, who are predominant in the agriculture sector (UNFCCC, 2021).

As perspective of the researcher no research has been done in the study area regarding the Climate Change Mitigation and Adaptation strategies. Therefore, assessing Climate Change Mitigation and Adaptation strategies practiced in the study area has a paramount importance in terms of understanding gaps that must be fulfilled. Therefore, to fill this gap, this study is to identify climate change mitigation and adaptation strategies in BerbereWoreda.

1.3. Objectives of the Study

1.3.1. General objective of the study

The general objective of the study is to explore the Climate Change Mitigation and Adaptation strategies practices in Case of Berbere District of Bale Zone, and Southeast Ethiopia

1.3.2. Specific Objectives of the study

The specific objectives of the study were:

1. To assess households perception on trends of climate variability in the study area
2. To assess trends of climate variability in the study area
3. To identify households climate change adaptation strategies in the study area
4. To identify household climate change mitigation strategies in the study area

1.4. Research Questions

The research questions are prepared in the line with specific objective, accordingly the research questions of the study were the following.

i. What is the perception of household on the trend of climate changes in the study area?
ii. What are trends of climate variability in the study area?
iii. What are the climate change adaptation strategies in the study area?
iv. What are the climate change mitigation strategies in the study area?

1.5. Significance of the study

Climate change is expected to exacerbate the occurrence and intensity of disease outbreaks and perhaps increase the spread of diseases and food security. As a result, this study is needed to identify different adaptation and mitigation strategies (both traditional and modern) to climate change used in different communities of Berbere Woreda. In other words, helps those communities to share the information about applicable and beneficial adaptation and mitigation strategies. In addition, the study was helpful for the government officials to developed climate change mitigation and adaptation strategies. The study helps the district to identify its strength and weakness in the area of climate change mitigation and adaptation strategies. The findings of the study gives guide line information for district management teams to improve the existing situation. In addition, the study is useful for researcher who may be interested in pursuing research in the same area.

1.6. Scope of the Study

The study is focused on the climate change adaptation and mitigation strategies in the case of Bale zone Berbere Woreda, South-east Ethiopia. Geographically, the scope of study delimited to three kebele of Berbere Woreda only, because conducting a research on all kebele of the woreda is complex, costly, and time taking. Methodologically, the study delimited to descriptive and multiple regression methods to analysis the collected data.

1.7. Limitation of the Study

Among the major constraints, the following can be mentioned. The COVID-19 crisis caused negative impact on study. Further, the limitations of the Study were skill gap in

the research and unavailability of network connection. The other apparent limitation was that most of respondents were busy and had no enough time to respond to questionnaires and interview. Some of them who have enough time were also reluctant to fill in and return the questionnaire as per the required time. So, the less - responsiveness of the research sample group has enormously affected the method and outcome of the study. Another limitation was lack of recent and relevant literature on the topic. In spite of these short comings, however, it was attempted to make the study as complete as possible.

1.8. Organization of the Study

Chapter one present background of the study, statement of the problem, general and specific objectives, research question, and significance of the study, scope of the study, organization of the study and definition of key terms. Chapter two describes literature review which considers concepts, theoretical aspects, empirical study and conceptual frame work. Chapter three describes research design, methodologies, and data gathering tools. Chapter four present data analyze and presentation. Finally, chapter five present conclusion and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. The Concept of Climate Change

Climate change is expressed as deviations from a regional climatology determined by analysis of long-term measurements, usually over a period of at least 30 years. Scientists believe that the global average surface temperature has risen over the past century. The Inter-governmental Panel on Climate Change (IPCC) asserts that continued emissions of greenhouse gases at or above the current rates would cause an increase in the global average surface temperature by 1.8oC to 4.0oC by 2100 (IPCC, 2014)(Daniel, Woldeamlak and Lal, 2014).

An increasing trend in annual rainfall in central Ethiopia while a declining trend has been observed over the Northern half and Southwestern part of the country Jain (2013) had investigated the spatiotemporal variability of annual and seasonal rainfall over Ethiopia and reported decreasing trends of kiremt and annual rainfall in northern, northwestern and western parts of the country; while an increasing trend in annual rainfall was observed in a few grid points in eastern parts of the country.

Ethiopia's climate is naturally both highly diverse and highly variable. However, the climate is dramatically changing in recent years (Mokria , 2017). Both climate variability and change have been occurring in Ethiopia. The temperature (maximum, minimum, mean) is increasing, but the rainfall does not show any definite trend– it shows high variability (Mokria , 2017). Since 1950, the annual average maximum and minimum temperatures of the country have been increasing every decade by about 1 and 0.25°C, respectively.

Another study in the upper Blue Nile River basin by Tabari, Meron and Willems (2015) revealed insignificant decreasing trends in annual precipitation at most of the stations. A relatively recent study conducted in central highlands of Ethiopia (which is very similar to our study area) by Arragaw and Woldeamlak (2017) disclosed that annual and June–September (kiremt) rainfall exhibited statistically insignificant increasing trends while March–May (belg) rainfall depicted significant decreasing trends.

2.1.1. Global over view of climate change

Climate change in IPCC usage refers to a change in the state of the climate that can be identified (E.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC, 2017).

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer (US EPA, 2016). As free encyclopedia it is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change in average weather conditions, or in the time variation of weather around longer-term average conditions (i.e., more or fewer extreme weather events). It is a large-scale, long-term shift in the planet's weather patterns or average temperatures (US EPA, 2016).

Its impacts are undermining a whole range of human rights: rights to food, safe water and health and education (Willis, 2015).It also by increasing hazard at the same time as it erodes resilience, and has a magnifying effect on disaster risk. In particular, climate change will magnify the uneven distribution of risk, skewing disaster impacts even further towards poor communities in developing countries.

At a global scale, pests and diseases attribute to an average yield loss of 18% and 16%, respectively in major crop species. Additionally it affects food and nutrition security and further undermines current efforts to reduce hunger and protect and promote nutrition. Consequently, under nutrition in turn undermines the resilience to shocks and the coping mechanisms of vulnerable populations, lessening their capacities to resist and adapt to the consequences of climate change. It directly affects food and nutrition security of millions of people, undermining current efforts to address under nutrition, one of the world’s most serious, but least addressed socioeconomic and health problems (EPCC, 2015). It further will alter potential losses to many pests and diseases as changes in temperature can result in geographic shift through changes in seasonal extremes.

2.1.2. Climate change in Africa

According to the IPCC (2014) report on the regional impacts of climate change, Africa is the continent most vulnerable to the impacts of projected changes because widespread poverty limits adaptation capabilities. The importance of agricultural activities for the economies of most African countries, combined with the farming sector's reliance on the amount of rain during the rainy season, make countries in the region particularly vulnerable to climate change. Thus, from the point of view of food security, the increasing incidence of drought represents a very serious threat. It has been argued that, in Africa, drought hazard and vulnerability is likely to be the most damaging impacts of climate change.

The warming of few degrees and increase in frequency of extreme weathers will consequently and strongly influences the agricultural production and make the society victim of the events and decreases the future adaptive capacities. The majority of local people in many part of Africa areas have the perception that rainfall is just decreasing, but scientific evidence (analysis of rainfall data obtained from the meteorological stations) shows rainfall variability (decreasing; increasing; unpredictable frequency, distribution, duration and timing) depending on location and time (season, year). On the other hand, the majority of people believe that climate change is caused by human activities such as deforestation, while some link it to supernatural wrath and punishment from God to the bad activities being done by human beings (Kassa, 2013).

As many scholars stated, climate change will lead to increased levels of drought in Africa if temperatures continue to rise. It can further lead to floods, starvation, landslides, drought and rising sea levels. According to the United Nations, climate change (2017) will affect Africa more than anywhere else will in the world due to extreme poverty levels, high rates of population growth, over-reliance on rain-fed agriculture and over-dependence on natural resource-based livelihoods.

2.1.3. Climate change in Ethiopia

Climate change will increase the frequency and intensity of extreme weather events (droughts, floods, heat waves, heavy rainstorms, strong winds, etc.). Recurrent droughts have been experienced in the recent past, and are also presently occurring in many parts of the country. The severe drought that occurred in 1984/1985 is one of the most serious drought events experienced in Ethiopia, still persisting in the minds of many. The magnitude of droughts has been increasing in space and time. Droughts have historically

been the immediate causes of food shortages and famines in Ethiopia. Recurrent droughts have resulted in loss of human and livestock life and property as well as migration of people (Zerga and Gebeyehu, 2016).

In the period 1999–2008, droughts and flooding affected nearly 21 million people (19.7 million by droughts and the remaining by flooding) in Ethiopia (CRED, 2009). Furthermore, climate models show warming in all four seasons over Ethiopia, which may result in more frequent heat waves (ODI and CDKN, 2014).Current climate variability is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters (ODI and CDKN, 2014).

Climate variability and changes such as the increased intensity of severe weather events (particularly droughts), prolonged intra-sessional dry spells, and flash flooding stemming from rising temperatures and increasing rainfall variability, have impeded the country's efforts to realize its vision of inclusion and prosperity(Mokria, 2017).

2.2. Causes of Climate Change

It occurs because of internal variability within the climate system and external factors. The external causes may be natural or human induced human activity. Human activities cause climate change mainly fossil fuel burning and removal of forests (Lovejoy and Hannah, 2005). These contribute to climate change by causing changes in Earth's atmosphere in the amounts of greenhouse gases, aerosols (small particles), and cloudiness (IPCC, 2007).

At global scale, the main cause of greenhouse gas (GHG) emissions is from carbon dioxide (70%), primarily from burning of fossil fuel (petroleum) imported from industrialized countries, while the other sources for GHG are methane and nitrous oxide caused by deforestation and agricultural activities, particularly the use of pesticides (Yohannes and Mebratu, 2009). Climate change, driven by fossil fuel combustion and deforestation, is a becoming threat to lives and livelihoods in every part of the world at this time (Abate Senbete, 2009).

The latest assessment report by IPCC (2013) states with 95% confidence that human influence is the main cause of the observed warming in the atmosphere and oceans and other indicators of climate change and that continued emissions of greenhouse gases

(GHGs) will cause further warming and changes in the components of the climate system. The emissions of greenhouse gases are predominantly from high-income countries while the negative effects of climate change are predominantly in low income countries. This means climate change is generally expected to hit developing countries harder than industrialized countries, as the developing countries are less capable of mitigating or adapting to the changes due to their poverty and high dependence on the environment for subsistence (UNDP, 2007).

2.2.1. Natural Causes of Climate Change

The earth's climate is influenced and changed through natural causes like volcanic eruptions, ocean current, the earth's orbital changes and solar variations:-

Volcanic eruptions: When a volcano erupts it throws out large volumes of sulphur dioxide (SO2), water vapor, dust, and ash into the atmosphere. Large volumes of gases and ash can influence climatic patterns for years by increasing planetary reflectivity causing atmospheric cooling. Tiny particles called aerosols are produced by volcanoes. Because they reflect solar energy back into space they have a cooling effect on the world. The greenhouse gas, carbon dioxide is also produced however the CO2 produced is insignificant when compared to emissions created by humans (UNDP Ethiopia, 2011).

Ocean current - The oceans are a major component of the climate system. Ocean currents move vast amounts of heat across the planet. Winds push horizontally against the sea surface and drive ocean current patterns. Interactions between the ocean and atmosphere can also produce phenomena such as El Niño which occur every 2 to 6 years. Deep ocean circulation of cold water from the poles towards the equator and movement of warm water from the equator back towards the poles. Without this movement the poles would be colder and the equator warmer. The oceans play an important role in determining the atmospheric concentration of CO2. Changes in ocean circulation may affect the climate through the movement of CO2 into or out of the atmosphere.

Earth orbital changes - The earth makes one full orbit around the sun each year. It is tilted at an angle of 23.5° to the perpendicular plane of its orbital path. Changes in the tilt of the earth can lead to small but climatically important changes in the strength of the seasons, more tilt means warmer summers and colder winters; less tilt means cooler summers and milder winters. Slow changes in the Earth's orbit lead to small but climatically important changes in the strength of the seasons over tens of thousands of years. Climate feedbacks

amplify these small changes, thereby producing ice ages (UNDP Ethiopia, 2011). Solar variations - The Sun is the source of energy for the Earth's climate system. Although the Sun's energy output appears constant from an everyday point of view, small changes over an extended period of time can lead to climate changes.

Some scientists suspect that a portion of the warming in the first half of the 20th century was due to an increase in the output of solar energy. As the sun is the fundamental source of energy that is instrumental in our climate system it would be reasonable to assume that changes in the sun's energy output would cause the climate to change. For instance a decrease in solar activity was thought to have triggered the Little Ice Age between approximately 1650 and 1850, when Greenland was largely cut off by ice from 1410 to the 1720s and glaciers advanced in the Alps. Current global warming however cannot be explained by solar variations. Some examples are evidenced such as since 1750, the average amount of energy coming from the Sun either remained constant or increased slightly. If global warming was caused by a more active sun, then scientists would expect to see warmer temperatures in all layers of the atmosphere (Abate Senbete 2009).

2.2.2. Human Causes of Climate Change

Human activities have led to the release of carbon dioxide and other heat-trapping "greenhouse" gases in sufficient quantity to change the composition of the atmosphere, resulting in an accumulation of heat in the Earth's system, commonly referred to as "global warming". The Earth's climate has responded through higher temperatures in the atmosphere, land and ocean, ice melting, rising sea level, and increases in extreme weather events (heat waves, wildfires, heavy rains and flooding). The calendar year 2016 is by far the warmest on record for the global mean surface temperatures (GMSTs). It easily beat out 2015, which in turn beat out the previous record holder 2014. Meanwhile, 2017 is now ranked third (or second, depending on dataset). There is no doubt whatsoever that the planet is warming and it has major consequences for other aspects of climate. However, there is also considerable natural variability manifested in the GMST record; the biggest fluctuations from year to year are associated with El Niño events. Decadal variations led to a pause in warming from 2000 to 2013. A major El Niño from 2015-16 somewhat inflated the GMST values, and 2017 values dropped slightly, as a result.

"It has been demonstrated beyond reasonable doubt that the climate is changing due to man-made greenhouse gases. We are already committed to future substantial change over the next 30 years and change is likely to accelerate over the rest of the 21th century.
No other single body has a comparable breadth of climate change science and modeling, or has made the same contribution to global climate science and current knowledge. Independent Review 2007 indicated there is strong evidence that the warming of the Earth over the last half-century has been caused largely by human activity, such as the burning of fossil fuels and changes in land use, including agriculture and deforestation (Independent Review, 2007).

According to Independents Review 2007 the study area also vulnerable or attacked by deforestation and burning of forest for agricultural purpose. "The Royal Society 2010 the Industrial Revolution in the 19th century saw the large-scale use of fossil fuels for industrial activities. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles generate electricity for industries and households (UNDP Ethiopia, 2011).

The energy sector is responsible for about ¾ of the carbon dioxide emissions, 1/5 of the methane emissions and a large quantity of nitrous oxide, Carbon dioxide is undoubtedly, the most important greenhouse gas in the atmosphere. Changes in land use pattern, deforestation, land clearing, agriculture, and other activities have all led to a rise in the emission of carbon dioxide.

Methane is another important greenhouse gas in the atmosphere. It is released from animals such as dairy cows, goats, pigs, buffaloes, camels, horses and sheep. Methane is also emitted during the process of oil drilling, coal mining, leaking gas pipelines, landfills and waste dumps. The certainty of global warming can be seen through some of the natural phenomenon like the effect on crops and extreme weather conditions around the world. It is especially clear in the dramatic change of the polar caps, i.e. the Arctic ice cap is shrinking and the Antarctica ice shelf is melting. Minor sources of emissions today are transport, power, industry, and buildings, as described below (Capoor and Ambrosi, 2008).
Transport: In transport, approximately 75% of the emissions come from road transport, particularly freight and construction vehicles, and to a lesser extent private passenger vehicles. Air transport also contributes a significant share (23% of transport related

emissions). Emissions from inland water transport are minimal. Increase in passenger-km traveled projected based on elasticity to real GDP. Increase in ton-km of cargo transported based on elasticity to real GDP. Ethiopia is endowed with vast energy resources particularly hydropower. Energy supply in the country is composed of three main sub-sectors, namely; biomass, petroleum and electricity. Currently the energy need of the country is satisfied by wood fuel (77%), dung (7.7%), crop residue (8.7%), Bagasse (0.06%), charcoal (1.15%), electricity (1%), and liquid petroleum gas (LPG) (0.05%), and oil products (4.8%). Most of the energy is utilized for household purposes. To date the country's total installed capacity of electricity is about 450 MW (UNDP Ethiopia, 2011).

Electric power: The electric power sector only accounts for very low emissions as it is largely based on renewable energy, with hydro power accounting for more than 90% of total power generation capacity, supplemented by the use of on and off-grid diesel generators administered by the Ethiopian Electric Power Corporation (EEPCo, 2011). Current emissions in the energy sector amount to below 5 Mt CO2 e or a share of 3% of the country's total emissions. (The global average for electric power generation's share of a country's GHG emissions is more than 25%). Switch of remaining fossil fuel capacity to 100% clean/renewable generation for on-grid (UNDP Ethiopia, 2011).

Industry: Given the comparably small share of organized industrial economic activity overall, industry accounts for only 3% of GHG emissions. At nearly 2 Mt CO2 to the 4 Mt CO e emissions from industry, cement is the single largest industrial source of emissions, followed by mining (32%), and the textile and leather (17%) industry. Emissions from steel, other types of engineering, the chemicals industry (incl. fertilizer), pulp and paper industry and food processing together account for only around 2% of industrial GHG emissions(UNDP Ethiopia, 2011).

2.3. Mitigation strategies of climate change

The Ethiopian Government has already put in place a number of policies, strategies and programs aimed at enhancing the adaptive capacity and reducing the vulnerability of the country to climate variability and change. Such programs include the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP), the Environmental Policy, and the Agriculture and Rural Development Policy and Strategy. The Government has established a Strategic Investment Framework for sustainable land management (SLM) but the cost and capacity implications of climate change have yet to be built into this.

To boost socio-economic development and combat climate change, Ethiopia developed a CRGE strategy in 2011 (Anonymous, 2011). The CRGE strategy is based on four pillars:

i) Improving crop and livestock production practices for higher food security and farmer income while reducing GHG emissions;

ii) Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks;

iii) Expanding electricity generation from renewable sources of energy for domestic and regional markets;

iv) Leap frogging to modern and energy-efficient technologies in transport, industry and buildings.

Ethiopia Plan of Action (EPA) is the national focal point for the UNCCD. The governance of the Nile Basin water resources is critical for climate change vulnerability in the Nile Basin countries. Ethiopia is one of the nine Nile Basin countries and secretariat of the Eastern Nile Subsidiary Action Program (Deressa*et al,* 2008).

National Adaptation Programs of Action (NAPA) identified a participatory process and integrated climate change adaptation activities with national development policies to ensure effective implementation of adaptation activities. The NAPA process in Ethiopia identified arid, semi-arid, and dry sub-humid areas of the country as being most vulnerable to drought; agriculture was identified as the most vulnerable sector; and in terms of livelihoods, small-scale rain-fed subsistence farmers and pastoralists are identified as the most at risk (NAPA, 2007).

Carbon trading: Carbon trading is a market mechanism to mitigate climate change (Capoor and Ambrosi, 2008). In carbon trading one party pays for another party in return for greenhouse gas emission reduction or for the right to emit (Capoor and Ambrosi, 2008).

The Kyoto mechanisms allow the countries with Kyoto commitments to meet their target of reducing greenhouse gas emissions in a cost-effective way and motivate developing countries to join global emission reduction (UNFCCC, 2009). Thus carbon trading offers an opportunity to increase climate equity. Treaties include potential to finance mitigation

and adaptation to climate change and enhance sustainable development (UNFCCC, 2009).

There are significant new opportunities in the Green Economy for absorbing carbon from the air, and simultaneously generating green products. Changing agricultural practices and improving land use is considered to be one of the cost effective ways of reducing atmospheric greenhouse gases. The restoration of degraded cropland soils can also increase soil carbon-storage and crop yields, while contributing to the conservation of agricultural biodiversity, including soil biodiversity. There is potential for global agreements to permit new 'crops and products' by tapping into new sources of funding through carbon trading and Reducing Emissions from Deforestation and Degradation (REDD+) African development (2010).

Market-based climate change mitigation instruments involve carbon trading between developed and developing countries. The most common market-based climate financing includes accessing climate finance for clean development mechanism and emission reduction. The mechanisms create a new niche market for developed countries that need to trade carbon to meet their climate change mitigation regulation such as GHG emission reduction targets through purchase of REDD credits. It is recognized that the market-based climate financing mechanisms would be more efficient, involve lower transaction costs, and are not prone to policy and governance failures (Kant, 2010).

In general four initiatives for fast-track implementation have been selected under the CRGE: (i) exploiting Ethiopia's vast hydropower potential; (ii) large-scale promotion of advanced rural cooking technologies; (iii) efficiency improvements to the livestock value chain; and (iv) Reducing Emissions from Deforestation and Forest Degradation (REDD) The government has also created institutional arrangements for CRGE strategy implementation. A CRGE facility has been put in place within the Ministry of Finance and Economic Development. The facility is responsible for resources mobilization and disbursement. The EPA shall develop a system for monitoring, reporting and verification. The UNDP, as interim trustee, is responsible to manage the CRGE fund and/ resources. On the other hand, each sector shall have an environmental unit, and are tasked with preparing their respective strategy for resilience (EPA, 2012).

Determined enough to combat climate change, Ethiopia has duly reacted by ratifying relevant international conventions and is taking the necessary steps to implement the two

categories of responses to climate change, mitigation and adaptation. With this respect, Ethiopia has so far (MoFED, 2008) ratified agreements such as the UNFCCC and its related appliance, the Kyoto Protocol. Existing national policies and sectoral programs targeted towards environmental rehabilitation possibly addressed the issues of climate change either directly or indirectly. Among others, the following are notable (MoFED, 2007).

conservation Strategy, Environmental policy, Agriculture and Rural Development Policy and Strategy, Integrated Watershed Management, Water Resources Management Policy, National Policy on Disaster Prevention and Preparedness and National Policy on Biodiversity Conservation and Research(MoFED, 2007).

The impacts of climate change and atmospheric pollution include weather variability, loss of pasture land, droughts, flood and thus food insecurity and other environmental related health problems. Proposed intervention measures include (MoFED, 2007): developing a federal strategy, standards, and law to improve urban air quality; developing a national strategy to enhance coping mechanisms regarding the adverse impacts of climate change; and launching environmentally sound investment and other programs that foster cleaner development mechanisms, including emissions trading(MoFED, 2007).

PASDEP has outlined six strategic goals towards the realization of the Environmentally Sound Development Vision of the country (Deressa, 2008): ensuring community-led environmental protection and the sustainable use of environmental resources for gender equity and improved livelihood; rehabilitating affected ecosystems; enhancing capacity of ecosystems to deliver goods and services, particularly biomass for food, feed and household energy; removing the adverse impacts of municipal waste preventing environmental pollution; and ensuring proactively the integration of environmental and ethical dictates especially mainstreaming gender equity in development(Deressa et al., 2008).

The participatory safety net program (PSNP) supports 7.7 million beneficiates by providing cash or food transfers, enabling them to reduce asset depletion and increase their resilience capacity to climate change. As a result, regenerated the environment, increasing access to water supply for beneficiaries, access to farmers training centers, and livelihoods were improved through improved productivity of land and assets. The

encouraging results of this programme need to continue as a tool to counteract climate change as well (MoA, 2010).

2.4. Adaptation strategies of climate change

Information on how to adapt natural ecosystems to the anticipated effects of climate change is rapidly growing as increasing numbers of land managers engage with the topic (Gunn, 2009). Much of this information, however, remains broadly applicable across ecosystem types without regard to geographic setting and does not provide sufficient detail for forest managers to identify specific response actions(Gunn, 2009). We have compiled and synthesized a list of regionally focused strategies and approaches that may be used to adapt the forests of northern Wisconsin to a range of anticipated climate conditions and ecosystem impacts (Gunn, 2009).

Importantly, the adaptation strategies and approaches presented in this chapter are nested within the existing paradigm of sustainable forest management (Admassie, 2008). A changing climate and the associated uncertainty will create many challenges, forcing managers to be flexible and make adjustments to management objectives and techniques; however, the overarching goal of sustaining forests over the long term will remain a cornerstone of management(Innes, 2009, Ogden and Innes 2008). Many actions to adapt forests to climate change are consistent with sustainable management (Innes, 2009, Ogden and Innes 2008) and efforts to restore ecosystem function and integrity. Additionally, many current management activities make positive contributions toward increasing forest health and resilience in the face of climate change.

Decisions on the type of adaptation are often made by individuals, groups within society, and organizations and governments on behalf of society. Some adaptation measures may be taken at individual level. Others like rainwater harvesting and investments (Yesuf*et*, 2008), building dams, releasing new cultivars that are more drought resistance require collective actions. These time societies have inherent capacities to adapt to climate change and have developed different adaptation and mitigation strategies to combat climate change (Admassie, 2008). They have developed knowledge, skills, technology, institutional arrangements and strategies that are important foundations for adapting to long-term climate change. Based on the type of economic activities and social networks societies can access local coping strategies against shocks (Admassie, 2008).

These highly differ among households and communities. Communities have always adapted to climate variations by making preparations based on their resources and knowledge accumulated through experience of past weather pattern. The adaptive measures that households use when faced with climate change could also differ in terms of their ease of implementation, equity effects, lag between implementation and effect, their cost of implications, compatibility with other programs, and agencies implementing measures (Admassie, 2008).

Climate adaptation measures will need to address systemic weaknesses and vulnerabilities that have historically impoverished those communities. Climate change will challenge the implementation of current and future development plans: adjustments and changes will be required at every level: community, national and international. A better understanding of the impacts, costs, changes and communities perceptions of climate change, ongoing adaptation measures, and the decision-making process is important to inform policy makers and sector institutions aimed at promoting successful adaptation strategies for the country in the next PASDEP currently under preparation. Ethiopia will need to both mitigate the impacts of climate change, where possible, and adapt to the situation where it cannot (Yesuf*et*, 2008).

As impact will differ regionally, based on the bio-physical and socioeconomic situations within Ethiopia, the management of impacts will need to be defined for each region based on the analysis of current information and practices, the scope for variability within these systems and the possibility of alternative farming and livelihoods. Given the challenges outlined above, delivering an integrated response will require enhanced capacity for coordinating and leading 'joined-up' actions. New technologies, as well as current technologies used in new ways can support this response, but only if the appropriate enabling institutional and policy environment is in place to encourage joint working and embrace adaptive learning to take account of ongoing uncertainties or new opportunities (Tadege, 2007).

Indigenous people all over the world have used different strategies to respond and adapt to climate change, these include (FAO, 2007): diversified resource base (to minimize the risk due to harvest failure, they grow many different crops and varieties, and they also hunt, fish, and gather wild food plants); change in crop varieties and species; change in the timing of activities (crop harvests, wild plant gathering, hunting and fishing); change

of techniques; change of location; changes in resources and/or life style(resorting to wild foods in the case of emergency situations such as droughts and floods); exchange (obtaining food and other necessities from external sources through exchange, reciprocity, barter, or markets in times of crises); and resource management (enhancing scarce and climate-sensitive resources management).

In Ethiopia cases, traditional and contemporary coping mechanisms to climate variability and extreme include (NAPA, 2007): changes in cropping and planting practices, reduction of consumption levels, collection of wild foods, use of inter-household transfers and loans, increased petty commodity production, temporary and permanent migration in search of employment, grain storage, sale of assets such as livestock and agricultural tools, mortgaging of land, credit from merchants and money lenders, use of early warning system and food appeal/aid, etc(NAPA, 2007).

As future climatic conditions unfold and farmers learn how to implement adaptive strategies (which in turn will depend on the form of tenure, incomes, etc.), farmers could make long term adjustments such as changing crop varieties that are grown as well as where they are grown (i.e. location). Potential options include switching to more robust varieties that are better suited to the new environment. In Zimbabwe farmers have switched successfully to the use of more drought tolerant crop in areas where the frequent recurrence of droughts has made agriculture production difficult using the traditional crop varieties. In the extreme case, where agriculture is no longer viable, farmers have converted land use from crop production to game ranching (Abate, 2009).

UNDP Ethiopia supports adaptation and building resilience through the following projects and programs:- Promoting Autonomous Adaptation at the Community Level in Ethiopia; (LDCF), Sustainable Development of Protected Area System (SDPA), Mainstreaming Agro-Biodiversity into the Farming System of Ethiopia, Afar integrated dry lands management, MDGF Environment-enabling pastoralist communities to adapt to climate change and restore rangelands｀environment(UNDP Ethiopia, 2011).

One proposed method to reduce atmospheric carbon dioxide is to increase the global storage of carbon in soils. Though, soil carbon storage is a win–win strategy. It mitigates climate change by offsetting anthropogenic emissions; improves the environment, especially the quality of natural waters; enhances soil quality; improves agronomic productivity; and advances food security (Lal, 2009; Adesodun and Odejim, 2010).

In addition to carbon storage, the turnover time of organic carbon is important in understanding the role of soils in the global carbon cycle. Thus, soil carbon sequestration through changes in land use and management is one of the important strategies to mitigate the global greenhouse effect. Important land uses and practices with the potential to sequester soil organic carbon include conversion of cropland to pastoral and forest lands, conventional tillage to conservation tillage or no-tillage, and no manure use to regular addition of manure. However, food security needs for the world teeming population make conversion of cropland to forestland unsustainable. Therefore, increased food demands call for management of croplands to ensure food security and at the same time enhanced soil organic carbon sink within the soil to minimized atmospheric emission of CO2 (Adesodun and Odejimi, 2010).

2.5. Conceptual Framework

Mugenda(2003) defines conceptual framework as a concise description of the phenomenon under study accompanied by a graphical or visual depiction of the major variables of the study. It is research tool intended to assist a study to develop awareness and understanding of the effects of independent variables on dependent variable with situation under scrutiny and to communicate this. Accordingly, in this study the independent variables are climate change adaptation strategies and climate change mitigation strategies and dependent variable (The trends of climate change) are presented in the figure below. There are two independent variables, climate change mitigation strategies and climate change adaptation strategies. On the other hand, the dependent variable is trend of climate change.

2. Conceptual Framework of the study

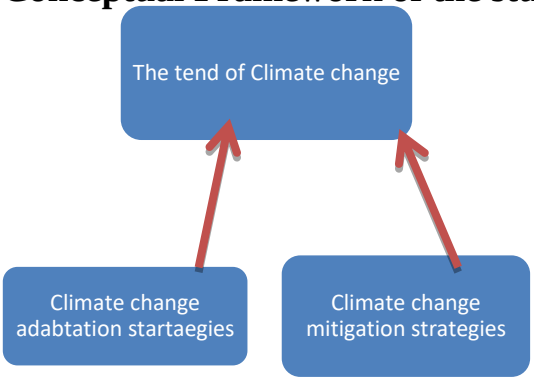


Figure 1. The conceptual Framework of the study

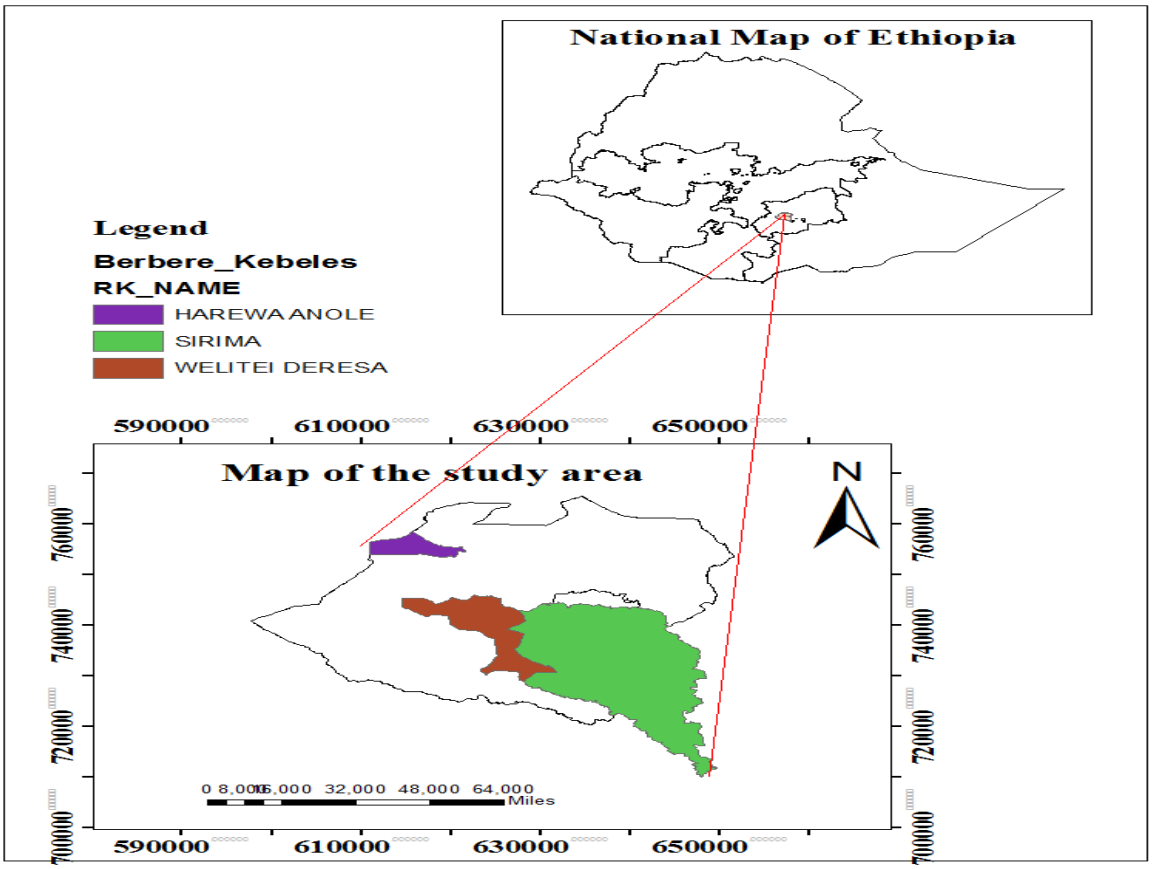
CHAPTER THREE

3. Methods and Materials

3.1. Description of the Study Area

3.1.1. Locations and Topography

The study conducted in BerbereWoreda of Bale zone, Oromia region. Berbere is one of the Woreda in the Oromia region of Ethiopia which is located in South-east part of Oromia region. It is located at a distance from Addis Abeba 534 km and study area is at distance from a Robe town 99 km. It is located to the East of Goba, South of Sinana, North of Mena and Agarfa and West of Goro(Bale zone Agriculture and Natural Resource Office, 2021). Geographically, the woreda is situated at 70 3' 30" N, to 70 10' 45''N latitude north and 390 57' 38"E, to 4002'38" E longitude east. The dominant feature of the topography of the selected Woreda(Bale zone Agriculture and Natural Resource Office, 2021).



Source: (BerbereWoreda Socio Economic profile, 2020)

Figure 2: Map of the Study Area

3.1.1. Topography

The total area of the district is about 1367 km^2 which ranked as the 13th largest district in the zone and their area account about 1.96 % out of the total area of the zone (69,661km^2).The lowest and highest altitude of the district is extended from 1050m below sea level namely called Deresea by local people which is located in the Eastern part of the district to 2500m above sea level locally called them Sirima which is found along the northern margin of the district respectively. From the total area of the district about 45 % is plain land, 18% is mountains, and 37 % is rugged and gorge

3.1.2. Climate

The climate of the study areas average temperature of 16.5^{0}c, average minimum and maximum temperature is 9.4^{0}c and 23.3^{0}c respectively (Goba woreda socio profile, 2018). The mean annual rainfall vary from 650mm from extreme lowland up to greater than 850mm on highlands. The rain fall increases from southern lowlands toward the northern highlands.

3.1.3. Season

Winter (*Belg*) Includes months of December, January, and February, Spring (*Bega*)-includes Months of March, April, May, Summer (*Kiremt*) - Includes months of June, July, August. Autumn - Includes months of September, October, and November. The study area receives bimodal rainfall (NMA, 2018). The study area classified as follows: temperate (*Dega* 5%), subtropical (*Weinadega* 25%), and tropical (Kola 70%) (NMA, 2018).

3.1.3. Relief

The relief configuration in the northeastern, the northern and the north western part of the district that shares the boundary with Guradhamole, Goro and Goba districts is generally highland mountains having a contour line of 1400-2500m.The mountain ranges are divided by relative dissected rivers, gorges and tributaries of various rivers Dumal, Awash, Bedanicho, Sokora and Burkitu rivers which across the district. Specifically, the highest point of the district is located on the northern extreme of the district. The most prominent highland peaks in the district are Sirima (2500m), Werabicho, Musucho, Shinano and others.

The central and southern part of the district is relatively lowland, the general land elevation progressively decrease from north to south. The central part terrains are a gentle

sloping which is more or less a lowland plain. Generally, the central and southern parts of low land are lying between 1000m-1400m contour line. The point of the district is located along the southern extreme of Dumal Rivers. The land configuration of the district account about 45 % is plain land, 18% is mountains, and 37 % is rugged and gorge.

3.1.3. Soil of the study area

In Berbere district there are about 3 major types of soils (Berbare woreda Agriculture development, 2020) have been identified as following.

Chromic Vertisoils: These are clay Black Basaltic soil which mostly develop from tertiary volcanic rocks this soil are very fertile they fairly good Agricultural potential .However, they have a limited agricultural use. The Soil shrink, develop deep cracks and become very hard in dry season. They swell and become sticky during the wet (rainy) Seasons. Besides, because of their low permeability, they are more prone to water logging during the rainy season. It located in the flat areas of southern part.

Chromic Cambisoils: They develop from recent lava and linked with sedimentary rocks .Their Agricultural value is limited as they are mostly found on rugged and steppy terrain. For this reason this type of soil left under natural plant cover. It is abundantly found in the central and southern part of the district.

Humic Cambisols (deep with high clay continent): Soils have good Agricultural potential (good physical and chemical properties, stable structure and high moisture storage capacity).

3.1.4. Vegetation

In Berbere district there are different type of natural vegetation which differs from one another in their structure such as leave, steams, branches, thickness and tree length. The common natural vegetation that found in the district (Berbere woreda Agriculture development, 2020) is the following.

Coniferous Forest - Dominated by Juniperousprocera (Gatira), and Podocarpousgracilior (Birbirsa).Juniperous Forest - Associated with Hagenia Abyssinia and Olean trees which mostly found at altitudes ranging from 2300-3100mm with mean annual rain fall of 800-1000mm.

The Podocarpous Forest - Associated with Olean, Acacias and cretonne which found at lower altitudes that extends from 1400-2200m with mean annual rain fall off 750-1000mm.

Broad Leafed Forest - Found in the most humid parts of the zones with Mean annual rain fall off 1000-3400mm and the elevation ranges from 1600-3400m above sea level. The most dominant plants are Wanza, Weira, Kerero, Bisana, Birbirsa, and Wild coffee shrub.

Wood land and Savanna -Found within 450-2,000 mm altitude with mean annual rain fall ranging from 250-1000mm. It consists of mixed deciduous plant, Bamboos, Incense, Gum Arabic, and 'Kerbie' tree species are the common

3.1.4. Population size of the study area

Berbere woreda is one of among 18 woreda of Bale zone. The total populations of the Woreda are 143245 from the total population the male population is about 73979 and the female population is 69266 (CSA, 2007).The households of the woreda is estimated 19790 household (Berbere woreda socio economic profile, 2021).

3.1.5. Major Economic Activities

The majority of the population of the study area practice traditional animal husbandry and agricultural crop cultivation economic activities(BWANRO, 2021). The dominant crops are (*Maize and Teff*) from cash crop (*Chat and Coffee*) from fruit (Orange and Banana) from vegetable (tomato cabbage and carrot) (BWSEP, 2021).Further, Berbere district has a very large Livestock and poultry resource. From early days, livestock rearing has played an important role in the life of district population. In the rural and lowland areas of the district, rearing and breading is the main stay of the people.

3.2. Research Methodology

3.2.1. Research Design

According to Chopra (2012) research design is the conceptual structure within which research is conducted. They specifically indicated that a research design is the arrangement of condition for collecting and analysis of data in a manner that aims to combine relevance to the research purpose.

In this study, the researcher used both descriptive and explanatory research design. Descriptive research, designs is chosen for it is appropriateness to the nature of the topic,

which needed wider description of facts and opinions as well as to collect and analyze data. On the other hand, explanatory research was used. Explanatory research, designs is chosen for it is appropriateness to the nature of the topic, which needed analysis of the cause and effect.

3.2.2. Data type and Sources

3.2.2.1. Data type

In order to furnish the research study, both qualitative and quantitative data types were employed. The qualitative data type was used to achieve objectives set in number one. Likewise, quantitative data types are used to achieve objectives set in number two, three and four. Moreover, in order to make the study more accurate and reliable through triangulation (cross checking purpose), the researcher used both qualitative and quantitative types.

3.2.2.2. Data source

For the accomplishment of the research, the study used both primary and secondary sources of data. The study used primary data from household's, local administrators, experts of forest management, elders and knowledgeable peoples, development agents and technical forestry supervisors of OFWE office. Primary sources are used due to more closely relate with the issues under study, they are more reliable and accurate. Secondary data collected from published and unpublished documents. These include manuals on participatory forest management, journals (annual, monthly and even weekly publications), reports, internet (web-sites).

3.2.3. Population, Sampling Technique and Sampling Size

Sekeran (2009) basically defined population as the entire group of people, events, or things of interest that the researcher wishes to investigate. Hence, out of total 18 kebeles in Berebere woreda, the researcher selected from Kola, Sirima and Welte'I Deresa sites and Harewa Anole site from Weina dega. Consequently the total household of the three kebeles are estimated to be 987 households (Berbere woreda socio profile, 2021). Further, the populations of the study were 3lleaders of each sample kebele, 5 experts of forest management, 6 elders and 6 knowledgeable peoples, 3 development agents and 2 technical forestry supervisors of OFWE office.

Berbere woreda is chosen by purposive sampling technique, because it is easily accessible to the researcher and to make it cost and time effective. To make an inference that can be generalized for the study, the study sites selected by stratified random sampling procedure based on agro-ecological zones to cross check the climate changes in their respective area.

Further, household selected by using systematic sampling method. Households were selected from each of the three Kebeles proportionally. In this case first the lists of the households were collected first from the manager of each Kebele. Systematic sampling method used to pick up the unit with which to start. This sampling procedure is useful when sampling frame is available in the form of a list.

To select knowledgeable person, at each village, 2 farmers who have long years in the area selected by snowball method, by asking respondents to inform knowledgeable person, and asked to give the name of 2 key informants, due to the respondents are small in number. Then, 6 most frequently appeared knowledgeable person and 3 development agents selected from each sample kebele selected for focused group. Further, 3 leaders of each sample kebele, 5 experts of forest management, 3 elders, and 2 technical forestry supervisors of OFWE office were selected by purposive sampling technique for interview.

To determine the sample size of households the study used Yemane (1967) formula.

$$n = \frac{N}{1 + N(e2)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where: n =sample size; N=total number of households in three sites; e = maximum variability or margin of error 5% (0.05); l = the probability of the event occurring.

$$n= \frac{N}{(1+Nxe^2)} n= \frac{987}{(1+987x0.05^2)} = \underline{285}$$

Therefore, the sampled households are 285.

After the sample size determined to 283 household individuals for study sites, by using stratified statistical formula semi sample size determined for each three sites.

$$N = N1 + N2 + N3 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

$$P1 = \frac{N1}{N}, P2 = \frac{N2}{N}, P3 = \frac{N3}{N} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

$$n1 = n * P1, n2 = n * P2, n3 = n * P3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where: -N = Total household of the 3 sites, N_1= subtotal of the household of Harewa Anole**,** N_2= subtotal of the household of Sirima**,** N_3= subtotal household of Welte'i Deresa**,** P_1, P_2, and P_3= Ratio of each subtotal household to total household of the three sites, n_1, n_2 and n_3 =semi sample size of each three site, n= Total sample size determined for all three sites.

Table 1: Distribution of HH population in the study sites

Name of District	Name of site	Number of household head	Sample Size
Berbere	Harewa Anole	461	135
	Sirima	189	55
	Welte'iDeresa	339	95
	Total	989	285

Source: - (BWANRO, 2021).

3.2.5. Data Collection Instruments

The methods of data collection depend upon the type (qualitative and quantitative) and sources of data. In this study to collect primary data, interview, focus group discussion, observation and questionnaire distribution were employed and to collect secondary data, websites and external sources also be utilized. Hence, both set of methods of data collection was employed; special emphasis was given for the primary data collection tools; as prior research had not been conducted in the area. The, secondary data collection tools employed to supplement the primary ones. The details of each data collection tools used as stated as follow.

3.2.5.1. Questionnaire

Questionnaire method was the most important approach through which the primary data in this study collected. Questionnaires are taken as a preferable data-gathering tool for this research because of the fact that the researcher used to collect information on facts and attitudes from a wide range of sources. The content of the questionnaire include structured questions. The reason to use semi-structured questions is to get more qualitative data to achieve the intended socio-economic objective.

The questionnaire administered to 285 farmers within their area of farming and/or residence. A research assistant were used in case where the respondent could not understand language and translated into local language. in order to administer

questionnaires and collect data in a way that the researcher intended, the researcher employ two enumerators and one supervisor and gave them one day training on the purpose and questionnaire collection procedures are concerned. The researcher participated as a supervisor. Following this, the final questionnaire distributed to 283 farmers by the enumerators to the sample selected at the time of rest on Sunday, during public meetings.

The questionnaire was applied the Likert scaling technique show that the points 1 strongly disagrees, 2 disagree, 3modrate agree, 4 agree and 5 strongly agree. It is a widely used rating scale which requires the respondents to indicate a degree of agreement or disagreement with each of a series of statements or questions. This rating scale is easy to respondents to give their response. The questionnaire consists of four parts with fixed response alternative that require the respondent to select a predetermined set of answers to every question. The first section collected information on background information. The second section is collected information on the trends of climate change. The third section collected information on the adaptation strategies practice. The fourth section is collected information on the mitigation strategies.

3.2.5.2. Key informant Interview

The interview permits greater depth of response which is not possible through any other means. Thus, the purpose of the interview is to collect more supplementary opinion on climate change adaptation and mitigation strategies practices, so as to stabilize the questionnaire response. Semi structure items prepared for the respondents. The reason behind the semi-structured interview items are the advantages of flexibility in which new questions could be forwarded during the interview based on the responses of the interviewee. With this in mind, interview conducted with 5 experts of forest management, 3 development agents and 2 technical forestry supervisors of OFWE office.

3.2.5.3. Focus Group Discussion

Focus group discussions conducted to collect information on climate change adaptation and mitigation strategies practices. Three focus group discussions selected from each kebele leaders having 18 members. On the other hand, FGD held with 6 knowledge person each group per village. In general four FGD collected in the study. To facilitate smooth discussions, checklists used as a guideline. Therefore, the knowledge or

information collected from group discussion used as complement to triangulate information collected through a questionnaire.

3.2.5.4. Field observation

The main advantage of this method assumed to be free from subjective bias if observation is done accurately. The information obtained under this method relates to what is currently happening and not complicated by either the past behavior or future intentions or attitudes. The researcher through field survey collected data on trend of climate change. Particularly the researcher observed mitigation and adaptation measure practice in the study area.

3.2.6.. Data Collection Procedures

To answer the research questions raised, the researcher would go through a series of data gathering procedures. These procedures would help the researcher get authentic and relevant data from the sample units. First the researcher having letters of authorization from University and woreda administrative for additional letters towards sample kebele for ethical clearance. Second, before beginning of all aspects the researcher had contacted to participants of respective kebele for consent. Third, the researcher introduced his objectives and purposes. Fourthly, the final questionnaires were administered to sample participant in the selected kebele. The participants allowed him to give their own answers to each item independently. Fifthly, the data collector closely assisted and supervises them to solve any confusion regarding to the instrument. Finally, the questionnaires were collected and make it ready for data analysis. Similarly the interview was conducted after the participants individual consent is obtained.

3.2.7.. Methods of Data analysis

In this study descriptive statistics were used. Accordingly, the demographic profiles analyzed using simple statistical tools such as tables and percentages. Charts were also used to describe the general characteristics of respondents. Descriptive statistics (Mean and Standard Deviations) of the respondent scores were also compute to analyze respondent's view of household's perception on trends of climate variability, household's climate change adaptation practice strategies and household climate change mitigation practice strategies. The data summarized and presented using tables, charts and percentage. All these followed by the necessary interpretations and discussions so as to achieve the desired specific objectives.

In this study, multiple regression analysis was used to measure the effect of climate change adaptation practice strategies and climate change mitigation practice strategies on trends of climate change. Multiple regressions analysis a statistical tool used to examine whether the independent variable, or predictor, explains any variations in the dependent variables; to inspect the strength of the relationship between the variables, thereby determining to what extent the predictor influences the variation in the dependent variable. More precisely, regression analysis deals with extent and nature of association between the examined variables.

The equation of regressions on this study is generally built around two sets of variables, namely dependent variable with the trends of climate change and independent variables climate change adaptation strategies and climate change mitigation strategies. The basic objective of using regression equation on this study is to make the study more effective at describing, understanding and predicting the stated variables. The regression equation, assumed the following multiple regressions model:

$Y= \beta 0+ \beta_1 X_1 + \beta_2 X_2 +e$

Y= Dependent variable the trends of climate change, whereas the independent variables, are identified as

X_1- Climate change adaptation strategies,

X_2 – Climate change mitigation strategies

$\beta 0$ = Constant, β_1 and $\beta 2$= Regression coefficients or Change included in Y by each X value and e = error term. On the other hand, the qualitative data collected from the respondents through interviews questions analyzed using descriptive narrations through concurrent triangulation strategy.

3.2.8.. Ethical Consideration

The researcher consider issues relating to the ethical conduct of research such as informed consent, confidentiality, privacy and anonymity were upheld. Participants and respondents had given full information on the purpose and objectives of the study in order for them to make informed decisions as to whether to partake or not. Moreover, all information concerning the identity and personality of respondents treated with utmost confidentiality. Additionally, all information gathered used for the sole purpose of the research study.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

Questionnaires were distributed to 285 farmers of selected sample kebeles and 260 questionnaires were filled completely and returned. The remaining 25 questionnaires were not returned in which the respondents were assigned on duty for field work without filling the questionnaire. The return rate was 91 %.According to Nulty, (2008) the response rate was acceptable as it had surpassed the 70% response rate threshold.

4.1. Demographic Characteristics of Respondents

As shown in figure below, 211 (81 %) of the respondents were male headed, while the remaining 49(19%) were female respondents. The implication of this distribution of these respondents' shows that the area study was been male dominated farming communities. In support with the finding it is believed that male headed farmers easily apply new technologies or skills acquired on their farms, as compared to female ones (UNFCCC, 2016).

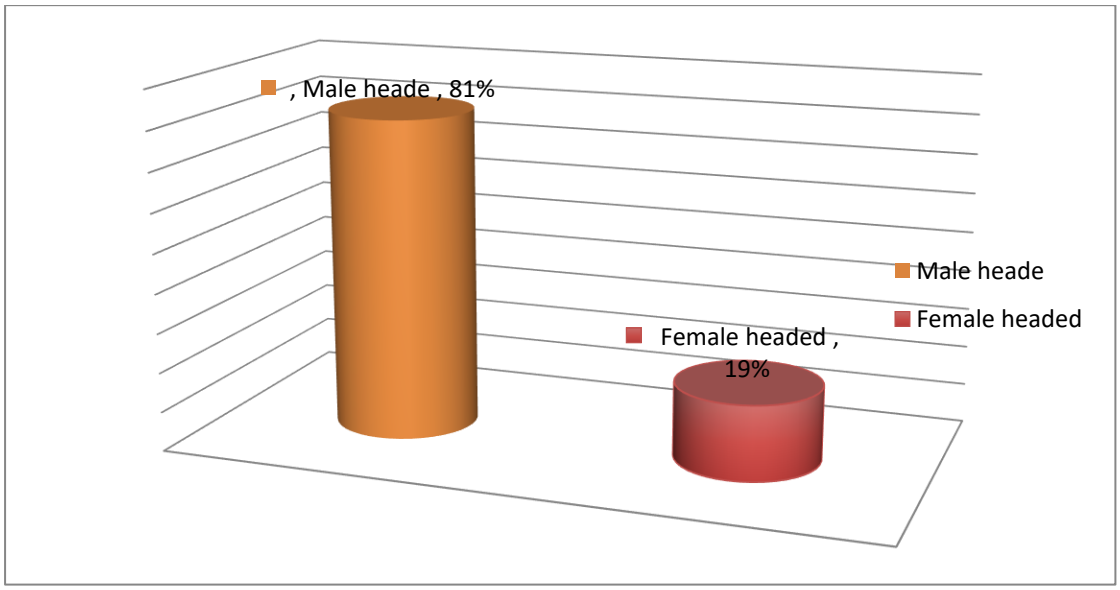


Figure 3. Respondent characteristics by type of household head

Source: Own Survey Data (2021)

In figure below, the majority 60 (23 %) of respondents were in between the age ranges of 41-50 years, followed by 149 (57 %) of the respondents who were found in the age group between 31-40 years. While 31 (12 %) of the respondents were in between the age

ranges of 18-30 years, the rest 20 (8%) respondents were above 51 years. From this we can see that majority of farmer's house hold were at adult ages that can participate in climate change mitigation strategies.

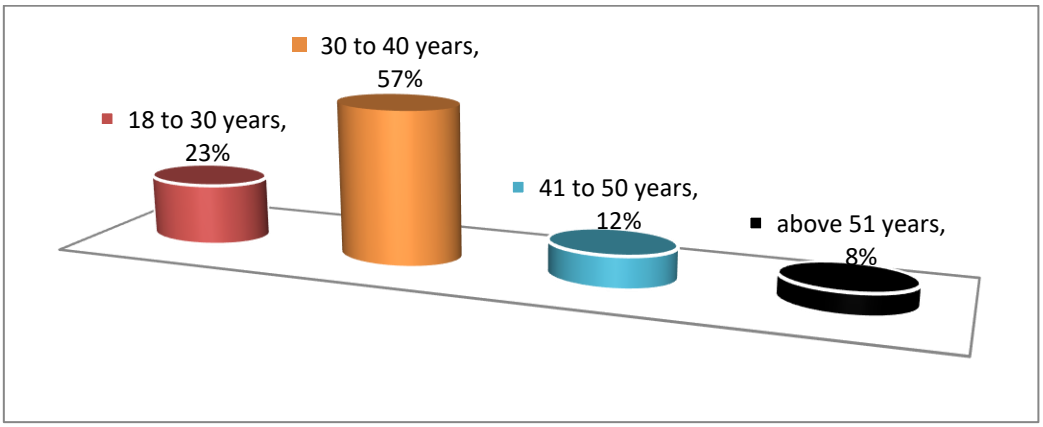


Figure 4. Respondent characteristics by Age

Source: Own Survey Data (2021)

On their highest educational level, the results show that the majority 175 (68%) of the respondents is primary school completed. This result implies that these farmers have low levels of education probably due to the fact that they are rural dwelling people and may not have access to good schooling facilities. However, studies have suggested that it is interesting to note that educated farmers also have the ability to explore different avenues to curb climate change due to their broad scope of knowledge (NyantakyiFrimpong, 2015).

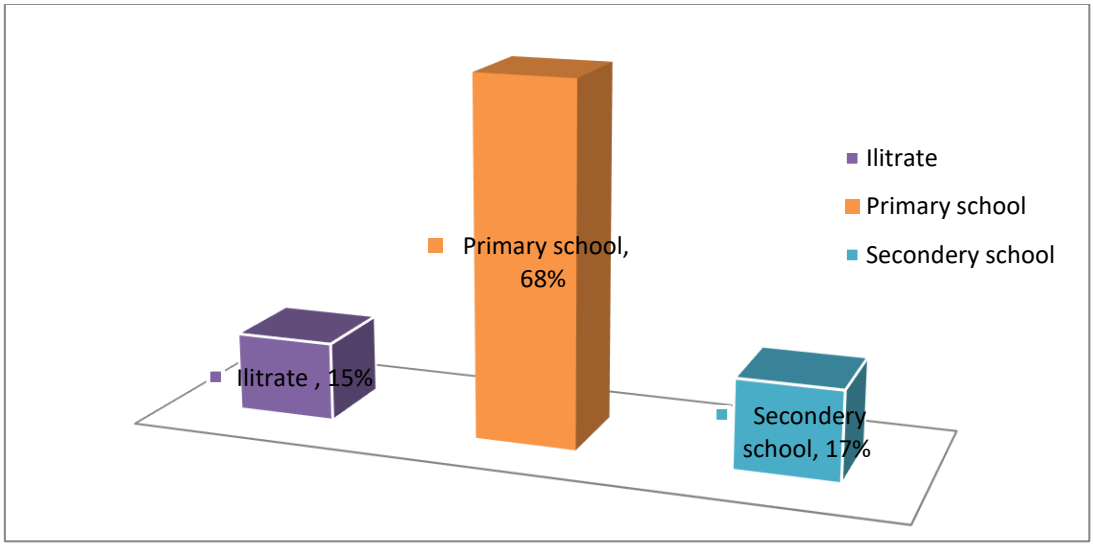


Figure 5. Respondent characteristics by Educational level

Source: Own Survey Data (2021)

As it indicated in figure below, the majority 54% of house hold size among these respondents is between 11 to 15 persons. This shows that theses farmers have large size household that is their household sizes are too large. According to the research, household size also has the possibility of influencing climate change adaptation.

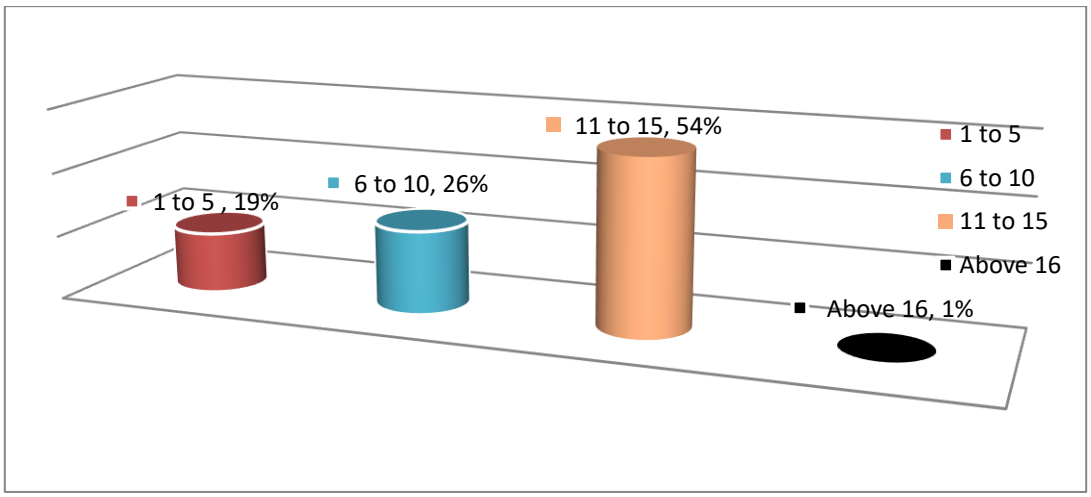


Figure 6. Respondent characteristics by Household size

Source: Own Survey Data (2021)

As it indicated in figure below, the majority 187(72%) of the respondents responded they don't accessed with agriculture extension service, this may be due to lack of skilled human power. This study indicated that the possibility of farmers adapting to climate change lack access to agriculture extension services. However, the finding indicated that agriculture extension agents (AEAs) play an essential role in agricultural promotion. They help in training and disseminating new and improve agricultural practices to farmers (Nielsen, 2010).

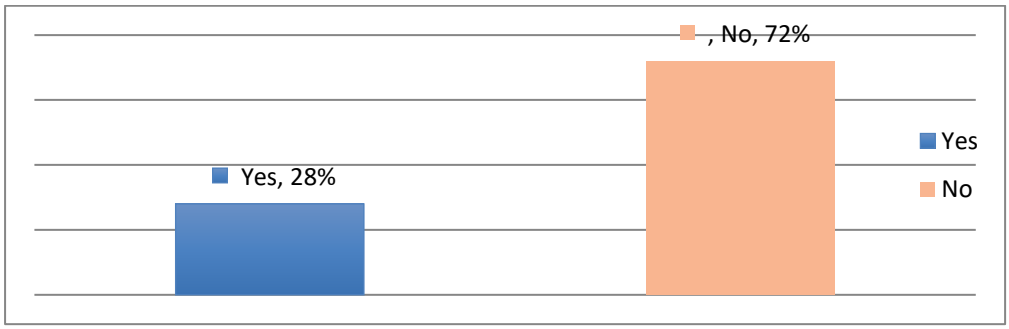
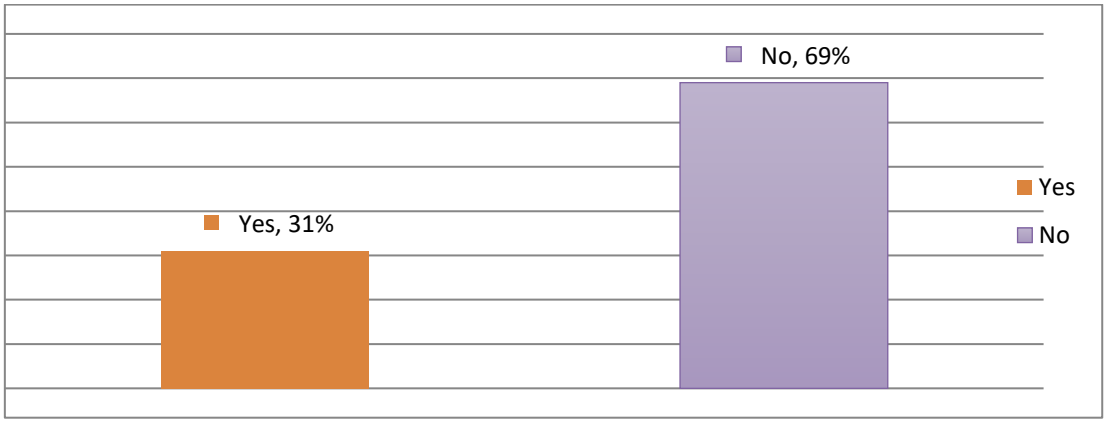


Figure 7. Respondent characteristics by access to agricultural agent

Source: Own Survey Data (2021)

As it indicated in figure below, the majority 179 (72%) of the respondents responded as they don't accessed to credit facilities. So one can concluded this has compelled most farmers to rely on their own meager income to purchase farm input. However, studies have shown that farmers with easy access to credit facilities have high preferences for adapting to climate change compared to those without access to credit (Mubaya, (2010), as some adaptation strategies affect the cost of production.

Figure 8. Respondent characteristics by access to credit facilities



Source: Own Survey Data (2021)

4.2.Household Perception on the Trends of Climate Change

This section was intended to assess household opinion on the trends of climate change. Accordingly, four questions were prepared to assess the respondent opinion on the trends of climate change. Descriptive statistics (Mean and Standard deviation) were employed, which was measured using the Five-Point Likert Scale. Thus, the views of the respondents were presented in table below.

Table 2: Household Perception on trends of climate change

No	Item	Strongly Disagree		Disagree		Moderate agree		Agree		Strongly agree		Mean	St. D
		F	%	f	%	f	%	f	%	F	%		
1	Evidence of increasing drought	42	16.2	46	17.7	48	18.5	103	39.6	21	8.1	3.05	1.24
2	Evidence of increasing poor rainfall	27	10.4	41	15.8	74	28.5	90	34.6	28	10.8	3.19	1.14
3	Major floods also occurred in different parts of the kebele	27	10.4	40	15.4	78	30.0	94	36.2	21	8.1	3.16	1.11
4	Increasing high temperatures including frequent natural disaster	45	17.3	56	21.5	63	24.2	59	22.7	37	14.2	2.95	1.30
	Grand Mean											3.09	1.00

The first objective of the study was to assess the perception of household on the trends of climate change. Accordingly, the respondents were asked to respond on the above statements. As the responses were rated on a five likert scale with SPSS version 22 outputs as depicted on table 2, an average likert scale, the responses had an overall mean of 3.09 which indicated that the study area is averagely vulnerable to the impacts of climate change.

Respondents through interview responded that the sample kebele identified as one of the vulnerable area to climate variability and change, and is frequently faced with climate-related hazards, commonly drought and floods. According to their view the variability of rain fall and the increasing temperature were a cause for frequent drought and famine, and putting disastrous impact on the livelihood of the peoples.

Respondents through FGD also pointed that major floods also occurred in the area. According to their view vulnerability is not the same for populations living under different social, economic, and environmental conditions of the study site. For example, pastoralist's kebele tends to be more vulnerable to climate change. Further through field observation the researcher also observed that the current rate of environmental degradation and climate change contribute to a faster rise in temperature.

4.3. Household Perception on the Trends of Climate Change

Further, secondary data contain cross-section units over 5 (2016 to 2020) years, which are advantageous to enlarge the number of observations were used. In this study grided data from perspective station on temperature and rain fall were collected to comprehend the trends of climate change.

Table 3. 5 years secondary data on annual temperaturerainfall pattern

Agro ecological sites	**Ave. annual temperature (oc)**					**Ave. annual rainfall (mm)**				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
Sirima sites	18^{0c}	19^{0c}	20^{0c}	22^{0c}	23^{0c}	850	775	710	699	650
Welte'IDeresa sites	19^{0c}	20^{0c}	21^{0c}	22^{0c}	23^{0c}	850	775	720	679	650
Anole sites	16^{0c}	17^{0c}	19^{0c}	20^{0c}	22^{0c}	850	775	765	760	710

Source- Berbere district Socio Economic profile (2021)

The overall monthly temperature and rain fall variation of the project area obtained from study site using the 5 years recorded data, from 2016 to 2020, at Berbere woreda is presented on table 3. Accordingly from the five years plan document review it understood that the annual average temperature is 16.5^{oc} whereas the minimum and maximum temperature is 9^{oc} and 23^{oc} respectively. However, based on 5 years, from 2016 to 2020, meteorological data recorded at Berbere woreda surrounding meteorological stations, the study site characterized by moderate diversity of temperature. However, the document review indicated that Sirima and Welte'I Deresa site experience warm temperature; however, Anole sites experience moderate warm temperature.

On the other hand, from five years plan document review it understood that the annual average rain fall is vary from 650mm from extreme lowland up to greater than 850mm on highlands. Based on 5 years, from 2016 to 2020, meteorological data recorded at Berbere woreda, the study site characterized by moderate diversity of rain fall, however, Anole sitescharacterized by high relatively with Sirima and Welte'I Deresa site.

4.4. The adaptation strategies implementation practices

This section was to assess the adaptation strategies implementation practices. The respondents were asked to respond on the issue in five likert scale tables below. Item scores for each category were arranged under five rating scales. The range of the rating scales were strongly Agree (SA) =5, Agree (A) =4, Natural (N) =3, Disagree (DA) =2 and strongly disagree (SD) =1.

Table 4:-Household practice on adaptation strategies

No	Item	Strongly Disagree		Disagree		Moderate agree		Agree		Strongly agree		Mean	St.D
		f	%	F	%	F	%	F	%	f	%		
1	Crop rotation	39	15.0	126	48.5	61	23.5	21	8.1	13	5.0	2.39	1.002
2	Use of water channels as draining system	12	4.6	45	17.3	64	24.6	106	40.8	33	12.7	3.39	1.058
3	Use of organic manure	31	11.9	28	10.8	48	18.5	133	51.2	20	7.7	3.31	1.143
4	Planting of cover crops	21	8.1	25	9.6	45	17.3	151	58.1	18	6.9	3.46	1.033
5	Mixed cropping practice	28	10.8	42	16.2	41	15.8	122	46.9	27	10.4	3.30	1.179
6	Planting of pest and disease resistant crops	41	15.8	130	50.0	50	19.2	39	15.0	-	-	2.33	.9172
7	Regular weeding to avoid breed of some insects pest	27	10.4	100	38.5	37	14.2	96	36.9	-	-	2.77	1.060
8	Breeding of drought and heat resistant crop varieties	11	4.2	98	37.7	56	21.5	95	36.5	-	-	2.90	.9517
9	Conserving of soil moisture through appropriate tillage operation	18	6.9	118	45.4	40	15.4	84	32.3	-	-	2.73	.9925
	Grand Mean											3.09	1.003

As it indicated in item 1 of table above, the majority 126 (48.5 %) of the households disagreed with the statement farmer practices crop rotation, while 34(13.1%) of the household agreed the opinion farmer practices crop rotation. The remaining 60(23.5%) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.39 which is in the range of disagree scale, so one can conclude that significant numbers of households of the sample kebele were perceived farmer failed to practices crop rotation continuously, this may be due to poor awareness on the issue.

As it indicated in item 2 of table above, the majority 106 (40.5 %) of the households agreed with the statement farmer used water channels as draining system, while 45(17.3%) of the household disagreed the opinion farmer used water channels as draining system. The remaining 64(24.6%) of the household were ignorant about this

issue. Further on likert scale, the responses had a mean value of 3.39 which is in the range of moderately agree scale, so one can conclude that average numbers of households of the sample kebele were perceived farmer used water channels as draining system.

As it indicated in item 3 of table above, the majority 133 (51.1 %) of the households agreed with the statement farmer use of organic manure, while 28(10.8%) of the household disagreed the opinion farmer use of organic manure. The remaining 48 (18.5 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 3.31 which is in the range of moderately agree scale. So one can conclude average farmers devised various ways to reduce the effects of climate change.

As it indicated in item 4 of table above, the majority 151 (58.10 %) of the households agreed with the statement farmer planting of cover crops around the farm, while 25(9.6%) of the household disagreed the opinion farmer planting of cover crops. The remaining 45 (17.3 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 3.46 which is in the range of agree scale. So, one can conclude that large number of farmers planting of cover crops to reduce the effects of climate change.

As it indicated in item 5 of table above, the majority 122 (46.9 %) of the households agreed with the statement farmer used mixed cropping practice while 42(16.2 %) of the household disagreed the opinion farmer used mixed cropping practice. The remaining 41 (15.8 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 3.30 which is in the range of moderate agree scale. So, one can conclude that average number of farmers used mixed cropping practice to reduce the effects of climate change.

As it indicated in item 6 of table above, the majority 120 (50 %) of the households disagreed with the statement farmer planting of pest and disease resistant crops while 39 (15%) of the household agreed the opinion farmer planting of pest and disease resistant crops. The remaining 50 (19.2 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.33 which is in the range of disagree scale. So, one can conclude that large number of farmers failed to planting of pest and disease resistant crops to reduce the effects of climate change through use of organic manure, this may due to poor awareness.

As it indicated in item 7 of table above, the majority 100 (38.5 %) of the households disagreed with the statement farmer regularly weeding to avoid breed of some insects pest while 96 (36.9 %) of the household agreed the opinion farmer regularly weeding to avoid breed of some insects pest. The remaining 37 (14.2 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.77 which is in the range of moderate agree scale. So, one can conclude that average number of farmers regularly weeding to avoid breed of some insects pest to reduce the effects of climate change.

As it indicated in item 8 of table above, the majority 98 (37.7 %) of the households disagreed with the statement farmer breeding of drought and heat resistant crop varieties while 95 (36.5 %) of the household agreed the opinion farmer breeding of drought and heat resistant crop varieties. The remaining 56 (21.5 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.90 which is in the range of moderate agree scale. So, one can conclude that average number of farmer failed to breeding of drought and heat resistant crop varieties to reduce the effects of climate change, this may due to poor awareness and lack of resources.

As it indicated in item 9 of table above, the majority 118 (45.4 %) of the households disagreed with the statement farmer conserving of soil moisture through appropriate tillage operation while 84 (32.3 %) of the household agreed the opinion farmer conserving of soil moisture through appropriate tillage operation. The remaining 40 (15.4 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.73 which is in the range of moderate agree scale. So, one can conclude that average number of farmer conserving of soil moisture through appropriate tillage operation to reduce the effects of climate change.

Respondents through interview responded that for example, people who live in the area are engaged in mass actively in the combat against climate change. This fight against climate change is indicated by the people's involvement in soil and water conservation practices, which helps to maintain the existing climate as well as to accommodate favorable climate. Respondents also added that the most common coping strategies are pastoral migration, food aid, and supply side and demand side interventions with regard to water.

Respondents through FGD respond that the adjustment responses are increased mobility, more adoption of drought-tolerant livestock species and fodder production. The researcher also observed that there are also institutional coping strategies such as emergency aid, credit services, safety net and water distribution.

4.5. The mitigation strategies implementation practices

This section was to assess the mitigation strategies implementation practices. The respondents were asked to respond on the issue in five likert scale tables below. Item scores for each category were arranged under five rating scales. The range of the rating scales were strongly Agree (SA) =5, Agree (A) =4, Undecided (U) =3, Disagree (DA) =2 and strongly disagree (SD) =1.

Table 5: Household practice on mitigation strategies

No	Item	Strongly Disagree		Disagree		Moderate agree		Agree		Strongly agree		Mean	St.D
		f	%	F	%	f	%	F	%	f	%		
1	Afforestation	24	92	155	59.6	45	17.3	36	13.8	-	-	2.35	.833
2	Proper conservation of seeds	41	15.8	130	50.	55	21.2	21	8.1	13	5.0	2.36	1.00
3	Avoidance of deforestation/ tree feeling	37	14.2	127	48.8	45	17.3	28	10.8	23	8.8	2.51	1.13
4	Reduced the use of wood for fire	19	7.3	123	47.3	67	25.8	28	10.8	23	8.8	2.66	1.05

As it indicated in item 1 of table above, the majority 155 (59.6 %) of the households disagreed with the statement farmer practice afforestation while 36 (13.8%) of the household agreed the opinion farmer practice afforestation. The remaining 45 (17.3 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.35 which is in the range of disagree scale. So, one can conclude that large number of farmer failed to afforest to reduce the effects of climate change.

As it indicated in item 2 of table above, the majority 130 (50 %) of the households disagreed with the statement farmer properly conserve seeds while 21 (8.1%) of the household agreed the opinion farmer properly conserve seeds. The remaining 55 (21.2 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.36 which is in the range of disagree scale. So, one can conclude that

large number of farmer failed to farmer properly conserve seeds to reduce the effects of climate change.

As it indicated in item 3 of table above, the majority 127 (48.8 %) of the households disagreed with the statement farmer avoid deforestation/ tree feeling while 28 (10.8 %) of the household agreed the opinion farmer avoid deforestation/ tree feeling. The remaining 45 (17.3 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.51 which is in the range of disagree scale. So, one can conclude that large number of farmer failed to avoid deforestation/ tree feeling to reduce the effects of climate change.

As it indicated in item 4 of table above, the majority 123 (47.3 %) of the households disagreed with the statement farmer reduced the use of generators for wood for fire while 28 (10.8%) of the household agreed the opinion farmer reduced the use of generators for electrification. The remaining 67 (25.8 %) of the household were ignorant about this issue. Further on likert scale, the responses had a mean value of 2.66 which is in the range of moderate agree scale. So, one can conclude that average number of farmer reduced the use of generators for electrification to reduce the effects of climate change.

Respondents through interview respond that mitigation focuses on the causes of climate change, and mitigation as indirect damage prevention, actions taken to reduce the extent of climate change, or actions to avoid the unmanageable. The most commonly used is intervention to reduce the sources or enhance the sinks of greenhouse gases. The respondents added that the farmers in the area still did not applied efficient use of solar, biofuels, through enhanced sinks (e.g., reforestation and afforestation).

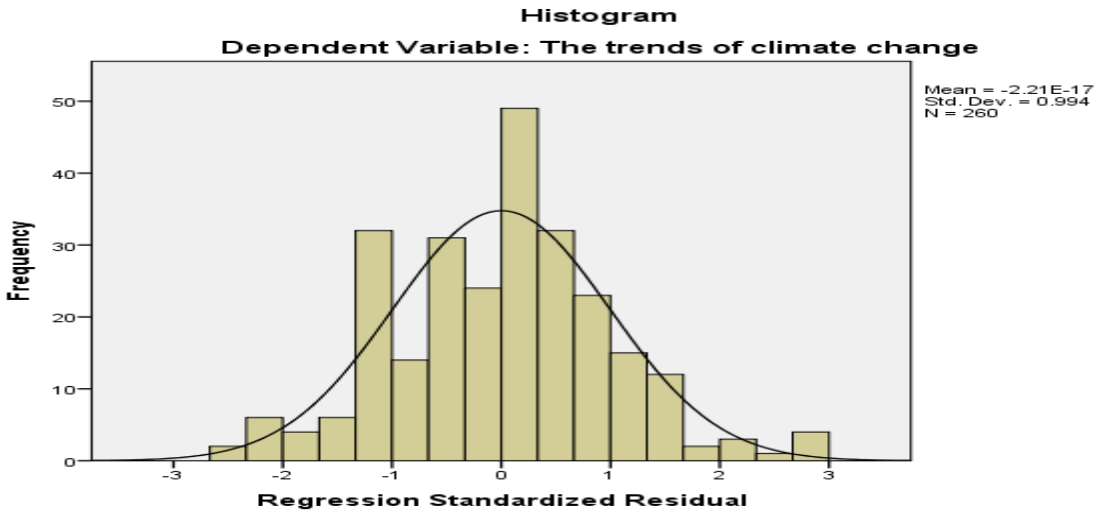
Respondents through interview respond that afforestation and conservation programs have been made in the last five years. However it is not similarly done in all kebeles of the woreda. The respondents also pointed that, some actions cover mitigation as for example, insulating houses decreases energy loss**,** while enabling improved cooling of the interior during extreme heat or cold. Another example is the incorporation of solar collectors for heating water. It can be observed here that strategies with low of practice.

4.6. Basic Assumption for Multiple Regression Analysis

In this study, multiple regression analysis was used to measure the effect of climate change adaptation strategies and climate change mitigation strategies on trends of climate change. Multiple regressions analysis a statistical tool used to examine whether the independent variable, or predictor, explains any variations in the dependent variables; to inspect the strength of the relationship between the variables, thereby determining to what extent the predictor influences the variation in the dependent variable. More precisely, regression analysis deals with extent and nature of association between the examined variables. Y= Dependent variable the trends of climate change, whereas the independent variables, are identified as X1- Climate change adaptation strategies, X2 – Climate change mitigation strategies.

Before, multiple regression analysis employed, in order to ensure the appropriateness of the outputs from the regression analysis; two assumptions of multiple regressions were cheeked. Accordingly, in the first case, it is checked the assumption of normality. To check the assumption histogram was used to test the assumption that residuals are normally distributed. Since a histogram of sample data produce a perfectly smooth normal curve like the one displayed over the figure below. As long as the data is approximately normally distributed, with a peak in the middle and fairly symmetrical, the assumption of normality has been met.

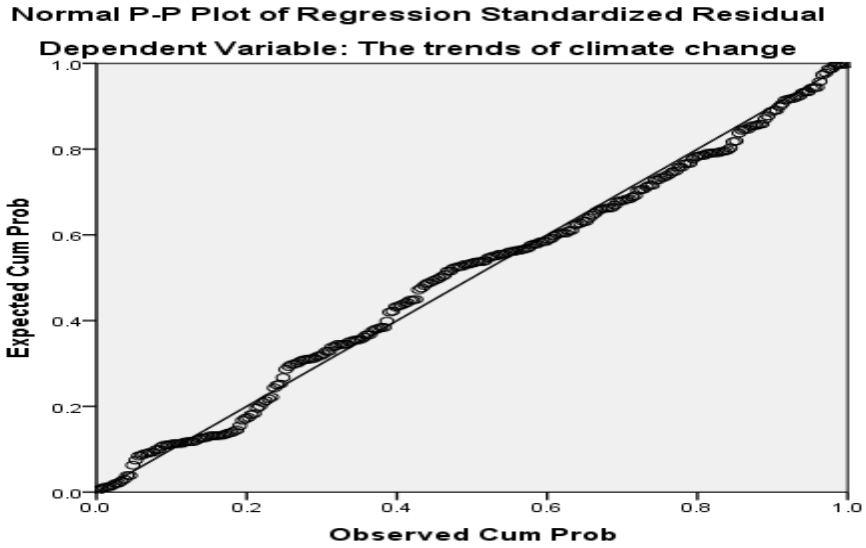
Figure 8: Histogram with normal curve plotted (SPSS output)



Source: Own Survey Data (2021)

In the second case it is checked the assumption of linearity. Accordingly, as it indicated in the scatter plot of residuals figure below scatter form a line in the plot rather than a curve or other shape. Linearity is indicated, when these values were spread or fan out from left to right or right to left. The scatterplot shows that the points are concentrated around 0, which shows that no violation of linearity. So it indicated the scatter plot below suggests that scatter plot spread from left to right and there is a linear relationship so the assumption has been met.

Figure.9: Linearity test



Source: Own Survey Data (2021)

4.7. Multiple Regression Analysis Result

After all the assumptions were complied, the multiple regressions analysis was carried out. Regression analysis shows how dependent variable is influenced with independent variables. The following section presents the outcomes of regression analysis. A multiple regression analysis was conducted to generate model of fitness, analysis of the variance and regression coefficients. The results of the multiple regressions are shown in table below.

Table .6: Model Summery

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.851	.725	.721	.52955

Source: Own Survey Data (2021)

As shown in the above table the overall bundle of the dimension of adaptation strategies and mitigation strategies explains 72.5 % (R2 = 0.735) of the dependent variable (trends

of climate change). This suggests that the model or the predictor variables have accounted for 72.5 % of the variance in the criterion variable, while the remaining 27.5 % is determined by other unaccounted factors in this study.

Table.7: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	188.856	3	62.952	224.493	.000
	Residual	71.787	256	.280		
	Total	260.643	259			

Source: Own Survey Data (2021)

In statistics significance testing the p-value indicates the level of relation of the independent variable to the dependent variable. If the significance number found is less than the critical value (p) which is statistically set at 0.05, then the conclusion would be that the model is significant in explaining the relationship; else the model would be regarded as non-significant. Accordingly, this model is significantly explaining relationship between predictor's variables and dependent variable.

Table8.Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta	
1 (Constant)	.671	.191		.001
Trend of climate changes	.666	.031	.825	.000
Adaptation strategies	.078	.063	.048	.020
Mitigation strategies	.059	.045	.043	.197

Source: Own Survey Data (2021)

From the above table, it can easily compare the relative contribution of each of the different variables by taking the beta value under the standardized coefficients. The higher the beta value, the strongest its contribution becomes. Accordingly, adaptation strategies (Beta=.079) with p=020) makes the small contribution to explaining the dependent variable in which the results revealed that, a one-unit positive change in adaptation strategies would lead to a 0.079 unit positive changes on trend of climate changes. While mitigation strategies practices were ignored in the implementation of plan of the study area.

4.9. Discussion

Based on 5 years, from 2016 to 2020, meteorological data recorded at Berbere woreda surrounding meteorological stations, the study site characterized by moderate diversity of temperature. However, the document review indicated that Sirima and Welte'I Deresa site experience warm temperature; however, Anole sites experience moderate warm temperature. On the other hand, based on 5 years, from 2016 to 2020, meteorological data recorded at Berbere woreda, the study site characterized by moderate diversity of rain fall, however, Anole sitescharacterized by high rain fall relatively with Sirima and Welte'I Deresa site (Berbere woreda socio economic profile, 2021).

Further, the study indicated that significant numbers of households of the sample kebele were perceived farmer failed to practices crop rotation continuously. The study indicated that average numbers of households of the sample kebele were perceived farmer used water channels as draining system, planting of cover crops, used mixed cropping practice, planting of pest and disease resistant crops. The study found that average number of farmers regularly weeding to avoid breed of some insect's pest through use of organic manure, breeding of drought and heat resistant crop varieties, conserving of soil moisture through appropriate tillage operation. The study also found that large number of farmer failed to use of organic manure, properly conserve seeds, avoid deforestation/ tree feeling, reduced the use of generators for electrification. In support with the finding coping strategies highly differ among households and communities based on their resources and knowledge accumulated through experience of past weather pattern (Admassie, 2008).

Overall the study indicated that adaptation strategies had significant effect on the trend of climate changes, while mitigation strategies had insignificant effect on the trend of climate changes. So the researcher concludes that in the study area farmers did not effectively used mitigation strategies. In support with the finding based on the type of economic activities and social networks societies local coping strategies highly differ among households and communities based on their resources and knowledge accumulated through experience of past weather pattern (Admassie, 2008).

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary of the Finding

From the demographic characteristics of respondents, majority 211(81%) of households were male head. Besides, majority 149 (57 %) of households who participated on the survey were ranging from 31-40 years of age. Regarding educational level, majority 175 (68%) of households were primary school. The study also indicated that average house hold size among these households were between 11 to 15 persons. As it indicated in the study, the majority 187(72%) of the households accessed with agriculture extension service. As it indicated in study, the majority 179 (72%) of the respondents responded as they don't accessed to credit facilities.

- Regarding the perception of the trends of climate change the overall mean of 3.09 which indicated that the respondents disagreed to all questions asked.
- The adaptation strategies, the responses had a mean value of 3.31 which is in the range of moderately agree scale. So one can conclude that the results reveal that the farmers have devised various ways to reduce the effects of climate change.
- The mitigation strategies, the responses had a mean value of 2.47 which is in the range of disagree scale. It can be observed here that strategies with low of practice.
- The study indicated that adaptation strategies (Beta=.079) with p=020) makes the small contribution to explaining the dependent variable in which the results revealed that, a one-unit positive change in adaptation strategies would lead to a 0.079 unit positive changes on trend of climate changes. While mitigation strategies practices were ignored in the implementation of plan of the study area.

5.2. Conclusion

The variability of rain fall and the increasing temperature were a cause for frequent drought and famine, and putting disastrous impact on the livelihood of the peoples. Major floods also occurred in the area. Vulnerability is not the same for populations living under different social, economic, and environmental conditions. For example, pastoralist's area tends to be more vulnerable to climate change.

Further, the study indicated that significant numbers of households of the sample kebele were perceived farmer failed to practices crop rotation continuously. The study indicated that average numbers of households of the sample kebele were perceived farmer used water channels as draining system, planting of cover crops, used mixed cropping practice, planting of pest and disease resistant crops. The study found that average number of farmers regularly weeding to avoid breed of some insect's pest through use of organic manure, breeding of drought and heat resistant crop varieties, conserving of soil moisture through appropriate tillage operation. The study also found that large number of farmer failed to use of organic manure, properly conserve seeds, avoid deforestation/ tree feeling, reduced the use of generators for electrification. Overall the study indicated that adaptation strategies had significant effect on the trend of climate changes, while mitigation strategies had insignificant effect on the trend of climate changes. So the researcher concludes that in the study area farmers did not effectively used mitigation strategies.

Mitigation focuses on the causes of climate change, and mitigation as indirect damage prevention, actions taken to reduce the extent of climate change, or actions to avoid the unmanageable. The most commonly used is intervention to reduce the sources or enhance the sinks of greenhouse gases. The farmers in the area still did not applied efficient use of solar, biofuels, wind, and ocean thermal exchange, carbon sequestration through enhanced sinks (e.g., reforestation and afforestation). Afforestation and conservation programs have been made in the last five years. However it is not similarly done in all kebeles of the woreda. Some actions cover mitigation as for example, insulating houses decreases energy loss**,** while enabling improved cooling of the interior during extreme heat or cold. Another example is the incorporation of solar collectors for heating water. It can be observed here that strategies with low of practice.

5.3. Recommendations

Based on the findings of this study, the following recommendations are made for consideration to help improve the practice.

- The study recommended that the local government more than 50 % highly work to reduce the use of generators for electrification.
- The study recommended that the local government highly work to avoid deforestation/ tree feeling
- The study recommends that local government should enforce local based strategies on afforestation as a mitigation measure against climate change
- In addition, there is need for government at local level to engage extension agents who should teach farmers climate friendly practices that mitigate climate and enable effective adaptation
- Moreover, since cost-efficiency is still crucial in making farmers attractive to stakeholders and funding agencies, then all activities in climate measures have to contribute substantially to an objective (adaptation or mitigation)
- In addition, it recommended that local farmers expected to practice crop rotation
- It recommend that the local government should work to promote perception of people on the area of climate change

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APPENDIX-I

Maddawalabu University

School Of Graduate Studies

Department of

Geography and Environmental Studies

Questionnaire to be filled by HHs

Dear respondent, this questionnaire is designed to be distributed for an academic purpose for the fulfilment of MA degree in Geography. I'm a MaddaWalabu University student. Now I'm working on the way to my Master's degree (MA) thesis. I am interested to know the peoples water usage practices and Perceptions about water source information in your village and I have prepared a small survey. As I told you and aware of my objective, that my research is purely for academic purpose. Having this introduction this short questionnaire will take some short minutes of your time. Would you allow me to go ahead? Thank you in advance. The responses only used for the research study.

Instructions:

i. Please do not write your name.
ii. If alternatives are given, please tick the letter of your choice.
iii. If you are required to provide specific data, please write it precisely on the spaces provided.

Section 1: Background Information

1. Male head[B. Female head [ ]
2. Your level of education
3. Age:
4. Household size
5. Access to agricultural agent
6. Access to credit

Section 2: The trends of climate change

The following are some of the questions regarding the trends of climate change adaptation strategies. Please using the scale below, indicate the extent of your level of agreement on the trends of the trends of climate change, by putting a tick mark (√) besides each statement where SA- Strongly Agree, AG– Agree, U, undecided, DA– Disagree and SD– Strongly Disagree.

SN	Item	Response				
		SD	DA	U	AG	SA
1	Evidence of increasing drought					
2	Evidence of increasing poor rainfall					
3	Major floods also occurred in different parts of the woreda					
4	Evidence of increasing high temperatures, including frequent natural disaster					

Section 3: The Adaptation strategies

The following are some of the questions regarding the adaptation strategies. Please using the scale below, indicate the extent of your level of agreement on the adaptation strategies, by putting a tick mark (√) besides each statement where SA- Strongly Agree, AG– Agree, U, undecided, DA– Disagree and SD– Strongly Disagree.

SN	Item	Response				
		SD	DA	U	AG	SA
1	Crop rotation					
2	Use of water channels as draining system					
3	Use of organic manure					
4	Planting of cover crops					
5	Mixed cropping practices					
6	Planting of pest and disease resistant crops					
7	Regular weeding to avoid breed of some insects pest					
8	Breeding of drought and heat resistant crop varieties					
9	Conserving of soil moisture through appropriate tillage operation					

Section 4: The Mitigation strategies

The following are some of the questions regarding the adaptation strategies. Please using the scale below, indicate the extent of your level of agreement on the adaptation strategies, by putting a tick mark (√) besides each statement where SA- Strongly Agree, AG– Agree, U, undecided, DA– Disagree and SD– Strongly Disagree.

SN	Item	Response				
		SD	DA	U	AG	SA
1	Afforestation					
2	Proper conservation of seeds					
3	Avoidance of deforestation/ tree feeling					
4	Reduced the use of generators for electrification					

APPENDIX-II

Maddawalabu University

School Of Graduate Studies

Department of

Geography and Environmental Studies

Interview Checklist

Dear respondent, this interview is designed to be distributed for an academic purpose for the fulfilment of MA degree in Geography. I'm a MaddaWalabu University student. Now I'm working on the way to my Master's degree (MA) thesis. I am interested to know the peoples water usage practices and Perceptions about water source information in your village and I have prepared a small survey. As I told you and aware of my objective, that my research is purely for academic purpose. Having this introduction this short interview will take some short minutes of your time. Would you allow me to go ahead? Thank you in advance. The responses will be only used for the research study.

1. What is the trend of climate changes in the study area?
2. What are the climate change adaptation strategies in the study area?
3. What are the climate change mitigation strategies in the study area?
4. What are the factors affecting the climate change in the study area?

APPENDIX-III

Maddawalabu University

School Of Graduate Studies

Department of

Geography and Environmental Studies

FGD Checklist

Dear respondent, this interview is designed to be distributed for an academic purpose for the fulfilment of MA degree in Geography. I'm a MaddaWalabu University student. Now I'm working on the way to my Master's degree (MA) thesis. I am interested to know the peoples water usage practices and Perceptions about water source information in your village and I have prepared a small survey. As I told you and aware of my objective, that my research is purely for academic purpose. Having this introduction this short interview will take some short minutes of your time. Would you allow me to go ahead? Thank you in advance. The responses will be only used for the research study.

5. What is the trend of climate changes in the study area?
6. What are the climate change adaptation strategies in the study area?
7. What are the climate change mitigation strategies in the study area?
8. What are the factors affecting the climate change in the study area?