DETERMINANTS OF ADAPTATION STRATEGIES TO CLIMATE VARIABILITY BY SMALLHOLDER FARMERS OF CHIRO WOREDA

MA THESIS

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DETERMINANTS OF ADAPTATION STRATEGIES TO CLIMATE VARIABILITY BY SMALLHOLDER FARMERS OF CHIRO WOREDA, WEST HARARGHE ZONE

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APPROVAL SHEET

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I hereby certify that I have read and evaluated this Thesis entitled Determinants of Adaptation Strategies to Climate Variability by Smallholder Farmers in case of Chiro Woreda, west Hararghe zone, Oromia Regional State, Ethiopia prepared under my guidance by Endalkachew Mogose**.**

I recommend that it to be submitted as fulfilling the thesis requirement.

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As a members of the Board Examiners of the MSc Thesis Open Defense Examination, we certify that we have read and evaluated the Thesis prepared by Endalkachew Mogose and examined the candidate. We recommend that the thesis be accepted as fulfilling the Thesis requirements for the degree of Master of Science in Environmental Science and Management.

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

DEDICATION

I dedicate this thesis manuscript to my brother and sisters for their affection, love and generous moral support during my studies.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this thesis is my own work. I have followed all ethical principles in the preparation, data collection, data analysis and completion of this thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every serious effort has been made to avoid any plagiarism in the preparation of this thesis. This thesis is submitted in partial fulfillment of the requirement for a degree from the School of Graduate Studies at Haramaya University

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BIOGRAPHICAL SKETCH

The author was Endalkachew Mogese born on September, 1984 at Ejefaraa kebele Chiro woreda, West Hararghe zone of Oromia region. He attended his elementary and junior education at Chiro Town number Two and number One School respectively. Then, he completed his secondary education at Chiro Senior Secondary School in 2003. In 2004, the author joined Mekele Universit College of Dry Land Agriculture and Natural Resource Management and graduated with BSc degree in Natural Resource Economics and Management in July 8,2007 Right after graduation, he was employed and served as a Forestry and Soil and Water conservation expert in Agriculture and Rural Development Office of Habro and Chiro Woreda respectively, West Hararghe Zone, Oromia Region, Ethiopia. Since October 2020 he was employed at Oromia REDD+ Investment Program as Chiro Cluster Woreda coordinator. He joined Haramaya University, Postgraduate Program Directorate in May 2019 for the MA program in School of Geography and Environmental Studies.

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ABBREVIATION AND ACRONYMS

CO2	Carbon dioxide
CRGE	Climate Resilient Green Economy
CSA	Central Statistical Agency
FAO	Food and Agriculture Organization
FDG	Focus Group Discussion
GDP	Gross Domestic Product
GAT	Growth and Transformation
GHG	Green House Gas
HH	Household
IISD	International institute sustainable development
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
NAPA	National Adaptation program strategy
NMA	National Metrology Agency
UNDP	United Nation Development Programs
UNFCCC	United Nation Framework Convention on Climate Change

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Abstract

Climate variability is a widespread challenge affecting many parts of the world It has adverse consequences on the world's ecosystems, economies, and societies. Ethiopia is heavily dependent on rain-fed agriculture, and its geographical location and topography in combination entail a high vulnerability to adverse impacts of climate variability. The specific Objectives of this study was to assess the perception of smallholder farmers on the climate variability, the effect of climate variability on the livelihood of smallholder Households and to identified factors that determine the choice of adaptation strategy by smallholder farmers in respond to climate variability. To attain thesis objectives, the data required for the study was obtained from both primary and secondary sources. The primary data has been collected through questionnaire, interview, focused group discussion and personal field observation. Secondary data were collected using available sources of information such as published and unpublished documents. The binary logistic regression model and Descriptive statistics were used to analyze the data. The binary logistic regression model on its part was used to identify factors that affect smallholder farmers' choice of adaptation strategies. Purposive and simple random sampling methods were used to select three kebele and 164 Household respondents respectively. The result show that the main factors that determine Adaptation strategy in the study area were distance nearest to the market from farmers resident, access to extension, family size, training, off-farm income, ,smallholders area of farm parcels, credit services, house hold income and family size were significant influence household heads decision to adopt best adaptation option for adaptation strategy. Based on the results, it recommended that strengthening existing off farm income benefit schemes and creating others benefit related to the agriculture product based income generating activities, which helps to strength their adaptation option. Therefore, recommended that to improve farmers' adaptation strategy, trading and Extension service play a vital role by providing information and developing skill to local farmers

Key words: *Adaptation Climate variability, perception, smallholders; Chiro Wereda, Western Hararghe*

1. INTRODUCTION

1.1 Background of the study

Climate variability is recognized as one of the greatest challenges of our world. It is predicted to have adverse consequences on the world's ecosystems, economies, and societies, as evidenced by (IPCC, 2021) which highlight increasing extreme weather events and shifts in climate patterns. Recent climate variability, including temperature and precipitation changes, impacts crop yields globally and exacerbates food insecurity (Wang.et al., 2022). The average globe temperature has increased from 1.8ºc to 4ºc. According to, IPCC increasing an atmospheric concentration of greenhouse gases (GHGs) will have a significant impact on the earth's climate in the coming decades. from 1906 to 2005, GHG emissions have significantly contributed to global warming, with an observed increase in average global temperature of approximately 0.70°C(IPC , 2021).

The effectiveness and accessibility of climate information services for farmers in Africa, addressing how these services can improve decision-making related to crop selection and planting times (Gizaw et al., 2023). High vulnerability of Africa to climate variability, including recent trends and projected impacts (Morgan et al., 2022). This vulnerability has been attributed to the continent's high poverty levels, low adaptive capacity, its dependence on rain-fed agriculture as well as its limited economic and institutional capacity. Most developing countries have high population growth rate and this high population pressures lead to the search of new farming place.

Due to increasing demand for farming land has led to deforestation, soil degradation, and associated environmental impacts in Sub-Saharan Africa (Brown et al., 2023). Under this pressure agricultural production is in most African countries have been impacted while this sector is mainly subsistence and lower adaptive capacities. In addition to this the size of the farm lands are very small and the Farmers are unable manage themselves throughout the year. How climate change has led to an increase in the frequency and distribution of natural hazards, including human diseases, livestock diseases, and crop pests in Africa (2023).

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The critical role of agriculture in Ethiopia’s economy and discusses trends and prospects for the sector (Yimar et al., 2023). Explores how rain-fed agriculture is particularly vulnerable to climate change and variability, highlighting recent evidence and implications for adaptation (Briones et al., 2023). Fluctuations in rainfall patterns are closely linked to Ethiopia’s GDP growth, highlighting the economic implications of climate variability (Hailu et al., 2023). The trends in the contribution of agriculture to the countries total GDP clearly explain the presence of strong relationship between the performance of agriculture and climatic conditions.

The severity of climate variability impacts agricultural productivity differently across regions and socio-demographic groups, emphasizing the role of exposure, sensitivity, and adaptive capacity (Tanaka et al., 2023). Climate variability have direct impact on agricultural productivity and indirect impact through by pests on crops, reducing water availability and increasing natural resources degradation. How agro ecology-based approaches contribute to climate adaptation strategies, focusing on research advancements and field practices (Walker et al., 2022). According to, (Desta et al., 2021) explores the patterns of climate variability and change across different regions of Ethiopia, highlighting the high variability in climate on annual, seasonal, and geographical scales. Especially the amount and seasonal distribution of rain are varying annually and difficult to predict while the temporal distribution of rainfall during the growing season is an important factor influencing crop yield.

However, increasing temperature and rainfall variability in different part of Ethiopia adversely influence the agricultural production of smallholder farmers. To various adaptation strategies employed by smallholder farmers in East Africa, emphasizing how these strategies can help minimize the shocks of climate change (Houghton etal., 2022).Various strategies adopted by governments and institutions to enhance adaptive capacity for climate change. It emphasizes the need for action across multiple sectors and levels (Wilson et al., 2021). How economic, technological, and institutional determinants influence adaptive capacity, highlighting the variability of these factors over time and space (Thompson et al., 2022) Climate change affects agricultural crop production and examines various adaptation strategies that can mitigate these impacts (Schwartz et al., 2023). Technological opportunities, economic status, community organizations, and other factors influence adaptive capacity across different regions (Thomas et al., 2022). Various adaptive strategies can help countries reduce the adverse effects of climate change on agricultural production (Smith et al., 2021). Ethiopia is found in the Eastern part of Africa and the major livelihoods of the people are mainly Agriculture (crop production and animal husbandry). This sector plays a main role in securing the livelihood of the people but the agricultural economy is based on the favorable condition of the climate. Due to the heavy and unseasonal rain the productivity of the sector is highly affected especially failure in “Kirmet”1 and “Belg”2 rain seasons. Farmers wait on the rain to cultivate their crops. How land degradation has led to reduced productivity and increased food insecurity, highlighting the challenges faced by farmers with limited coping mechanisms (Brown et al., 2023). District has three major agro-ecological zones. These are Lowland with 56%, Midland with 33% and highland altitude with 11%. The district experiences two distinct seasons - the dry season (October to March) and the rainy season (April to September). The mean annual temperature ranges from 12 to 23 °C while mean annual rainfall is between 900 and 1,800 mm and is concentrated into one season. In the study area , high experiences of climate variability suck as less amount of precipitation, high intensity of heats, and Climate shocks like Drought and floods. Therefore, this research such as part of a more recent strand of adaptation research which seeks to identify the determinants of adaptation strategies to climate variability by smallholder farmers in the study area.

1.2 Statement of the problem

Climate change and variability lead to food and water shortages, energy availability issues, and how these factors contribute to increased poverty and limited educational attainment (Patel et al., 2021). Sub-Saharan Africa's dependence on agriculture and natural resources, coupled with weak adaptive capacity, exacerbates its vulnerability to climate change (Njenga et al., 2022). Different sectors of Ethiopia's economy, particularly agriculture, are affected by climate variability (Gebremariam et al., 2024). Ethiopia’s geographical and topographical conditions, combined with its nature-dependent agricultural sector and low adaptive capacity, heighten its vulnerability to climate change impacts (Mekonnen et al., 2022). Provides a comprehensive review of climate-related hazards in Ethiopia, detailing the impacts of droughts, floods, heavy rains, and other extreme weather events (Aklilu et al., 2023).

Adaptation to climate change is an essential strategy for reducing the severity and cost of climate change impacts. Various adaptation strategies that help farmers cope with rising temperatures and declining precipitation, including technological and management practices (Thompson et al., 2023). Different socio-economic, cultural, and institutional factors influence adaptation processes and human-environment interactions in the context of climate change (Green et al., 2023). How adaptive capacity, access to knowledge and skills, the robustness of livelihoods, available resources, and institutional support influence the effectiveness of climate adaptation strategies (Anderson et al., 2023). Knowledge about climate variability access to assets and technology, as well as institutional and policy factors, shape adaptive capacity. It also highlights the impact of environmental perceptions on adaptation strategy adoption (Patel et al., 2023).

Chiro woreda is one of the vulnerable districts to climate change and variability in west Hararghe zone which poses a major threat to farmers in the district due to their over powering dependency on small-scale agriculture (woreda Agriculture Office, 2022). Regarding to the study area some experience indicates that climate change parameters or proxy indicators like frequent drought occurrence, erratic rain fall, increased temperature, low agricultural production and productivity, change of cropping pattern and seasons, draying of water sources, occurrence of unusual diseases, change of species or biodiversity, changing of soil humidity are some indicator for the adverse impact of climate change (woreda Agriculture Office, 2022). As Agriculture is the main source for their livelihood of the district, smallholder farmers face drought frequently that negatively impacts their agricultural production and socio economic status due to climate change. The rapidly growing number of population in the district increase the demand of food, resources, land and other basic needs for life, especially, during drought time and the problem will become very challenging for the community especially children & women fall in a state of severe malnutrition than others (woreda Agriculture Office, 2022).

Adaptation responses of smallholder farmers to climate change and variability and discuss how understanding these responses can lead to more effective adaptation measures (Robinson et al., 2022). Different studies regarding Impacts of Climate Variability on the Livelihood of smallholder farmers and Determinates of adaptive Capacity were carried out in different countries including Ethiopia. However, most of the studies were undertaken at a macro level which might make the results vague to generalize about specific households.

So in the study area still there is the lack of studies regarding to determinants of adaptation strategies to climate variability by small holder Farmers in the study area. Even though there have been many implemented governmental & non-governmental programs and projects that enhance strategies for adaptation measures, which indicate that relief agent provide evidence that there is no enough agricultural production which is Local farmers can't produce enough to meet their subsistence foods requirement due to effects of climate variability**,** has a particularly negative influence in locations where rain-fed agriculture is practiced. Smallholder farmers, in particular, Response to climate change through adaptation however, appears to be weak. It seems that there is a gap between the rate at which climate is changing and the response to reduce its effects through employment of adaptation strategies that ensure sustainable food security by Chiro Woreda farmers

Chiro Woreda highly experiencing climate variability such as late onset and early termination, less amount of precipitation and erratic pattern of precipitation, high intensity of heat for prolonged period of time, and extreme climatic shocks like droughts and floods which leads to reduce the agricultural production of the smallholder farmers, micro-level studies at the farm level on how rural smallholder farmers perceive these Climate variability and how they are responding to the effects of a climate variability are limited. Additionally, due to the lack of information and knowledge of farmers about variation of temperature and rainfall, the farmers deforests tree for expansions of agricultural land is the major problem in study area again. So knowledge and perception of smallholder farmers about climate variability are vital to improve adaptation strategy, productivity and environmental condition. As to the knowledge of the researcher, there were very few researches conducted on the determinants of adaptation strategies to climate Variability by smallholder farmers in this study area. Hence, considering this knowledge gap, the researcher would study on the local level determinants of adaptation strategy to climate variability by smallholder in the study area by using cross sectional research method to come up with solution among the farmers in the study area

1.3 Objectives of the study

1.3.1 General Objective

The general objective of this study was to identify determinants of adaptation strategies to climate variability by Small holder farmers in Chiro Woreda of West Hararghe Zone, Oromia Regional State, Ethiopia.

1.3.2 The specific Objectives of this study was.

1. To assess the perception of Smallholder farmers about the climate variability on the study area
2. To assess the effects of climate variability on the livelihood of smallholder farmers
3. To identified factors that determine adaptation strategy of smallholder farmers to respond the impacts of climate variability

1.4. Research Questions

The following are key questions the research tried to address:

1. How smallholder farmers perceive climate variability?

2. What are the effects of climate variability on livelihoods of smallholder farmers in the study area?

3. What are the majors factors that determine smallholder farmers choice of adaptation strategy in the study are?

1.5 Significance of the study

Climate variability has become a serious challenging factor for the implementation of the country development strategies. Even though climate variability is affecting the whole world, the extent differs from region to region and from locality to locality. Similarly, Adaptation strategy differs from community to community. These together indicate the fact that local studies are necessary to understand the extent of climate variability and Determinants of adaptation strategy at different levels and different coping mechanisms that may be replicated and used as remedial measures in other similar occasions. This paper had identify the determinants of adaptation strategies to climate Variability by smallholder farmers in Ethiopia, Oromia regional states, West Hararghe, in the case study of Chiro woreda. Therefore, this study will benefit policymakers, researchers, governmental and non-governmental organizations, private sectors, extension agents and farmers who have stakeholders participating in the designing and developing adaptation strategies based on specific agro-ecological zone

1.6 Scope of the study

The study was conducted in west Hararghe zone in Chiro District. The scope of the study covers three kebeles (*Tayfe, Madhicho no-2 and Lugo-bachesa)* of the district from three agro ecology highland, midland and lowland respectively. Similarly, the study was restricted on the effect of climate variability on local farmer's livelihoods and their adaptation strategy. This was because, farmers of these kebeles were highly dependent on rained agriculture and livestock rearing in which mostly affected by climate change and variability in the study area.

1.7 Limitation of the study

This study had limitation in relation to number of sample size; this is mainly because of absence of the HHHs at their home during the survey and constraints of money. The other challenge encountered during the survey was shortage of secondary data and unwillingness of some officials to be interviewed. The other limitation of the study is that there is only one meteorological station in adjacent district namely me'eso wereda. Lack of related literature in study area was takes as limitation for this study.

1.8 Organization of the Thesis

The study is organized in five parts. The first part back ground part. The second one review important literatures related with climate variability, agriculture, and adaptation. The approaches and methods applied in the analysis are presented in the third part. The fourth part presents and discusses the results of the analysis. Summery, Conclusions and implications for Adaptation strategies are presented in part five.

2. LITRATURE REVIEW

2.1 Definition and Concepts of Climate Change and Variability

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Greenhouse gas emissions from fossil fuels, deforestation, and industrial activities are driving global warming, with substantial impacts on weather patterns and ecosystems (IPCC, 2023).Ongoing and future climate changes will influence biodiversity, water resources, and human societies, emphasizing the importance of adaptation and mitigation strategies (Schneider et al., 2024).

The change of climate could be slow and gradual, rapid and catastrophic, short-term or long term could be at local, regional and global scales; and it could be due to natural factors or anthropogenic factors. The overwhelming majority of climate change researchers have reached the understanding-based on decades of evidence, modeling, and debate that it is extremely likely that human activities are responsible for the rising temperatures on Earth. Different behavioral factors, such as risk perception, social norms, and cognitive biases, influence climate change mitigation and adaptation strategies (Raube et al., 2021). Climate Variability is variations in the mean state and other statistics (such as standard of deviations, the occurrence of extremes, etc. of the climate on temporal and spatial scales beyond that of individual weather events. Internal climate variability, such as oceanic and atmospheric oscillations, has influenced recent trends in global warming (Rahmstorf et al., 2022).Historical climate variability, current trends, and future projections using an extensive dataset spanning several centuries (Trenberth et al., 2021).

The variability of climate could be slow and gradual, rapid and catastrophic, short-term or long term could be at local, regional and global scales; and it could be due to natural factors or anthropogenic factors. Agricultural practices and expansion contribute to GHG emissions. It assesses the relationship between agricultural land use and climate change, highlighting potential mitigation strategies (Bohn et al., 2023).Most important GHSs are emitted from electric power station, various industries, the transport sector and deforestation due to human activities. These activities increase the concentration of different greenhouse gases. In-depth analysis of historical GHG emissions data, focusing on the contributions of CO_2, CH_4, N_2O, and CFCs. It compares past emission shares with more recent data to show how the relative importance of these gases has evolved (David et al., 2021).

In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate. Evidence of observed climate change impacts is the strongest and most comprehensive for natural systems. Some impacts on human systems have also been attributed to climate change, with a major or minor contribution of climate change distinguishable from other influences. Climate change impacts vary across different regions due to local climate variables and socio-economic conditions. The paper highlights the complexity of attributing specific impacts to climate change at local scales (Hayhoe et al., 2021).

2.2 Global Overview of Climate Change and Variability

Climate change is a widespread challenge affecting many parts of the world. How climate change affects ecosystems, agriculture, water resources, and human health. It highlights the interconnectedness of environmental and societal impacts (Parmesan and Mann , 2021). The change in climate will appear and will have important positive or negative impacts on rain fed crop production. Climate change has raised much concern regarding its impacts on future global agricultural production varying by region, time, and socio-economic development path (Liambila et al., 2016). According to the Intergovernmental Panel on Climate Change (IPCC, 2021).It confirms that human influence has been detected in various aspects such as atmospheric and ocean warming, changes in the global water cycle, reductions in snow and ice, global mean sea level rise, and changes in climate extremes. The report asserts that it is extremely likely that human influence is the dominant cause of the observed warming since the mid-20th century.

Future projections of climate change depend upon the path of future emissions. Even if all emissions of GHSs were ended today, the world would continue warming over the next few decades because the ultimate environmental effects of emissions are not realized immediately. Projections of future global mean surface temperature increases. The IPCC

(2021) states that for the period 2081–2100 relative to 1986–2005, global mean temperatures are projected to likely exceed 1.5°C and could be as high as 4.8°C depending on future emission scenarios. The Arctic region will warm more rapidly than the global mean, and mean warming over land will be larger than over the ocean.

2.3. Overview of Climate Change and Variability in Ethiopia

Climate change will be manifested through changes in climatic and atmospheric factors (rainfall, temperature and CO2 concentration), and a host of other changes and interactions. Provides projections of future temperature increases across Africa. It highlights that under high emission scenarios, the mean annual temperature is likely to exceed 2°C by mid-century (Adjemian et al., 2022).Changes in precipitation will be less uniform across the continent, with a varying degree of consensus between models across the regions. For southern Africa, most projections suggest a drying of the climate. For eastern Africa, however, an opposite trend is projected, with the Ethiopian highlands in particular likely to witness an increase in average and extreme rainfall. the variability and divergence in climate projections across West Africa. It analyzes how different climate models produce varying predictions for temperature and precipitation changes in the region (Akinyemi et al., 2022).Examines recent trends in weather variability and extreme events, highlighting the growing confidence in projections despite remaining uncertainties.

The research focuses on how different models predict changes in the frequency and intensity of extreme weather events (Allen et al., 2022). Ethiopia's topography is characterized by large regional differences which are the main factor for high annual variation of precipitation. The country has three rainy seasons: June–September (kiremt), October–January (bega), and February–May (belg). Kiremt rains account for 50–80 percent of the annual rainfall totals and most severe droughts usually result from failure of the kiremt. The lowlands in the southeast and northeast are tropical with average temperatures of 25°– 30°C while the central highlands are cooler with average temperatures of 15°–20°C. Lowlands are vulnerable to rising temperatures and prolonged droughts, while highlands are prone to intense and irregular rainfall (NCEA, 2015).The various climate changes impacts Ethiopia faces, including erratic rainfall, severe droughts, and floods. It highlights the country's vulnerability due to its reliance on rain-fed agriculture and limited adaptive capacity (Daniel et al., 2021).

The country has frequently experienced extreme events like droughts, floods, and other climate related hazards. The variability of rainfall and the increasing temperature are blamed for the frequent droughts that at times lead to famine and affect livelihood of the people. Since the early 1980s, Ethiopia has suffered seven major droughts, five of which led to famines in addition to dozens of local droughts. Major floods also occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996 and 2006. Climate change influences flooding patterns, referencing historical flood events for context (Lee and Zhang , 2022).

According to Oxfam International (2016), climate changes can result in numerous extreme events like drought mostly in developing countries including Ethiopia, which experienced worst droughts for 50 years and also has left many poor and vulnerable families with nothing. The El Niño weather system, exacerbated by climate change, comes off the back of 12 to 18 months of erratic or failed rains. It led to crop failures of the 2015 meher harvest of between 50 and 90 percent, particularly in the eastern part of the country including Oromia Regions; the El Niño has dried up many water sources. Hundreds of thousands of livestock have died and malnutrition is at alarming levels. Crop agriculture is dominated by small-scale subsistence farmers who remain heavily dependent on rain, employ low-intensive technologies and lack access to services. This leaves the sector highly vulnerable to changing rainfall and other climate patterns. Limited water storage capacity further increases vulnerability to climate risks. Crop productivity may increase in the short term due to warmer temperatures, but continued high temperatures will result in heat stress and crop failure. By one estimate Ethiopia may forgo over 6 percent of its agricultural output annually if the current trends in rainfall decline persist (Mastrorillo et al., 2023).

2.4. Impacts of Climate Variability

2.4.1. Impacts on Crops Production

Climate change is exacerbating the challenges faced by the agriculture sector. Climate change induced increases in temperatures, rainfall variation and the frequency and intensity of extreme weather events are adding pressure on the global agriculture system, which is already struggling to respond to rising demands for food and renewable energy (OECD, 2015). Besides, agriculture is sensitive to climate, even under current conditions. Both mechanized and subsistence farming systems are affected by current climate variability and future climate change (Mastrorillo et al., 2021).

According to UNDP (2021), rising winter temperatures and reduced frost days may benefit certain crops while negatively impacting others due to increased summer temperatures These include: a) Temperature: Higher winter temperatures and less frost days may mean that some crops benefit. However, other crops may suffer from higher summer temperatures. The shifts in temperatures may shift the ideal planting and harvesting times for some crops or shift the type of crop varieties which should be grown. Temperature can also have a direct impact on livestock health and reproduction. b) Precipitation and soil moisture: an increase in average global temperatures will also mean an increase in the intensification of the global water cycle. Higher temperatures will mean more evaporation, and possibly more intense rainfall in some regions which can lead to flooding. Other regions may however experience longer spells of drought. The changes to the water cycle are critical to consider when examining the agricultural sector. c) Climate change and extreme events: while long-term changes in the average climate may require adaptation measures, greater risks to food security may be posed by changes in year-to-year variability and extreme events.

Extreme temperatures, droughts and floods may result in greatly reduced productivity, and in some cases crop failure. Negative impacts of climate trends on crop production, noting the prevalence of adverse effects and price spikes following extreme weather events (Lobell et al., 2021), with negative impacts more common than positive ones, including several periods of price spikes following climate extremes in key producing regions. Negative impacts of climate change on wheat and maize yields across various regions, as well as at a global scale (Lobell et al., 2021). Impacts of climate change on agricultural revenues globally, indicating that rising temperatures and changing precipitation patterns are likely to reduce incomes for producers, particularly in vulnerable regions (Nelsonet et al., 2021), summarize the results of a series of studies of projected impacts of climate change on agricultural revenues. They stated that impacts of climate change are generally found to be negative across a wide range of locations, temperature increases and assumptions. In another recent study modeling the potential effects of climate change on agricultural incomes across a wide range of farming systems in Central Asia, the authors found positive income gains for large-scale commercial farmers in northern Kyrgyzstan, but negative impacts for small-scale producers in arid areas of Tajikistan.

Climate change and variability are likely to severely compromise agricultural production in various African countries, adversely affecting food security and increasing malnutrition rates (Gaillard, 2021).Agricultural yields and dependence on natural resources constitute a large part of local livelihoods in many African countries. Agriculture is a major contributor to the current economy of most African countries, averaging 21% and ranging from 10% to 70% of GDP with indications that off-farm income augments the overall contribution of agriculture in some countries. In Niger and Ethiopia, both rainfall and maximum temperature variability appear to exert a negative impact on consumption expenditure, household income and food security, which points towards the absence of income-smoothing behavior. In Uganda, however, the limited impact of climate shock on household welfare together with highly significant effects of other socio-demographic and wealth indicators could indicate a consumption and income-smoothing behavior. In most of the East African countries, disparities in how different income groups are affected by rainfall deficits, emphasizing the heightened vulnerability of lower-income rural households (Lindgren et al., 2022).

2.4.2. Impacts on Livestock Production

Increased temperatures impact feed intake, animal physiology, and subsequently affect growth, health, fertility, and milk production in livestock (Zhao et al., 2021). Although the exact impact of heat stress in animals is not well established for the tropics it is likely that with increased temperatures, African livestock keepers may have to shift to more heat tolerant breeds or species. Livestock are indirectly affected by changes in forage and crop residue production and grazing resources.

Livestock are a major asset among rural communities, providing a range of essential services, including saving, credit and buffering against climatic shocks and other crises. Beyond agriculture and food security, the income from livestock thus directly contributes to education and human health. The prevalence of livestock keeping in SSA, noting that more than half of the population engages in livestock production and discusses the challenges faced by poor livestock keepers (Thornton and Herrero, 2020).Increasing temperatures and humidity levels could lead to a significant rise in cattle mortality, estimating an increase of up to 60% (Crescio, 2021). Serious drought events in SSA have led to livestock losses ranging from 20% to 60% over the past few decades and discusses potential reductions in dairy yields (Thornton and Herrero , 2021),reported that dairy yields may decrease by 10 to 25 percent under certain climate change scenarios.

In South Africa, another case study reported by the same authors estimated a 23 percent rise in the cost of supplying water to animals from boreholes in Botswana. According to FAO (2021), Direct and indirect effects of climate change on livestock production, detailing how changing climatic conditions impact animal health, feed availability, and overall productivity. Climate change affects livestock production in multiple ways, both directly and indirectly. The direct effects of climate change will depend very much on the livestock production and housing system, with high-output breeds in confined systems being better protected from natural adversities than breeds in extensive grazing systems. The need for increased production efficiency while reducing the environmental footprint of livestock will continue to be major future challenges.

2.4.3. Social Impacts

2.4.3.1. Impacts on Education

Educational system should be oriented towards resolving socioeconomic constraints of the country or region. However, during climate change induced impacts such as prolonged droughts and flooding, schools would become victims of climate shocks and hazards, hence vulnerable to climate change impacts. Consequently, change disrupts educational processes, leading to school closures and increased dropout rates, particularly in vulnerable regions (Mastrorillo et al., 2021). As study conducted, for example, in west Arsi zone, Increase in student dropout rates in Siraro district, noting that dropouts rose from 2% during normal conditions to 21.76% during drought events. (Hailu and Getachew, 2021). Moreover, low class attendance, late coming and early departure, low educational achievement and high teacher turnover was also indicated in the report. In addition, another study reported by (Senbeta, 2008) has showed that more student dropouts and poor educational performance took place during the drought events due to climate change imposed drought and famine or malnutrition. Considering the importance of child health and education for long-term prospects, productivity and income, even a moderate impact of climate change on these dimensions could affect poverty visibly over the long-term. Moreover, since poor households are suffering disproportionally from impacts, it would increase the poverty legacy and reduce the chance for children from poor families to escape poverty, reducing further social mobility. Climate change exacerbates vulnerabilities for female-headed households and those with limited access to resources, highlighting the intersection of gender and poverty (Kabeer and Sweeney, 2021).

2.4.3.2. Impacts on Human Health

Climate variability will affect human health and well-being through a variety of mechanisms. Climate variability adversely affects fresh water availability and the efficiency of sanitation systems, highlighting implications for public health (Lal and Kaur, 2021). Impacts of climate change on the prevalence of diseases such as malaria, tuberculosis, and diarrhea in Africa, highlighting the region's vulnerabilities (Kangalawe and Njunwa,2021).

Rising temperatures and climate variability are shifting the geographical distribution of malaria vectors, exposing new populations, particularly in the East African highlands (Mordecai et al., 2020).Health challenges are not limited to shocks: malnutrition can be a chronic condition linked to usual economic and climate conditions. Climate change could lead to an increase in moderate stunting of 1-29% by 2050 in Sub-Saharan Africa, with severe stunting projected to increase by up to 23% in SSA and 62% in South Asia (Sanchez et al., 2021), estimated that climate change will lead to an increase in moderate stunting of 1-29% by 2050 in compared to a future with no climate change while severe stunting could increase by up to 23% in SSA, and 62% in South Asia even. Climate change also causes scarcity of water resources and severe floods that leads to outbreaks of waterborne diseases. Various health issues in African countries attributable to climate change, including increased incidence of vector-borne diseases and heat-related illnesses (Haines and Ebi, 2021). Moreover, UNECA also justified that, Africa is the most susceptible continent to climate change related to health problems due to the existing poverty and weak institutions to deal with health challenges posed by climate change.

In Oromia National Regional State, existing linkages between impacts of climate change and human health related diseases show strong relationships, where with increased droughts and climate stresses, human diseases occurrence and prevalence marked increasing trend. Approximately 65% of Oromia's population is affected by malaria, resulting in around 1 million clinical cases annually (Tadesse and Godefay , 2021). In an effort to curb the hitch, the regional health bureau implemented the national malaria prevention and control strategies. Nonetheless, lack of adequate human resources, analytical skills, and inadequate and inconsistent reporting hindered the region from further attainment.

2.5. Projected Negative and Positive Effects of CCV

2.5.1. Projected Negative Effects

According to report of IPCC (2021), effects of projected carbon dioxide doubling, including loss of land area, species, and forest, as well as health impacts, agricultural losses, and disruptions in weather patterns . Some of the predicted effects are: (a) loss of land area, including beaches and wetlands due to sea-level rise, (b) loss of species and forest area, including coral reefs and wetlands, (c) disruption of water supplies to cities and agriculture, (d) health damage and deaths from heat waves and spread of tropical diseases (e) increased costs of air conditioning, (f) loss of agricultural output due to drought, (g) disruption of weather patterns, with increased frequency of hurricanes and other extreme weather events,(h) sudden major climate changes, such as a shift in the Atlantic Gulf Stream, which could change the climate of Europe to that of Alaska and (i) positive feedback effects,18 such as an increased release of carbon dioxide from warming arctic tundra, which would speed up global warming.

Climate change is expected to affect food and water resources that are critical for livelihoods in SSA where much of the population, especially the poor rely on local supply systems that are sensitive to climate variation .Rising temperatures and changing precipitation patterns are significantly reducing access to food in SSA, exacerbating food insecurity (Vermeulen et al., 2021). Climate change will have huge effects on rain fed agriculture such as for instance, in Ethiopia, crop productivity, among other agricultural activities, continued high temperatures will result in heat stress and crop failure. By one estimate, Ethiopia could lose more than 6% of its annual agricultural output if the current trends of declining rainfall persist (Seyoum and Degu , 2021).

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2.5.2. Projected Positive Effects

Positive effects of climate change and variability might include: increased agricultural production in cold climates, lower heating costs, less deaths from exposure to cold, modest reductions in cold related mortality and morbidity in some areas due to fewer cold extremes, geographical shifts in food production, and reduced capacity of vectors to transmit some diseases. The negative impacts of climate change will increasingly outweigh any potential positive effects as the century progresses (IPCC , 2021).As a result of climate change, changes in agricultural productivity, with gains in some places will affect the income of workers in the agricultural sector, and therefore poverty in countries such as Burundi, Burkina Faso, Ethiopia, Mozambique, Sierra Leone, and Tanzania. Over 75% of workers in many countries are engaged in agriculture, with a significant proportion of poor adults relying on farming, underscoring the importance of agricultural income for poverty reduction (WB, 2021).

2.6. Adaptation Strategies to Climate Variability

Adaptation is used to increase food security through increased agricultural productivity through strategies of risk management, diversification and sustainable intensification. Risk management typically aims to reduce the variance of an outcome (e.g. crop yield), whereas intensification primarily aims at increasing the mean of the outcome. Diversification may lead to a shift in both the variance and the mean. Improved management practices in crop and livestock systems can enhance productivity while contributing to climate change

mitigation (Thornton et al, 2021). Risk management strategies, such as choosing adapted animal types and breeds, may decrease greenhouse gas emissions rates because of a smaller proportion of non-productive animals in the herd.
Agro forestry as an effective diversification strategy that enhances feed quality through leguminous trees and shrubs while also contributing to carbon sequestration (Nair.et al., 2021). Non-agricultural livelihoods can enhance resilience among agricultural communities, particularly in light of population growth and climate change impacts (Rural Futures Institute, 2021).Various barriers to adaptation, highlighting how social, economic, and institutional contexts can hinder effective climate response strategies (Adger et al., 2021), adaptation to climate change has many barriers, which emanate from different social, economic and institutional situations.

The most important factor mentioned as barrier to adaptation is lack of information about climate change and adaptation strategies. This is attributed to various factors including lack of institutional support mechanisms and failure to mainstream the issue of climate change in the public extension system of the country. Lack of farm inputs including seed, chemical fertilizer and oxen are the second most important impediments. Both on-farm diversification, including mixed crop-livestock systems, and off-farm diversification through non-agricultural jobs as essential components of effective climate change adaptation (Hassan and Nhemachena, 2023). As reported by IPCC (2023), the urgent need for adaptation strategies in Africa to address the adverse effects of climate change, focusing on various sectors including food security and ecosystems In the short term, integrating climate change adaptation and disaster risk reduction will help withstand shocks to human security and economic development. The same report indicates that, African governments, businesses and communities can do much to anticipate and reduce risk, rather than reacting after impacts have occurred. Support for effective disaster relief and recovery needs to continue, along with proactive efforts to reduce risk, such as integrating comprehensive risk assessments and risk reduction measures into national economic and development policy.

The bulk of climate change impacts and thus adaptation costs will occur after 2030. For example, the annual costs for Africa in 2030, based on current policy projections, is expected to be 15 USD 2012 billion, but it is expected to grow to 35 USD 2012 billion in 2040, and to 70 USD 2012 billion in 2050. Agricultural production and associated wages contribute significantly to household income across different farm sizes, emphasizing their role in rural economies (WB, 2021).Migration can serve as a coping mechanism for communities affected by climate change, helping to mitigate welfare impacts from extreme weather events (Rigaudet etal., 2021).In that case, migration increases the set of opportunities available to an individual or household, improving wellbeing and prospects. However, there is some evidence that the poorest households have lower capacity to migrate, and may therefore be unable to use this option. This is also the case for households in conflict and fragile areas, or those facing exclusion. Ethiopia is already implementing the adaptation options as reflected in its draft Climate Change Adaptation Action Plan of Water and Energy Sector, the Ethiopia's National Adaptation Programmed of Action (NAPA) and Ethiopia's Programmed of Adaptation to Climate Change (EPACC), the Water Sector strategy and also in the 5-year Growth and Transformation Plans (GTPs). The following are further examples of adaptation options that the need for improved access to water and ecosystem services in Ethiopia, advocating for rainwater harvesting, water transfer schemes, and increased storage capacity (Mekonnen and Hoekstra, 2021).

Ethiopia needs to adapt to climate change since its mainstay economic sector, agriculture, is highly susceptible to climate shocks. Currently, the country is implementing the Climate Resilient Green Economy (CRGE) strategy to achieve the vision of becoming a low carbon; middle income economy by 2025. This strategy will also enable the country to strengthen its capacity to adapt to the effects of climate change. The CRGE strategy as a framework to enhance resilience against climate change impacts while promoting sustainable economic growth (FDRE, 2021).

2.7 Determinant of Adaptation Strategies

As indicated here below we there are several determinants of adaptation strategy. Adaptation to climate change and risks takes place in a dynamic social, economic, technological, biophysical, and political context that varies over time, location, and sector. This complex mix of conditions determines the capacity of adaptation strategies. The main features of communities or regions that seem to determine their adaptive capacity, economic wealth, technology, information, skills, infrastructure, institutions, and equity. A key determinants of both adaptation and mitigation efforts in Ethiopia, highlighting socio-economic and environmental factors (Mastrorillo et al., 2021).

2.7.1. Economic Resources

Whether it is expressed as the economic assets, capital resources, financial means, wealth, or poverty, the economic condition of nations and groups clearly is a determinant factor that can negatively affect climate change adaptation and mitigation capacity or strategy. Financial means and economic conditions serve as significant determinants of climate adaptation and mitigation strategies (Bhowmik and Gupta, 2022).

2.7.2 Technology

In addition to the above lack of technology has the potential to seriously hinder a nation’s capacity to implement adaptation options by limiting the range of possible responses, technological limitations restrict the adaptation options available to nations, particularly in developing contexts (Liu, 2021). Adaptation option is likely to vary, depending on availability and access to technology at various levels (i.e., from local to national) and in all sectors. Many of the adaptive strategies identified as possible in the management of climate change directly or indirectly involve technology (e.g., warning systems, protective structures, crop breeding and irrigation, settlement and relocation or redesign, flood control measures).Hence, a community’s current level of technology and its ability to develop technologies are important determinants of adaptive capacity. Moreover, openness to the development and utilization of new technologies in improving adaptive capacity for sustainable resource management (Mastrorillo et al., 2021).

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2.7.3. Information and Skills

Successful adaptation requires recognition of the necessity to adapt, knowledge about available options, the capacity to assess them, and the ability to implement the most suitable ones. In the context of climate variability and change, this idea may be better understood through the example of the insurance industry: As information on weather hazards becomes more available and understood, it is possible to study, discuss, and implement adaptation measures. Building adaptive capacity requires a strong, unifying vision; scientific understanding of the problems, an openness to face challenges, pragmatism in developing solutions, community involvement and commitment at the highest political level. Lack of trained and skilled personnel can limit a nation’s ability to implement adaptation options. In general, countries with higher levels of stores of human knowledge as a determinant of adaptive capacity, comparing developed and developing nations (Mastrorillo et al., 2022).

Includes illiteracy along with poverty as a key determinant of low adaptive capacity in northeast Brazil. Such findings have prompted. To ensure that systems are in place for the dissemination of climate change and adaptation information nationally and regionally and that there are forums for discussion and innovation of adaptation strategies at various levels.

2.7.4. Infrastructure

Adaptive capacity is likely to vary with social infrastructure. Some researchers regard the adaptive capacity of a system as a function of availability of and access to resources by decision makers, as well as vulnerable subsectors of a population. For example, Significant contribution of hydroelectric power to Mindanao’s electricity generation and its impact on local development Madrigal and Cabral (2021).

2.7.5. Institutions

The role of institutions is as a means for holding the society together and enabling to adapt the problem. In general, countries with in strong social institutions in improving adaptive capacity, particularly in the context of developing and transitional economies (Aldunce et al., 2022).

Institutional constraints limit entitlements and access to resources for communities in coastal Vietnam and thereby increase vulnerability. Bangladesh is particularly vulnerable to climate change especially in the areas of food production, settlements, and human life reflecting serious constraints on adaptive capacity in the “existing institutional arrangements (which) is not conducive to ease the hardship of the people. It is generally held that established institutions in developed countries, water management institutions over the past 25 years and their capacity to facilitate adaptive responses to climate change (Pahl-Wostl et al, 2022).

2.7.6. Equity

It is frequently argued that adaptive capacity will be greater if social institutions and arrangements governing the allocation of power and access to resources within a community, nation, or the globe assure that access to resources is equitably distributed. The extent to which nations or communities are "entitled" to draw on resources greatly influences their adaptive capacity and their ability to cope. In general, various determinants of adaptive capacity, emphasizing how economic, social, institutional, and technological factors influence the effectiveness of adaptive measures (Mastrorillo et al., 2021).

2.8. Conceptual Framework

The increasing trend of climate change has led to growing concern on its impact on different sectors of the economy particularly on agriculture. Coping with the vulnerability and negative effects of climate change on agriculture requires mitigation at the policy level and adaptation at the farm level. Adaptation does not occur without influence from other factors such as socio-economic, cultural, political, geographical, ecological and institutional that shapes the human-environment interactions. However, the ability of farmers to adopt the various adaptation strategies constrained by a number of factors. Therefore, this study identified the micro-level climate adaptation strategies adopted by farmers in Chiro woreda and subsequently examined the determinants of farmers' adoption of adaptation strategies to climate variability.

To respond to these changes, farmers have adopted crop diversification, planting different crop varieties, changing planting and harvesting dates to correspond to the changing pattern of precipitation, irrigation, planting tree crops, water and soil conservation techniques, and switching to non-farm income activities. The major factors identified to be driving farmers' investment in adaptation practices were age, level of formal education and level of awareness of climate change issues. The major factors constraining them from adapting to climate Variability were poverty; farmland scarcity and inadequate access to more efficient inputs, lack of information and poor skills, land tenure and labor constraint

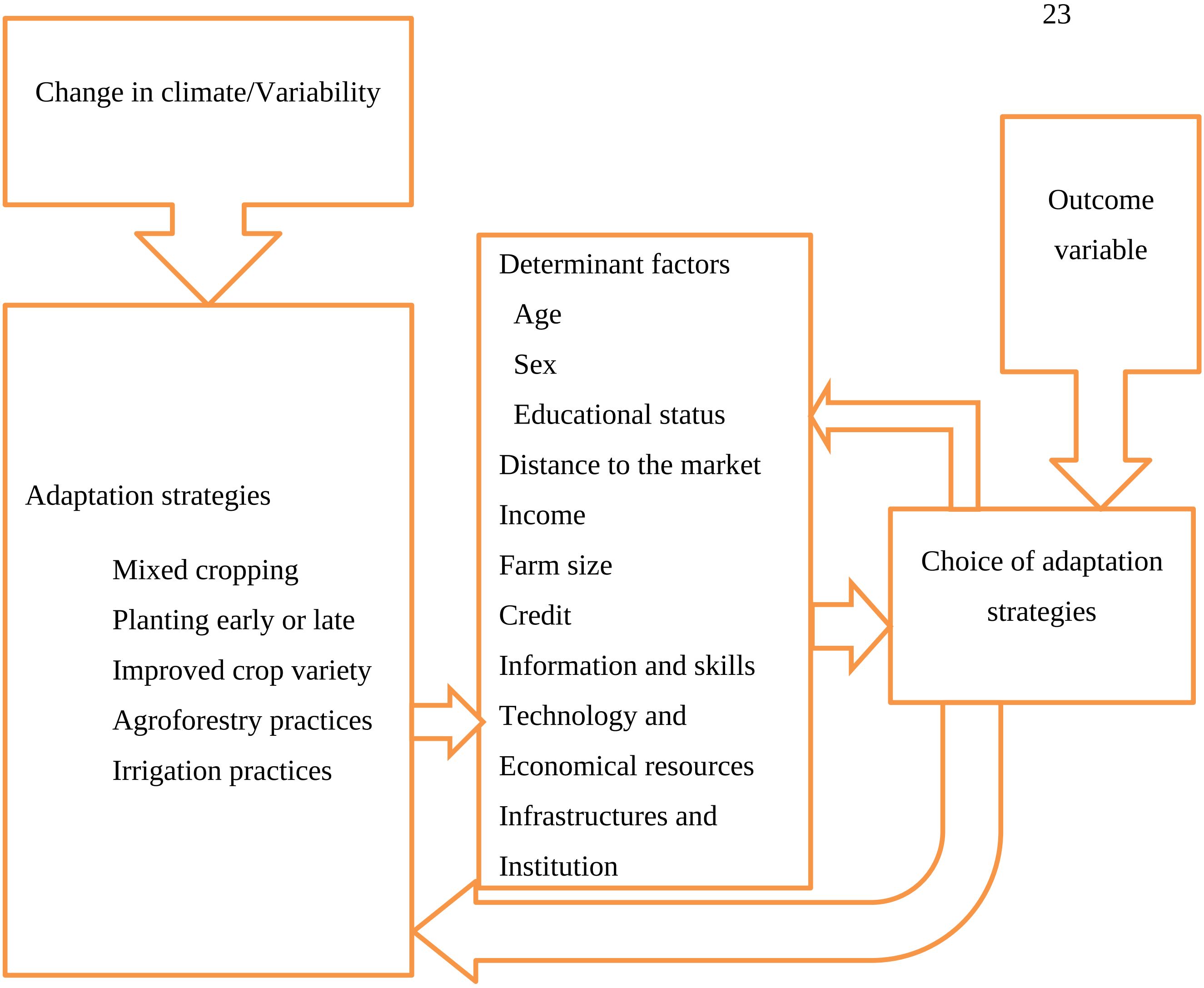

Figure1; The conceptual framework of the study

Source: Adapted from (Deressa etal,2009)

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

3.1.1 Location

The study was conducted in a rural community of Chiro district, West Hararghe zone, Eastern Ethiopia. Chiro district is one of the 16 districts found in West Hararghe zone. The town of Chiro district is Chiro by itself for the district and west Hararghe zonal administration which is located at 324 km away from Addis Ababa; capital city of Ethiopia. Geographically, it is located between 10°24′N and 10°66′N latitudes, and between 38°43′E and 38°81′E longitudes It is bordered by Gemmachis and Oda bultum district in south East, Masala in north East, Mi'esso and Gumbi Bordodde in West and Guba Koricha in south west direction. The districts has a total land area of about 70962.834km^2. The geographical location of Chiro district and study area on the map of Ethiopia is represented as indicated in the figure below.

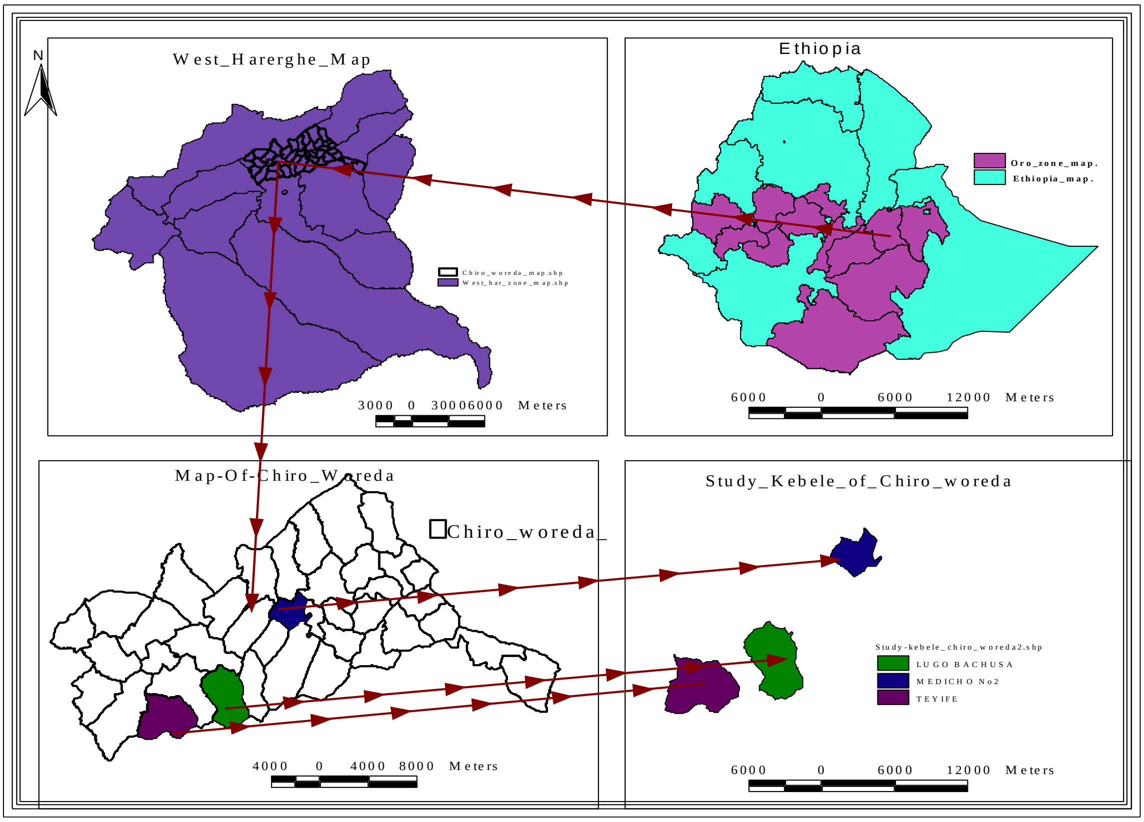

Figure 1: Map of the Study Area

Sources; Chiro woreda land use and Administration offices

3.1.2. Topography and Soils

According to 2020 report of west Hararghe Zone agricultural department, the astronomical location of the Chiro district is approximately 8.370-8.980 N and 42.010-42.460 E latitude and longitude respectively. From the total land area/topography of the district 45% is plain and 55% steep slope (data from Office of Agriculture and Rural Development of the district). The district is mainly characterized as steep slopes and mountains with rugged topography, which is highly vulnerable to erosion problems. In the district there are sandy soil, clay soil (black soil) and loamy soil types covering 25.5%, 32%, and 42.5% respectively according to 2012 E.C data from Office of Agriculture and Rural Development. The soil types vary with the topography mainly black soils are observed in the highland and midlands while one can see red soil in the lowland areas.

3.1.3. Climate

Normally the district is divided into three major agro-ecological zones. These are Lowland with 22 kebeles, Midland with 13 kebeles and highland altitude with 4 kebeles.The district experiences two distinct seasons - the dry season (October to March) and the rainy season (April to September). The mean annual temperature ranges from 12 to 23 °C while mean annual rainfall is between 900 and 1,800 mm and is concentrated into one season.

3.1.4. Demographic characteristics

The district inhabited a total population of 207,553 of which 106,277 were males and 101,276 were females. From these 192, 194 are rural dwellers and 15,359 are urban dwellers (CSA , 2020). The district known to have a heavy population density per square kilo meter. According to Chiro woreda Agricultural & Natural Office, (CWAO, 2018) .Information from Chiro woreda Health Office, (CWHO , 2018), an average family size of a house hold in the district was 5 with fertility rate per women is 5.9 of which 3.3 is for urban and 6.4 for rural & growth rate is estimated to be 2.9%. Data obtained from West Harerghe CSA Office (WHCSAO) on age classification show, 97,549 (47%) are below 15 years of age while 4981(2.4%) are above the age of 65 years & economically active groups (15-64 years) is 103776(50%).In addition, as per the woreda, the total household of the

District is 41,510 out of which 31,133 are males and 10,376 is females. The average family size of the woreda's population is 4.9.

3.1.5. Socio-economic characteristic of the study area

Agriculture is the main economic activity and source of livelihood in the study area. Land is the most important asset of households for the productions of crops and rearing of animals. Mixed crop livestock farming system is subsistence which covers about 98% while the remaining 2% are pure pastoralist. Major food crops of the area are cereal crop such as sorghum, maize, haricot bean and a chickpea, moreover, chat is dominants cash crops. Livestock comprising small and large ruminants such as: goats, sheep and cattle are also an important source of household income and food. Overexploitation of natural resources exacerbated soil fertility, agricultural production, water tables and forest resources & put livelihood at risk for about decade in the study area (CWAO, 2019)

3.2 Research Design

The research used a cross sectional Research designs, collecting qualitative and quantitative data once. A cross-sectional survey design can be identify current attitudes, beliefs, options or practices these attitudes, beliefs and options was sever to investigate the ways in which individuals think about issues and it was help to know the actual behaviors of research participants The reason why prefer this method was it helps to get the desired information with low costs or expense and takes a short period for administering the survey and collecting the information. Therefore, the design of the study was based on an cross sectional method design that aimed to collect qualitative data in first stage to assist in building the second stage quantitative data collection instrument (Merdy et al., 2018)..

3.3 Data Type and Sources

The data required for the study was obtained from both primary and secondary sources. The primary data has been collected through questionnaire, interview, focused group discussion and personal field observation. Secondary data was collected from Chiro Wereda Agricultural office, Climatic data rainfall and Temperatures from Me;eso

Metrological Station, Chiro Wereda and Town Administrative offices, Central Statistical Agency, and published and unpublished documents in government and Non-governmental.

3.4. Sample Size and Sampling Procedure

Sampling methods were used that to incorporate both purposive and random sampling had been put in to practice to selects Woreda, Kebele and households respondent respectively. The Chiro district was selected purposively. In the first stage, district was classified into three stratums based on the agro ecological zone as Highland, Lowland, and Midland by using stratified sampling technique. In the second stage, three kebeles were selected randomly to represent each agro ecology of the district namely Tayfe from highland, Madhicho-no-2 from mid land and Lugo-bachesa from low land Where the total targeted population were 980. The total household heads of these three kebeles are 620, 150 and 210 respectively. In the third stage, 164 sampled households were selected from those three kebeles by using systematic random sampling technique. A sample size of the households was determined by using Yemane, (1967) formula which is developed to calculate a representative sample for proportions as considering a 7% level of precision. Since the sample households are different in agro ecology, Yemane, (1967) formula is applicable to determine the sample size. The aim of the calculation is to determine an adequate sample size which can estimate results for the whole population with good precision. The formula was as follows:

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

Where: n=Sample size

N= Sample frame

e=marginal error (0.07), used to reduce error and to proportionate sample size.

Therefore, N=980

$$\frac{980}{1+980(0.0049)}$$

$$\frac{980}{5.802}$$

n =164

The sample household heads were selected by Systematic Random Sampling at interval based by Byjus N Choose K Formula, **N** choose **K** is called so because there are (n/k) number of ways to choose **k** elements, irrespective of their order from a set of n elements. So, K=N/n on the formula, where K is sampling frame, N is the total number of households in the three kebeles and n is the sample size. So n= 164, N= 980 and sampling interval, K became 6 which will be taken as Sixth. Thus, the sample interval K was 6 and every fifth household heads from the source list of each kebele were selected systematically. In addition to this the key informant interview with 12 respondents including Woreda agriculture office expert, Kebele leaders and model smallholder farmers and NGO workers were selected. Also focus group discussions were held among 8 respondents which included local elders, agricultural extension workers and model smallholder farmers. There are two focus group discussions in each kebele.

Table 1 Sample size of selected kebeles

No	Kebele	Total household heads	Percent	Sampling size
1	Tayfe	620	64%	104
2	Madhicho-no-3	150	15%	25
3	Lugo-bachesa	210	21%	35
Total				164

Source: Based on 2020 years projected

3.5. Method of Data collection

The data collection methods includes questioner household surveys, key informant interviews (KIIs), focus group discussions (FGDs) direct observations and transect walk. Semi-structured and open-ended questionnaires developed to administer the household survey. Likewise, Semi-structured checklists were designed to administer the FGDs and KIIs.

Household survey

From the three selected kebeles Tablet 1:Sample size of selected kebele respondents were asked questions by selected and trained enumerators at their village home to home questionnaire which includes both sexes and different age categories. Structured and semi-structured interview questionnaire were prepared to collect data The aim of the household survey questionnaire was to understand their perception, major impacts of climate change, and adaptive Strategy of smallholder farmers, the trends of rainfall and temperature, farmer's adaptation strategies mechanisms, with socio-economic data, and agro-ecological zones, the relationship between farmers' perceived and actual adaptation strategies, and other related issues.

Key Informant Interviews (KII)

Key informant interviews were conducted with different individuals at different levels. At kebele level, individual interviews were conducted with elderly people aged more than 65 years thinking that they have sufficient knowledge about the area and be able to memorize well its historical climate trends. Experts with environment and agriculture backgrounds in the kebeles, weredas, and zone agriculture offices were interviewed

Focus Group Discussions (FGDs)

Discussions focused on the research issues were carried out among groups classified by sex and age. Separate discussion was held with young, old and female groups so as to avoid specific group's idea dominancy and capture gender, and age disaggregated data. There were a total of Three FGDs and each group involved 8 individuals who were not involved in household survey. To guide the discussion, semi-structured checklists were designed specific to the research issues.

Field Observations

During field surveys, transect walks were conducted in the three kebeles with the guidance of the kebele's chairman leading the team, including voluntary farmers, development workers and the researcher. In the meanwhile, the researcher tried to triangulate farmers' responses with actual physical observations; and took pictures of important observations which are actually put as exhibits to support findings.

3.6 Method of Data Analysis

3.6.1. Descriptive statistic

Primary data collected on the field was coded and imputed into Microsoft Excel 2007 and SPSS 20.0 statistical packages for descriptive and inferential statistical analysis.. Descriptive statistics computed were table and percentage indices, while inferential statistics computed were t-test statistic, and chi-square test. The independent samples t-test and chi-square (X2) test statistics were used to identify the relationship between dependent and independent variables.

3.6.2. Empirical Model

The binary logistic (BNL) regression model was used to identify factors that affects smallholder farmers choice of adaptation strategies.. The binary logistic regression model predicts the log ODDS of having made one decision or the other. This model permits the analysis of decisions across two categories (Tchamba et al., 2018). Overview of regression models, including logistic regression for binary outcomes, and illustrates how explanatory variables influence event probabilities (Gelman and Hill, 2020). This model helps to explore the degree and direction of the relationship between dependent and independent variables in small scale farmer of study area. The logistic regression model is an appropriate statistical tool to determine the influence of independent variables on dependent variables when the independent variable has only two groups

3.6.2.1 Binary Logit Model specification**.**

In this study, therefore, a binary logit model specification is adopted to model climate change adaptation behavior of farmers involving dummy dependent variables with binary choices. According to Gujarati (2003), the logistic distribution function for the decision on adoption of adaptation measures to climate change and variability can be stated as:

$$\left(P_i \frac{1}{1+e^{-z(i)}}\right) \text{--} (1)$$

Where **P (i)** is a probability of deciding to adopt an adaptation measure for i[th] Farmer and **Z (i)** is:

$Z(i)=B_o+B_1+B_1X_2+B_2X_2+$----------------- $+BmXm$-- (2)

Where **B 0** is the intercept and **Bi** is the slopes parameter in the intercept model

But $(1-p_i)\left(=\frac{1}{1+e^{-z(i)}}\right)$-- (3)

Therefore, $\left(\frac{P_i}{1-P_i}\right)\frac{1+e^{z(i)}}{1+e^{-z(i)}}=e^{zi}$-- (4)

$\left(\frac{P_i}{1-P_i}\right)=\frac{1+e^{z(i)}}{1+e^{-z(i)}}=e^{zi}=e^{\beta_0}+\sum_{i=1}^{m}\beta_i y_i$--(5)

Taking the natural logarithms of the odds ratio of equation (5) will result in what is called the logit model as indicted below.

$\ln\left(\frac{P_i}{1-P_i}\right)\ln\left(e^{\beta_0}+\sum_{i=1}^{m}\beta_i y\right)=Z_i$ --(6)

If the disturbance term **ui** is taken in to account, the logit model becomes:

$Zi = Bo+ \Sigma BiXi+ U_i$--- (7)

The parameter estimates of the binary logit model provide only the direction of the effect of the independent variables on the dependent (response) variable, but estimates do not represent either the actual magnitude of change nor probabilities. Differentiating equation (1) with respect to the explanatory variables provides marginal effects of the explanatory variables given as:

$\frac{\partial P_i}{\partial \bar{X}_i}P_i(\beta_i-\sum_{i=1}^{m}P_i\beta_i)$.-- (8)

The marginal effects or marginal probabilities are functions of the probability itself and measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean (Koch,2007). All analysis was done after the coded responses to the questions in the interview schedule were entered in to computer and the final analysis was done using the SPSS 20.0 statistical packages for descriptive and inferential statistical analysis.

3.7. Definition of Variables and Working Hypothesis

Both dependent and independent variables were used.

3.7.1. Dependent variables

The dependent variable was adaptation Strategy, which the dependent variable for the adoption model indicates whether a household has adopted the best adaptation option or strategy or not. Therefore, in this study adopters are households who adopted adaptations option while non-adopters are those who do not adopt "the adaptation strategy The ''adopt option'' include adoption of adaptations strategy which is the best of climate smart agriculture option. In the study the following 5 common endogenous adaptation strategies which are all explained by similar explanatory variables were identified: different crop variety, implement soil conservation, diversify crop, changed use of chemicals or fertilizer, adjust to crop management, engaged in off-farm activities, using irrigation, change crop, diversify from farming to non-farming activities, change quantity of land, and others including making flood to lay down on flat plain, agro-forestry, using deposited soil as fertilizer, using pesticides and herbicides In this study, a farmer who has adopted: adaptations strategy or option was defined as adopter. A value of ''1'' was assigned to all households who adopted: *all* option (the 'adopters'') and ''0'' was assigned to households using not complete all option (the ''no adopters''). Whether to adopt any climate adaptation option is determined by personal, social, economic, institutional and geographical factors. These variables were treated as explanatory variables in this study.

3.7.2 Independent variable

Studies made on farmers' adoption option / adoption theories provide long list of factors that influence farmers' decision. These studies indicated demographic, socioeconomic, physical and institutional factors influence the adoption of. The lists of independent variables, which include both categorical and continuous, were expected to influence households' adaptation option. The expected effect of these 13 explanatory variables was presented as follow accordingly; the descriptions of independent variables were indicated Independent or independent variables (different capital assets) were age of household head, household size, size and number of farms, income of household, educational level, gender of household head, practice of agroforestry, information accessibility, credit accessibility, land accessibility, and access to extension services. Because the dependent and independent variables were mainly qualitative in nature, the statistical Tablet 2: Summery of hypothesized explanatory variable analyses were done using non-parametric tests and the discrete regression model (binomial logistic regression).

Table 2 Summery of hypothesized explanatory variable

No	Variables	Definition	Descriptions	Expected out put
1	SEX	House hold sex	Dummy	+/-
2	Age of house hold	Age of house- hold head	Continuous	+/-
3	MS	Marital status	Dummy	+/-
4	EDUL	Education level of house- hold head	Dummy	+
5	Farm Size	Farm sizes	Continuous	+
6	Land size	land holding size	Continuous	+
7	ACFAMMEM	Active member of house-hold in numbers	Continuous	+
8	HHINCOM	House-hold income	Continuous	+
9	TRNING	Training for house hold	Dummy	+
10	Distance	Distance from the market in KM	Continuous	+
11	AccAgEXSer	Access of agricultural extension services	Dummy	+
12	OFFACT	Off farm activity	Dummy	+
13	CRDITSERV	Credit services	Dummy	+/-

Source: Own survey

3.7. Ethical Considerations

Studies involving interaction with human samples will usually have some ethical implications.

It is important to establish trust with the research participants, and this was achieved by ensuring anonymity and confidentiality to all respondents; carefully explaining the research process and how the data was be presented; providing as much information on the study and its aims and objectives without influencing responses. It is my promise that, while carrying out this research, what was observing the highest possible ethical standards in the preparation, data collection, data analysis and completion of this research by maintaining the highest integrity at all times regarding the data collection. It was only report information that in the public domain and within the law. Avoid plagiarism and fully acknowledge the work of others to which have referred in my work. All scholar matter that was included in the thesis was given recognition through citation. I guarantee that I was respect intellectual property, privacy and confidentiality and give proper for any contribution from other researchers. Acknowledged the rights of all research participants. Report findings honestly and truthfully. Guaranteed which maintaining a record of all research activities and report data as carefully and objectively as possible. It was consider the research project worthwhile and benefits to the local community and the country as well. Covert data gathering was not a feature of my study.

4. RESULTS AND DISCUSSION

This portion presents the findings obtained from the study and composed of two parts. In the first part, descriptive and inferential statistics analysis are employed to describe Demographic and physical characteristics, socio-economic characteristics, institutional Factors, adoption status of the adaptation option, the perception of farmers, major constraints to Adopt the best Climate variability adaptation option and smartness of best adaptation option. The second part was address econometric analysis (binary logit model), used to determine the main constituents that govern adoption of the best adaptation option.

4.1 Characters of Household Respondent

This section presents the summary results of demographic and physical, socio-economic and institutional factors of sample respondents in the study area. The results on Table 3 shows that summary of dummy explanatory variables influences adopted option

Table 3 Summary of descriptive and inferential statistic for dummy variable

No/	Variable	Score/Rank	Respondent	Percent	x-2	Sign
1	Sex of House hold	Total	164	100%	0.02	0.301
		Male	134	81.7 %		
		Female	30	18.3%		
2	Training	Yes	73	44.5%	0.575	0.00
		No	91	55.5%	-	-
		Total	164			
3	Access to Agriculture	Yes	87	53%	0.019	0.00
		No	77	47%	-	-
		Total	164	-		
4	Off-farming	Yes	80	49%	0.000	0.00
		No	84	51%	-	-
		Total	164	-		
5	Credit services	Yes	88	53.6%	0.132	0.00
		No	76	46.4%	-	-
		Total	164	-		
6	Soil and water Conservation	Yes	102	62.1%	0.000	0.00
		No	62	37.9%	-	-
		Total	164	-		
7	Agro-forest	Yes	88	53.6%	0.000	0.00
		No	76	46.4%	-	-
		Total	164	-		
8	Crop diversity	Yes	89	54.26%	0.116	0.00
		No	75	45.74%	-	-

		Total	164	-		
9	Agriculture input	Yes	97	59.14%	0.003	0.00
		No	67	40.86%	-	-
		Total	164	-		
10	Access irrigation	Yes	79	48.17%	0.027	0.00
		No	85	51.83%	-	-
		Total	164	-		

Source: Field survey results, 2024

4.1.1. Descriptive statistics of dummy explanatory variables

Sex of the Household Head

Sex of the head of the household is believed one of the determinants of adaptation strategy towards Climate variability. The sample respondents considered during the survey was 164. According to the data in the Table 3 the majority of the respondents are 141(86%) male-headed households and the remaining 23 (14%) are female-headed households. The survey result showed that (19) 20.6% of the female sample households and (73) 79.3% of the male sample households were adopter of best CCI option to scale up CSA. On the other hand, (11) 15.277% of the female sample households and (61) (84.72%) of the male sample households were non-adopter of best CCI option in the study area**.** The Chi-square result of Table 3 indicated that (X2 = 4.795, sig. =0.017) there was significant difference between female and male households in adoption of the best CCI option. According to focus group discussion of the study area there were limited participation of women in the farming practices and in the adoption of adaptation strategy or option and had limited access to information. However, they were highly involved in regular household activities than men. Male household heads are more likely to engage in SWC practices compared to their female counterparts (Mekonnen, and Belay, 2021).This is because most women in the study area spent their time in domestic responsibilities and activities

Off- farm activities

Participation in off- farm activities is common in the study area. Some of them involved in petty trade, daily labor work, fire wood selling, handicrafts. These off-farm activities served as a source of additional income to cover cost of home consumption products, for buying agriculture fertilizers, different cattle and clothes. However, based on the survey result in Table 3 shows, (80) 48,8% of household respondents participated in off-farm jobs while (84) 51.2% did not engage in such activities. Among the total respondents, (80) 48.8% of the adopters participated in off-farm activities whereas none of the non-adopter respondents participated in off-farm activities. On the other hand, (12) 13% and (72) 100% of the adopters and non-adopters did not involve in off- farm activities respectively. Farmers who were participating in off-farm activity had more chance to participate in the adopt practice than those who were not participating in off-farm activities. The Chi-square result indicated that (X 2 = 0.000, P=0.00) there was significant difference between household who were participating in off-farm activities and households who were not participating in off-farm activities in adoption of Adopt practice and in their adaptive capacity. Off farm income has been shown to have a positive impact on technology adoption. This is because off-farm income serves as a crucial strategy for rural households to overcome credit constraints, facilitating the adoption of new technologies (Reardonet al., 2017). Off-farm income serves as a substitute for borrowed capital in rural areas with limited access to functioning credit markets (Morris, 2021). Off-farm income and investments in agricultural inputs, noting that it plays a significant role in facilitating access to improved agricultural technologies (Barrett and Luseno, 2020).

Credit Access

In the study area, it was found that only (88) 53.7 % of the respondents have reported obtaining credit at least once since the last five years. Whereas, (76) 46.3 % of respondents have not obtained credit from formal sources. On the other hand, (4) 4.3% and (72) 100% of the adopters and non-adopters did not involve in credit services activities respectively. Farmers who were participating in obtaining credit services had more chance to participate in the adopt practice than those who were not participating in credit services. The Chi-square analysis of Table 3 disclosed that (X 2 = 0.132, P=0.00) there was highly significant association between access to formal credit service and adoption option and it is highly significance. This could prove that farmers who have access to credit have no an equal probability of adopting or having adaptive capacity option than those with no access which contradicted that Eleni conclusion. Eleni (2022), conclude that Access to credit does not significantly influence farmers' decisions to adopt CSA practices, as funds may be diverted to other uses rather than adaptation strategies or option.

Access to credit was found highly significant with positive relationship with adoption of adaptation strategy. This is contradicting with the study done in Ethiopia by Mberengwa

(2021), that access to credit is generally associated with positive adoption of adaptation strategies, it presents contrasting evidence regarding its significance in Ethiopia. The observed positive relationship could be due to the fact that, those who are likely to access credits are more likely in doing business than that were not have access to credits services to support farming activities, unlike those who are unable to access credits they mainly depend on farming as their main livelihood option and hence less likely to adopt adaptation option practices which were lowering their adaptive capacity.

Extension Access

Access to extension service is very important element of institutional support needed by farmers to enhance the use of CSA options in general and Adaptation climate smart option in particular. Three Development Agents (DA's) were assigned in each sample *kebeles*. It was expected that sample farmers in the study area have an access to extension services through the DAs, attending field days and training. The survey result indicates that from the total sample household heads about (87) 53% of households have access to extension services, while the remaining (77) 43% of sample populations do not have access to extension. The result further indicates that from the total 92 adopters of adaptation climate smart option, (87) 94.5% of the households have access to extension services. On the other hand the total 72 non-adopter households and 5(5.5%) adaptor have not access to those extension services. The Chi-square analysis(X 2 = 0.019, P=0.00) reveals that difference among adopters and non-adopters of adaptation climate smart option is found to be highly significant at less than 5% significance level. Extension agents usually target specific farmers who are recognized as peers (farmers with whom a particular farmer interacts) exerting a direct or indirect influence overall population of farmers in their respective areas (Genius *et al.,* 2010).

Many authors have reported a positive relationship between extension services and technology adoption. In general it imply that , how extension services play a vital role in helping smallholder farmers in Ethiopia adapt to the impacts of climate variability. Which it supported by finding that, agricultural extension services contribute to smallholder farmers' capacity to adapt to climate variability. It highlights the importance of training and information dissemination in enhancing farmers' knowledge of climate-resilient practices and technologies (Ayele and Bediye , 2022)

Training Access

It is believed that farmers who did not have information about adaptive capacity and climatic adaptation strategy or option and cannot be expected to adopt it. Otherwise, farmers perceive its expected cost and benefits. Timely training and accurate information had a positive influence on farmer's best adaptation option. Targeted training enhances farmers' understanding and decision-making related to climate-smart agriculture options (Fischer et al., 2018).The result in Table 3 shows that, (73) 44.5% of sample household adopters had access to training whereas, only (91) 55.5% of adopters do not have access to training. On the other hand (19) 20.6% and (72) 100% of adopters and non-adapter not access to trainings respectively. This shows that being trained technically helped the household farmers in order to adopt adaptation strategy to strength their adaptive capacity adaptation of climate smart option. The Findings of chi-square analysis (x2= 0.575, df =1, p= 0.00) indicates that, there was highly significant difference between household heads who had access to training and not access to training in adoption of best adaptation strategy for better adaptive capacity adaptations climate smart option. This means that, an opportunity getting of training makes farmers to be well informed and be technically in adopting adaptation of climate smart option.

Agroforestry practices

Agroforestry is important element in adaptation option in the study area.it is purposeful integration of tree or shrubs with crops and livestock at the plot farm, and landscape scale which is one of potential element. The survey result indicates that from the total sample household heads about (88) 53.7% of households have agroforestry practices, while the remaining (76) 46.5% of sample populations do not have access to agroforestry practice. The it was found that only (89) 54.3 % of the respondents have reported, Doing crop diversity practices at least once since the last five years. Whereas, (75) 47.7 % of respondents have not doing crop diversity practices on their farm land. On the other hand, (3) 3.26% and (72) 100% of the adopters and non-adopters did not involve in crop diversity practices respectively.

Farmers who were participating in crop diversity had more chance to participate in the adopt practice than those who were not participating in crop diversity practices. Result further indicates that from the total 92 adopters of adopting adaptation strategy, (88) 95.6% of the households have access to Agroforestry practices. On the other hand, the total 72 non-adopter households and 4(4.3%) adaptor have not access to those agroforestry practices The findings of chi-square analysis (x2= 0.00, p= 0.00) indicates that, there was highly significant difference between household heads who had access to Agroforestry practices and not access to Agroforestry practices in adoption of best adaptation strategy for better adaptations option. This means that, an opportunity doing Agroforestry practices farmers to be well Adopt climate smart option for better adaptation strategy. This is also supported by the findings of/According to, Agroforestry systems, especially those with leguminous species, contribute to both enhanced livestock feed and carbon storage (Nair and Garrity, 2021). Non-agriculture-based livelihoods are likely to play an increasingly important role in building resilience among agricultural populations due to projected population growth patterns as well as potential climate change impacts to consider how to improve pathways for low-income and food-insecure people in both the agriculture and non-agriculture sectors to access resilient livelihoods (Schmidt et al., 2022).

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Access to irrigation

One commonly debated adaptation solution is irrigation, which involve artificial application of water to land for agricultural purpose. While irrigation has been used to increase crop yield and support food production while in the study area irrigation were used mostly for chat production to twice a year for the purpose of market or generate income /cash which to purchase their foods and other consumption The survey result indicates that from the total sample household heads about (79) 48.2% of households have access to irrigation practices, while the remaining (85) 51.8% of sample populations do not have access to irrigation practice. The result further indicates that from the total 92 adopters of adapting climate smart option, (79) 85.8% of the households have access to Agroforestry practices. On the other hand, the total 72 non-adopter households and 13(14.1%) adaptor have not access to those irrigation practices.

The findings of chi-square analysis (x2= 0.027, p= 0.00) indicates that, there was highly significant difference between household heads who had access to irrigation practices and not access to irrigation practices in adoption of best adaptation strategy for better adaptive capacity adaptation of climate smart option. This means that, an opportunity having irrigation practices farmers to be well Adopt climate smart option for better adaptation option , which is supported by finding, what the role of access to irrigation in adaptation options in climate variability is critical (Mishra et al., 2023).

Crop diversity practices

One commonly debated adaptation solution is crop diversity practices, which involve growing of more than one crop in an area while accomplished by adding a new crop species or different variety, or by changing crop systems currently use. Commonly it can mean adding more crops in to existing rotations. Crop diversification can be implemented by farmers using different approaches such as cover crops, crop rotation, intercropping and agroforestry (Wezel et al., 2023). It provides resilience to highly variable weather conditions resulting from climate changed. diversifying cropping system ,in general, tend to be more agronomic ally stable and resilient which associate with reduced weeds ,insect pressure ,needs for nitrogen fertilizers, erosion and increase soils fertility and yield per unite area(Lin , 2011). In the study area, while intercropping were more common and used type of crop diversity system, In the study area, it was found that only (89) 54.3 % of the respondents have reported Doing crop diversity practices at least once since the last five years. Whereas, (75) 47.7 % of respondents have not doing crop diversity practices on their farm land. On the other hand, (3) 3.26% and (72) 100% of the adopters and non-adopters did not involve in crop diversity practices respectively. Farmers who were participating in crop diversity had more chance to participate in the adopt practice than those who were not participating in crop diversity practices. The findings of chi-square analysis (x22= 0.116, p= 0.00) indicates that, there was highly significant difference between household heads who had practices crop diversity and not practices crop diversity in adoption of best adaptation strategy for better adaptive capacity adaptation option. This means that, an opportunity doing crop diversity practices farmers to be well Adopt climate smart option for better adaptation option

Agricultural inputs

Agricultural inputs means the resource that are used during the process of farm production , this resource include seeds, fertilizers, energy, pesticides, veterinary drugs, equipment, animals feed and processing plants. The most commonly used Agricultural input like improved seeds, pesticide, artificial fertilizers were commonly used in the study area, it was found that only (97) 59.1 % of the respondents have reported access to use agricultural input practices at least once since the last five years. Whereas, (67) 40.9 % of respondents have not access to agricultural input practices on their farm land. On the other hand, (0) 0% and (67) 40.9% of the adopters and non-adopters did not involve in access to agricultural input practices respectively.

Farmers who were access to agricultural in put had more chance to participate in the adopt practice than those who were not have access agricultural inputs. The findings of chi-square analysis (x2= 0.003, p= 0.00) indicates that, there was highly significant difference between household heads who had access to agricultural inputs practices and not access to Agricultural inputs practices in adoption of best adaptation strategy for better adaptive capacity adaptation smart option. This means that, an opportunity having access to agricultural input practices, farmers to be well Adopt climate smart option for better adaptation option which supported by finding , The role of agricultural inputs in adaptation strategies for climate variability among smallholder farmers is crucial (Moges et al., 2023).

Soil and water conservation practice

Soil and water conservation are those activity at the local level which maintain or enhance the productive capacity of the land including soil, water and vegetation in areas prone to degradation through prevention or reduction of soil erosion compaction, salinity conservation or drainage of water. In the study area the most common soil and water conservation practice physical structures like soil bund, stone bund, hillside traces and biological or agronomic measures , it was found that only (102) 62.2 % of the respondents have reported doing soil and water conservation technology practices at least once since the last five years. Whereas, (62) 37.8 % of respondents have not doing soil and water conservation practices on their farm land. On the other hand, (0) 0% and (62.2) 37.8% of the adopters and non-adopters did not involve in soil and water conservation practices respectively.

Farmers who were done soils and water conservation technology had more chance to participate in the adopt practice than those who were not done soils and conservation technology. The findings of chi-square analysis ($x2= 0.00$, $p= 0.00$) indicates that, there was highly significant difference between household heads who had done soil and water conservation technology practices and not had done soil and water technology practices in adoption of best adaptation strategy for better adaptive capacity . This means that, an opportunity having done soil and water conservation technology practices, farmers to be well Adopt climate smart option for better adaptive capacity which is supported by finding, the role of soil and conservation practices in adaptation strategies for climate variability among smallholder farmers is significant (Meyer et al, 2022).

4.1.2. Descriptive statistics of continuous variables

Age of Household Respondents

The result of the study in Table 4 shows that the mean age of the sample households is 41.12 years with standard deviation of 6.66. This shows that the sample households are dominated 41 by relatively middle adult hood farmers who are still within the economically active group. According to Shamrock (2011), the age is grouped based on psychological age classification as early adult hood (20 to 40‘s years), middle adulthood (41 to 60‘s years) and late adulthood (60 years and above). The age of the household head represents the experience in farming and the work force for the adoption of climate smart Adaptation strategy or option for better adaptive capacity. As indicated in the Table 5 the mean age of respondent that fall in the adopter categories 41.12 and non-adopters were 44.00 respectively.

Descriptive Statistics

Table 4 Descriptive statistic of continuous variable

Continues variable	N	Mean	Std. Deviation
Age of house hold headed	164	41.12	6.666
Family sizes	164	5.14	1.387
house hold land holding size	164	.74	.379
Active member of house hold in numbers	164	3.27	1.367
Distance from the market	164	12.85	3.115
Valid N (listwise)	164		

Source: field survey result, 2024

As indicated in the Table 5 the mean age of respondent that fall in the adopter categories 41.12 and non-adopters were 44 respectively. In a similar manner the standard deviation for adopter and non-adopter categories are 6.66 and 7.001 respectively, which are not far from each other as the mean age does. The result of t-test showed that the mean age of the sample household's Tablet 3: descriptive statistic of continuous variable difference between the two Groups was significant. Accordingly, statistically insignificant relationship between the Household head age and adoption of best adaptation option, which shows age, is not significantly determining the status of best climate smart option adoption.

Table 5 Summary of descriptive and inferential statistic for continues variable

No	Variable	Adopter(92)		Non-Adopter(72)		t-value	p-val	X2
		Mean	Standard deviation	Mean	Standard deviation			
1	Age of House hold	41.12	6.66	44.00	7.001	78.99	0.000	0.000
2	Family size	5.14	1.387	6.07	1.053	47.445	0.000	0.000
3	Land size	0.74	0.379	1.02	0.261	24.97	0.000	0.000
4	Active family member	3.27	1.367	4.28	1.010	30.67	0.000	0.000
5	Distance to markets	12.85	3.115	11.5	1.444	52.826	0.006	0.000

Source: field survey result, 2024

Family Size

The other major factor played a crucial role in the adoption of climate smart option adaptive capacity. The family size of the respondents was with a mean family size of 5.14 and standard deviation of 1.387. The study result in Table 5 shows that, the mean household family size of adopters and non-adopters of best adaptation strategy climate smart option were 5.14 and 6.07 respectively. In a similar manner the standard deviation for adopter and non-adopter, categories are 1.387 and 1.053 respectively. Thus, it can be concluded that the non-adopters had relatively larger family size than adopters did. The t-test finding depicted that, the respondent family size is statistically significant at < 0.01%

of level of significance (t=47.445, P=0.000). This result in Table 5 implies that family size of household members has strong relationship with the introduction and adoption of best adaptation smart option. Households with small number of family size were more likely to adopt adaptation strategy climate smart measures than with large family size this imply that more dependent sidearm and more consumption in large family size

Farm Size

The survey results showed that landholding mean land size 0.74he and its standard deviation were 0.379. The average landholding size of adopters and non-adopters was 0.74 and 1.02 he with a standard deviation of 0.379 and 0.261, respectively. There was a slight difference in the mean size of landholding between the two groups. However, the result of t-test showed that the mean landholding size difference between the two groups was significant. Land is one of the most important production factors for agricultural production. That means adoption of adaptation strategy climate smart option was influenced by the size of farmlands. According to this study, Farmers who have smaller farm size were adopting adaptation strategy climate smart option. This is because farmers who have smaller farmland were young, have no other option and required training to adopt adaptation option. This is contradicting with the study done by Kassie (2021) , that farmers who had large farm sizes showed interest in investing in perennial cash crops and intercropping measures.

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Active Family Members

The number of labor force available in the family is assumed to influence decision of farmers to adopt adaptation strategy of climate smart option. The survey results showed that active family members mean size 3.27 in numbers and its standard deviation were 1.367. In addition, the result of t-test revealed that there was significant difference in the mean size of active family numbers between adopters and non-adopters. When the cross-tabulation is analyzed, the mean active family number for the respondent’s family members that fall in the adoption categories was 3.27 and non-adopters 4.28. In a similar manner the standard deviation of active family numbers for adopter and non-adopter categories are 1.367 and 1.010 respectively. The t-test finding in the Table 5 shows that there is significant mean difference between the groups of adoption categories at less than

0.01 significance level (t= 30.67, P =0.00) with regards to active family numbers. In the study Area this result implies that**,** Families with small active family members that cloud be required to adopt adaptation strategy than who have more Active family members due to dependency send ram. This is contradicting with the study done by Shama (2023), that the role of active family members in climate adaptation options is crucial for improving smallholder farmer adaptation strategy.

Market Distance

The distance between the resident and market is assumed to be determining factor for adoption of the adaptation strategy climate smart options. It was hypothesized that as the distance increases the rate of adoption would be decreased since adaptation climate smart option could be compromised. In a similar manner as the distance between market place and the home increases the marketing linkages for the farm inputs and output is not be strong and have a negative relationship. The result of the study in Table 5 shows (t=52.82, P=0.006) the mean and standard deviation for the adoption and non-adoption categories with regard to market distance and it shows that there is insignificant relationship. From this result, we can interpret that market distance is not a significant determining factor for adoption of the climate smart option.

4.1.3. Farmers' Perception of Climate Change and Variability in the study area.

Perception of temperature and rainfall pattern changes is a necessary prerequisite for any kind of climate variability adaptation including agriculture, natural resource management, and health. Farmers who perceive the change in climate are hypothesized to make adjustments in their farms to reduce climate change born impacts unless they do face some barriers. However, identifying agricultural adaptation options to climate variability is not an easy task as there is no adaptation started for climate change purpose alone. Most adaptation options have values of broad spectrum which can be undertaken as an adjustment to climate change, market, policy, demography, economic condition, resource availability, and technology. Thus, it is important, if not sufficient, to have an in sigh it of farmers' views on temperature and rainfall trends in advance to dig out genuine locally available climate change adaptation technologies on the ground.

Table 6 Respondent house hold perception on local climate variability indicators

No	Climate variability indicators	Increase, % No %	Decrease, %	No change, %	Don't know, %
1	Temperatures	164, 100%			
2	Drought	160 , 97.6%		4, 2.4%	
3	Rainfall	3,1.8%	156, 95.1%	3, 1.8%	2, 1.2%
4	Floods	16 ,9.8%	132,80.5%	8,4.9%	8, 4.9%%
5	Duration of short belge season rain fall	27, 16.5%	137, 83.5%		
6	Delay on set of belge season rainfalls	128,78%	36, 22%		
7	Duration of long kiremt season rainfall	13, 7.9%	151, 92.1%		
8	Early end to short belge season rainfall	131, 79.9%	33, 20.1		
9	Early end to long kiremt season rainfall	133, 81.1%	31, 18.9%		

Source: field survey result, 2024

4.1.3.1. Small holder household perception on temperature variability

Among the interviewed respondents, 100% perceived long-term change in temperature in this study are over the last 20 years. (table: 6). In order to assess the details of perception on the climate variability indicators or events subsequent questions were administered to the individual sample households and the results was summarized as it is described in Table 6. All the 164 sample respondents' reported that in the last 20 years there was climate variability in the Woreda in general. Specifically, 100% and 97.6% of the interviewed households responded for temperature and drought increase respectively and the remaining 2.4% responded that there was no change in drought over the last two decades in the study area. The smallholders' perception or attitude that has been developed over time due to different determining factors has its own stake in influencing the adoption of the best climate smart agricultural options or strategies (Zighe, 2016). As can be seen in figure below, the trend analysis of annual mean temperatures follows increasing trends. This is in accordance with the perception of most farmers (100%) towards temperature.

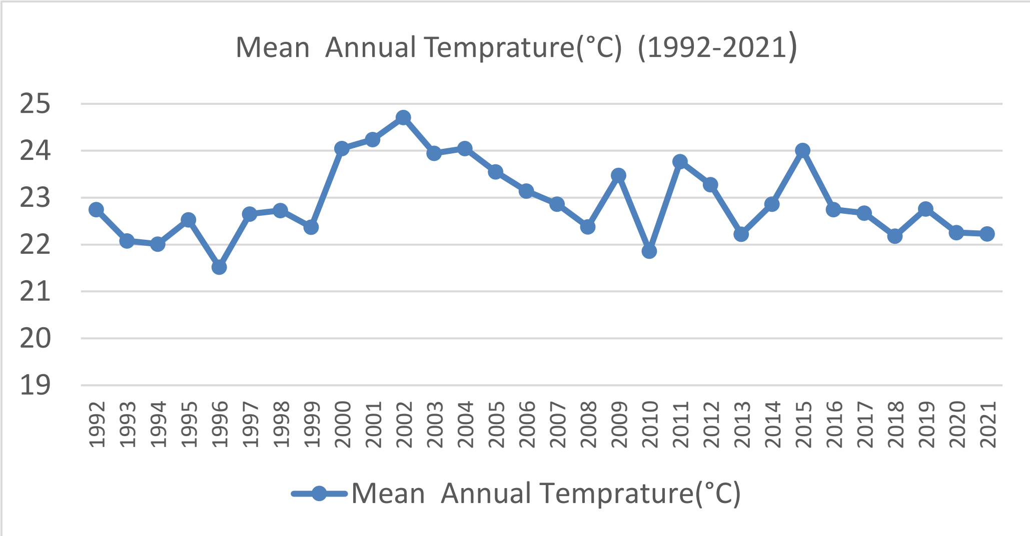


Figure 2: Mean annual temperature of Chiro wereda (1992-2021)

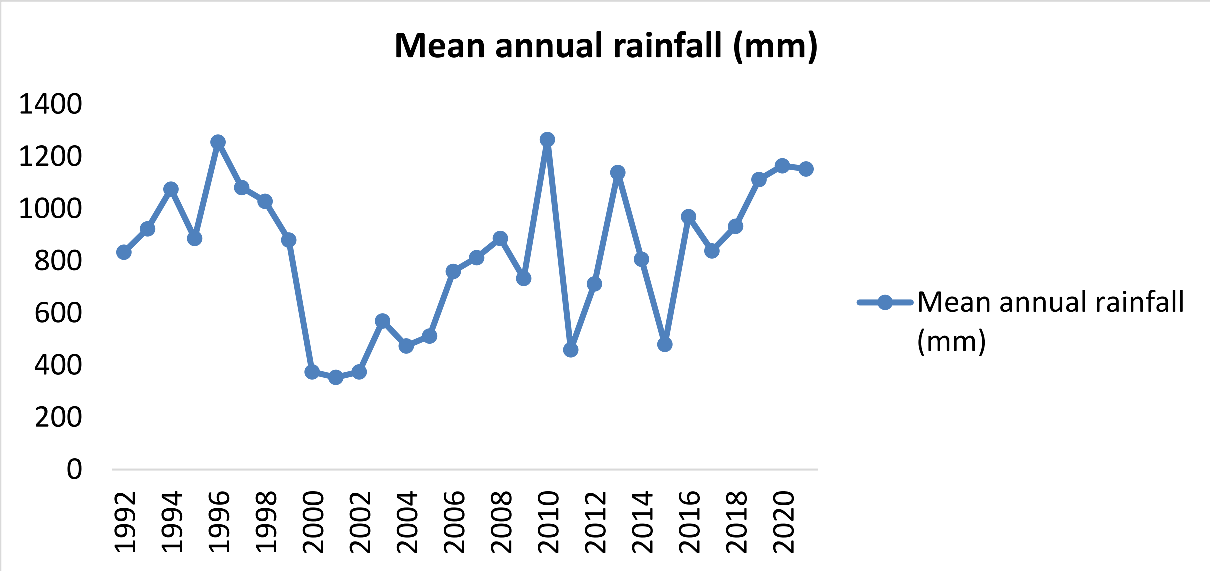
Source NMI, 2024

4.1.3.2. Small holder household perception on rainfall variability

All of the interviewed informants in one way or another perceived changes in rainfall volume and distribution in the study area over the period. As depicted in fig 3, the majority of the respondents i.e., 156 (95.1%) noticed significant decrease, 3(1.8%) of respondent said decrease and no change, and 2 (1.2%) of the respondent said that what they did not in the pattern of rainfall. When it comes to duration of short Belg season rainfall, delay onset of Belg season rainfall and early end to short Belg season rainfall indicators of the study area 16.8%, 78%, 79.9% of household's responded indicators were increased; and 83.5 %, 22%, and 20.1% of households responded the indicators were decreased respectively for the last 20 years. In a similar way, as it is indicated in the result Table 6 Specifically when it comes to duration of long Kiremt season rainfall and early end to long Kiremt season rainfall 7.9%, and 81.1% responds indicators were increased and 92.1% and 18.9% responds indicators were decreased respectively over the past 20 years (Table 6). We can generally observe that the majority of household claimed that water availability and rainfall amount was decreased; early end of rainfall, late onset of rainfall and rainfall variability was increased.

In a similar way, after subsequent discussions with FGDs of the study area highlighted that strong change in rainfall patterns were perceived as the most significant impact on farm production which imply that straggling adaptation strategy of small holder farmers in the study area.

Figure 3: mean annual rain fall of distribution of Chiro wereda (1992-2021)



Source NMI, 2024

4.1.3.3 Annual total rain fall and mean annual temperatures

In Chiro woreda, annual rain fall ranges from 443.7 to 1265 mm with mean rainfall amount of 866.8mm, a SD of 252.6 mm and CV of 29% (Mahammed , 2021). This indicates rainfall has moderate variability but it is very cloth to high variability. The area received lowest and highest annual rainfall amount at 2013 and 1999 year respectively.

The study agree with (NMA and McSweener, 2010) finding, who stated that both seasonal and annual rainfall exhibit. High variability in Ethiopia, and study reported by Deressa et al, (2011) stated that moderately to high variability in rainfall was perceived in the country over the last ten years. The rainfall trend analysis shows some significance change in the rainfall pattern over the past 20 years in Chiro wereda. The trend equation and trend line of the annual average rainfall has been decreasing in the study area. The degree of variation (R2=0.0173, implies that there has not been significant variation of rainfall with the district in the last 20 years (1992-2021) figure:4. It is clear that from figure:3 than the rainfall in Chiro woreda indeed experienced a number of fluctuations over period. Analysis of annual average rainfalls for the past 30 years show that the highest annual rain fall amount occurred in 2011 and the lowest annual rain fall amount was experienced in 2001.Astudy conducted in Burkina Faso by (Ouedraogo et al., 2006) found out that if precipitation increase by 1mm per month, net revenue increase by 2,7USs/h using standard Ricardian model. This show that agriculture is very is very sensitive to precipitation in Burkina Faso. A study done in Ethiopia by Deressa (2006), revealed that an increase in precipitation during spring will increase net farm revenue. As can be seen in figure:3 above, the trend analysis of annual mean rainfall follow decreasing trends. This is in accordance with the perception of majority of farmers (95.1%) towards rain fall.

4.1.4. The Adverse Effects of Climate Variability in the Study area

The districts of Chiro are among the most vulnerable woreda to the impacts of climate change, since the majority of the population lives in poverty and rely heavily on rain fed agriculture for its economic and livelihood survival. Therefore, their economic and social sustainability is negatively affected by changes in rainfall patterns and temperature. Because major shifts in rainfall patterns and temperatures affecting agriculture are the main long-term impacts, there is an anticipated significant reduction in food security, worsening water shortages and diseases.

Farmers 'environmental expectations of the risk of climate change are associated and have an impact on farmers' ability to resolve the impacts caused by climate change. Smallholders’ perception with regard to in relation to climate variability as well as its associated adverse impact on soil erosion viewed differently from household to house hold and place to place which is influenced by different factors (Mengistu and Mekuria, 2015).Accordingly, the general climate variability and its associated adverse impact on the agricultural sector were surveyed. . In order to assess the details of effect of the climate variability on the livelihoods of smallholder farmers’ indicators or events subsequent questions were administered to the individual sample households and the results was summarized as it is described in .above Table 6. As can be seen in figure above, from total house hold respondent, 164(100%) and 97.6% interviewed households responded for temperature and drought increase respectively over the last two decades in the study area When it comes to flooding, as we can see in table 6, 9.8%, 80.5 %, 4.9% and 4.9% of the household responded household said that there was increase, decrease, No change and do not know response over the past 20 years respectively**.**

During focus group discussion, what observed in increased drought and flood frequency, rainfall distribution, imply that decline of soil fertility or productivity, and decreased available water. Among the impacts, droughts or longer dry-spells were mentioned by several farmers as being their greatest challenge. The farmers explained that it led to uncertainty about when to start planting, while several reported crop losses due to misinterpreting a short early rain followed by a return of long dry periods. Overall, they agreed that the growing season had shifted, suggesting that existing seasonal calendars with information and recommendations on planting activities would need to be reviewed and updated**.**

Several farmers mentioned that delays in rainfall increased the occurrence of pests and diseases, harming plant health considerably and lowering yield levels of the staple crop. Specifically the identified climate variability indicators are temperature, drought frequency, rain fall intensity and unpredictability shows increased; rainfall amount and duration decreased; they were also highlighted that occurrence of unusual coldness, shift in agro ecology and for example, for many years they were loss to cultivate the belg season**.** These findings are confirmed by the IPCC (2021) study, which indicates that climate change and variability have become both global and local phenomena, manifesting in various forms of weather events. However, in recent years there is unusual long Kiremt season rainfall in the study area

4.1.4.1. Climate change induced hazards in the study area

Climate change vulnerability largely depends on the community 's main livelihood activities (including its reliance on livestock and rain-fed agriculture) and the unique physical , financial, human and historical natural resources required to carry out these activities, as well as the effect on these key livelihood resources of climate hazards. While the protection of household and community livelihood assets reduces vulnerability to the effects of climate change, climate change is already having an effect and will affect the world by adversely affecting livelihood assets through various hazards. Likewise, the effect of climate change found in Ethiopia by numerous studies has shown that drought is the major climate danger affecting the communities in the Chiro district. Drought was ranked as the key climate threat affecting their lives by most respondents (57.9%) of the households. The second, third and fourth major threats affecting their livelihood are accounted for by livestock diseases (29.9), insect infestations (7.3%) and extreme weather floods (4.9%) respectively.

Table 7 Hazards identified by sample respondent in the study area

Type of hazard	Frequency	Percent	Rank
Drought	95	57.9	1
Livestock disease	49	29.9	2
Pest infestation	12	7.3	3
Flood	8	4.9	4
Total	164	100.0	

Source: Field survey, 2024

The qualitative FGD and KII respondents in the survey areas described the lack of improved seed varieties and the ability to afford seed prices, the lack of access to credit, the scarcity of animal feed, the scarcity of land and high population pressure as the key factors exacerbating the effect of climate variability.

4.1.4 Adaptation Strategies to Climate Variability in the study area

According to respondents, they are using different adaptation options to reduce the negative effect of climate change. So adaptation strategies used in the study area include planting trees, Agroforestry, soil and water conservation, Crop diversity, Agricultural input and small scale irrigation by existing rivers with motor pumper (Table 8). These adaptation strategies are methods that local people used to adjust themselves to the existing change and minimize the impact of climate variability. About (62.2%) of the respondents prefer and used soil and water conservation as adaptation option. Soil and water conservation practice includes soil erosion preservation, management and care of soil in order to make it suitable for their crops, and about (53.7 %) 0f the respondent practice agro-forestry to reduce soil loss from farm plots, preserving critical nutrients and increasing crop yields. In line with this, a key informant from the district agriculture office stated that: In the district, various strategies are already taking place to increase the smallholder farmer’s adaptive capacity and resilience of their agriculture to climate change. Some of the activities that are already taking place currently include, soil and water conservation structures on both private and communal land, rehabilitation of degraded land in the study area. As it was discussed in the previous section all the sample respondents, key informants and focus groups have reported that climate variability occurred during the last 20 years in the study area.

This climate variability has brought an adverse impact on the smallholder farmers of the study area. In response to these, adverse impact both government and nongovernmental organizations working in the area had promoted climate smart land management practices. According to the information gained during the secondary data collection process, these practices helped to adapt and mitigate soil erosion and flooding from the upper slope of the catchment occurred due to the effect of deforestation with frequent climate variability during the past five to ten years. Government agriculture and natural resource office, productive safety net Program (PSNP), REDD+ investment projects (RIP) are some of the climate smart land management promoting organizations and programs in the study area. However most of the time these organizations were focused on long-term soil and water conservation, afforestation and reforestation practices on the communal lands. Conversely, this has not a promising for short term problems which most of the smallholders needs to overcome. This is because the adoption of soil and water conservation technology should not be regarded as an end in itself but rather as an iterative decision-making task (Brooks *et al*, 2019). This shows how poor rural land users may heavily discount long-term conservation benefits in order to meet short-term subsistence needs like food security. "When economic benefits are low, farmers fail to either adopt the recommended practices or abandon them (Matuschke and Qaim, 2020).

Table 8 Existing adaptation strategy used by small holder to reduced impact of variability in the study area

No	Adaptation strategies	Frequency					
		Used	%	Not-used	%	Total	%
1	Agricultural input	97	59.1	67	40.9	164	100
2	Agro-forestry	88	53.7	76	46.3		
3	Crop diversity	89	54.3	75	45.7		
4	Soil and water conservations’	102	62.2	62	37.8		
5	Small scale irrigation	79	48.2	85	51.8		

Source: field survey result, 2024

Focused Group discussants identified: In rural community level some strategies to adapt to effects of climate variability in the area. These includes soil conservation measures (digging farm trenches) in Tayfe kebele, planting of tree nurseries in Tayfe, lugo bachesa and madhiicho kebele, emerging or establish community business organization(CBO) rounds initiative in the area Lining with Non-governmental and governmental institutions ,practice of irritation with existing rivers dominantly for the production of "Khat" in all sample Kebele. In addition to that as the key informant from kebele Das put: Having worked for about 8 years with the farmers around this area, I have realized that most of them are using various adaptation methods include water harvesting methods from existing rivers to conserve water to be used during drought, off-farm livelihood activities as source of income to support their family.

During drought, most farmers also practice irrigation using water from the side way existing rivers. As indicated in Table 8 above, from total respondents, (54.3%) of the respondents use Crop diversity to reduce the negative effect of climate change in this study, which the Intercropping system is commonly practiced in the study area where a combination of perennial bush crop "Khat", cereal crop (sorghum), legume crop (haricot bean) are grown together, while According to focus group discussion made, noted that they have wide field knowledge on the advantages of planting along the row and intercropping with varying attributes in terms of market value, maturity period, maintaining soil fertility, drought tolerance, input requirements and end users of the product as adaptation and productivity strategy to reduce the adverse effect of climate change on farm productivity.

Afforestation was used as adaptation practice by (53.7%) of the respondents to reduce the negative effect of climate variability. In the study area, farmers strongly associate planting trees with rain and they believe that planting trees can increase rainfall in addition to its high contribution in soil conservation. Participants of FGDs and key informant in the interview also confirmed that: Soil erosion by running water and increased temperature forced them to reforest hilly areas so that they protect their farm land from soil erosion by flash flood. Such method is viable in increasing Agricultural productivity and assists to control increasing temperature. As indicated in Table 8 above, from total respondents, (59.1%) of the respondents use agricultural input like artificial fertilizers, seeds, pesticide to maximize crop yields in this study Key informant from the district agriculture office suggested that: The government is supplying new agricultural input or varieties of crop seeds and inorganic fertilizer. Nevertheless, the high price of seeds and fertilizer coupled with low awareness of farmers in the use of agricultural technologies is impeding the expected high yield per a plot in some parts of the district. In general, the views of farmers and observations made in the field showed that many of the adaptation options were not implemented in a well-coordinated and organized manner. This is therefore weakening farmers' endeavors for adaptations to climate variability and in some study kebeles (lugo bachesa and madhich) there is a tendency of dependency syndrome, and expecting the government to provide them essential commodities for their livelihoods. This implies that the existence of institutional gap that hinders farmer's motivation to pursue climate change adaptation practices. Particularly failure to complement the efforts of innovative farmers with the required technological and other supports is likely to hamper adaptation efforts and may also induce tendency of dependency syndrome in the farming community

4.1.5. Challenges of Farmers' Faced to Implement Adaptation Strategies or option in the Study Area

Regarding the problems faced by households in adopting adaptation strategy to climate variability, respondents were asked different problems based on four magnitude criteria. That is not a problem at all, low problem, medium and a serious problem and summarizes respondent

Table 9 Major constraint of adaptation option in the study area

No/	Major determinants	High		Moderate		Law		No	
		No/	%	No/	%	No/	%	No/	%
1	Land shortage	144	87.8	20	12.2	-	-	-	-
2	Lack of credit	130	79.3	20	12.2	10	6.1	4	2.4
3	Lack of labor	123	75	21	12.8	10	6.1	10	6.1
4	Poor farm land	125	76.2	25	15.2	10	6.1	4	2.4
5	Expenses of Agricultural in put	124	75.6	22	13.4	13	7.9	5	3
6	Lack of awareness on the Impact of climate variability	90	54.9	50	30.5	15	9.1	9	5.5
7	Lack of awareness on adaptation strategies	110	67.1	30	18.3	14	8.5	10	6.1
8	Law of Agricultural input	146	89	10	6.1	8	4.9		
9	Number of Unproductive family	104	63.4	40	24.4	20	12.2		
10	Lack of Off farm activity	108	65.9	30	18.3	16	9.8	10	6.1

Source: field survey result, 2024

4.2. Econometric Results

Logistic regression model was used to address the third objective of the study. That identifies the factors that determine adaptation strategy of smallholder farming households to respond the effect of climate change and variability in the study area. To identify the major factors that determine adaptation strategy of smallholder farming households' household heads to respond the impact of climate variability, the dependent variables were analyzed with 13 explanatory variables by using binary logistic regression (BLR) omnibus test of model coefficient. These shows that the binary logistic model was statistically significant at (Chi-square=149, P-value=<0.000 with df=13), so it was appropriately fit for the data. In relation to the predictive efficiency of the model, the fitted binary logistic model explains that 92.9%, from the total 164 respondents included in the model were correctly predicted.

The Cox and Snell and Nagelkerke R-square value were 0.598 and 0.808 respectively (appendix Table -1.2). The Hosmer-Lemeshow test result also showed that, the Chi-square value of 0.59.22 with P-value of 0.000. l (appendix Table -1.3).The existence of Multi collinearity among the explanatory affects the parameter estimates seriously and influences the interpretation of the result Gujarati *(*2004*)*. Accordingly, the explanatory variables were checked for Multi collinearity using variance inflation factors (VIF) which none of variable no have 10 and above value and all tolerance value greater than 0.2 all continuous variables. However, in the result of VIF and tolerance test indicate that is no problem of Multi collinearity among the variables of this study (Appendix Table -1.6). In addition, coefficients of contingency test is computed to detect if there is an association between dummy variables, which can lead to the problem of Multi collinearity and the result also showed that there was no high degree of association between dummy variables (Appendix Table -1.4). For this reason, all of the explanatory variables were included in the final analysis. As can be seen from the BLR results in Table 14 numbers out of 13 independent variable one of which the Distance, house hold income, training, agricultural extension, off-farm activity, and credit services were significant and positively influenced the determinant factor of adaptation of smallholder farmers household heads decision to adopt Adaptation strategy or option. On the other hand, family size and land size were significant and negatively influenced which were the determinant factors of adaptive capacity of smallholder farmers household heads decision to adopt Adaptation strategy or option. However, variables like sex, marital status, number of active family members, education, and age of house hold were non-significant. In the subsequent section, only the variables that were statistically significant at less than or equal to 10% probability levels are interpreted and discussed.

4.3. Determinants of Smallholders Farmers Adaptation Option in the Study Area

Family size; The BLR analysis in Table 14 indicates that Family size of the household head small holder farmers was found to be negative and significant at 1% level of significance [B= -1.740; P-value=0.003] on the adoption of adaptive capacity option. The result implies that family size is a major determining factor that hinders farmers from becoming adopter of adaptation climate smart option. The argument is that the negative association is due to a larger family, particularly more dependents, might discourage participation in capital-intensive activities due to consumption pressure imposed by a large family (Taruvinga *et al*, 2016). On the other hand, larger families might divert part of their labor into non-farm economic activities to generate additional income and reduce consumption (Davis and Winters, 2021).

Table 10 Result of Binary regression models

	Variables	B	S.E	Wald	Df	Sig	Exp(B)	95%C.l forE(B)	
								Lower	Upper
	Constants	.713	.244	8.527	1	0.003	2.040	0.48	0.210
1	Sex(1)	0.497	0.484	1.055	1	0.304	1.645	0.637	4.249
2	Aghh	0.165	0.098	2.841	1	0.092	1.179	0.973	1.429
3	MS(1)	0.497	0.484	1.055	1	0.304	1.645	0.637	4.249
4	EDUL	-0.579	0.508	1.299	1	0.254	0.561	0.207	1.516
5	FamSaz	-1.740	0.587	8.782	1	0.003	0.176	0.056	0.555
6	Landsiz	-6.385	1.838	12.064	1	0.001	0.002	0.000	0.062
7	ACFAMMEM	-20.275	1959.9	0.000	1	0.992	0.00	0.00	0.00
8	HHINCOM	1.468	0.316	21.653	1	0.000	4.345	2.340	8.067
9	TRNING(1)	1.202	0.421	8.144	1	0.004	3.326	1.457	7.593
10	Distance	0.842	0.138	37.307	1	0.000	2.321	1.771	3.041
11	AccAgEXSer(1)	2.041	0.458	19.907	1	0.000	7.704	3.141	18.883
12	OFFACT(1)	1.808	0.456	15.744	1	0.000	6.1	2.497	14.901
13	CRDITSERV(1)	2.295	0.374	37.641	1	0.003	9.928	4.769	20.669

Source: SPSS version 20.0 result output, *, ** and *** and statistically significant at <0.01, 0.05 and < 0.1, level of significance respectively.

Farm size: It is a continuous explanatory variable measured in hectares. Indicates that there is negative and significant relationship between the adoption of Adaptation option and size of household's farm plot. The result of negative logit coefficient shows that of households owns more hectare than one farm plot have low chances to adopt adaptation option than households owns only less hectare of farm plot. On the other hand, farm parcels or land is significant factor at (P<0.001) for the adopters of adaptation option. The hectare or area of farm parcels negatively and significantly affects the probability of adoption of adaptive capacity strategy or option. The odds ratio factor 0.002 in the adopter indicate that assume the influence of other factors constant, the adoption of adaptation option likely decreases by 0.002 as the households owns more than hectare of farm plot. This finding suggested that the hectare of farm parcel affects the adoption of Adaptation option means that as the households owns only single farm parcel are motivated and eager to adopt adaptation strategy or option. In contrast, Farm size has a positive and significant association with most of the adaptation strategies (Abrham *et al*, 2017).

Agricultural extension services:

It is a dummy explanatory variable. Access to agricultural extension services is the major sources of information for smallholders adopting the adaptation strategy or option. Agricultural extension services are a means through which smallholders access information about improved technologies by contacting extension agents (Benin et al., 2020)." The result in Table 10 shows that, access to extension services had a positive and statistically significance at < 0.000 level of significance [B=2.041, P <0.000]. The odd ratio result depicts that those farmers who have access to extension service are increase in the ratio of 7.704 times to adopt adaptation option than those who do not have contact with extension service. The result also implies that extension service is a major determining factor that to be farmers becoming adopter of adaptation option in the study area which imply that, the household headed who have access to extension services, more to adopt adaptation strategy or option than those who have not an access, this could result due to attitudinal and their awareness, purchasing power input of Small holder farmers. The result is consistent with the findings of *a* study by, the extension services have a significant effect on using crop diversification to combat climate change effect (Zerihun *et al*, 2018).

Credit access (ACRS)**:** It is a dummy explanatory variable, the availability of credit is significantly and positive influencing purchasing inputs, improved crop varieties, and irrigation facilities Access to credit services is the significant for smallholders to adopting the adaptive capacity strategy or option. Availability of credit is a means of which smallholder's can purchase access about improved technologies. The result in Table 10 shows that, access to credit services had a positive and statistically significance at < 0.003level of significance [B=-2.295, P <0.000]. The odd ratio result depicts that those farmers who have access to credit service are increase the probability in the ratio of 9.928 times to adopt adaptive capacity option than those who do not have contact with cred, that availability of credit is positively and significantly influencing purchasing inputs, improved crop varieties, and irrigation facilities. The result consist with that A significant correlation between credit access and the adoption of advanced farming techniques, demonstrating that financial resources enable farmers to invest in better inputs and technologies (Mishra and Singh, 2022)

Training: It is dummy variable which the result indicates that the participation on training variable is positive and statistically significant at (p < 0.004) level of significance [B= 1.202, p-value= 0.004] for adoption of the best adaptation option. The results show that farmers who participate on training from local organizations are more likely to adopt of adaptation option of climate smart agriculture option. The odds ratio of 3.326 indicates that holding all other variables constant, for every one unit increase in the training score, we predict a 3.326 times increase in the log-odds of adoption of best adaptation option. This is also supported by the findings of Tesfaye et al. (2021), who found that training makes farmers conscious of using conservation measures by providing adequate and recent information and technical support about the significance of newly adopted climate-smart adaptation mechanisms as well as their cost-effective implementation.

Access to off/non-farm income (AO/NF): It is a dummy explanatory variable, availability of off/non-farm income for small holders' farmers were adopting the adaptive capacity strategy or option. Off/non-farm income, income obtained from an employment of the household in member off-farm and non-farm (hand craft, selling of fire wood, petty trading and remittance). The result in Table 10 shows that, availability of off farm income had a positive and statistically significance at < 0.000 level of significance [B=1.808, P <0.000].

The odd ratio result depicts that those farmers who have access to off farm activity were increase in the ratio of 6.1 times to adopt adaptation option than those who do not have contact with off farm activity in the study area. The result also implies that availability of off farm activity were a major determining factor that farmers becoming adopter of adaptive capacity option in the study area which imply that, household headed who have access off farm activity have more chance to adopt adaptive capacity strategy or option than those who have not an access, this could result due to as these activities share most of farmer's time, farmers pay more attention to both their farming activity and off/non-farm activities. This study hypothesized that off/non-farm income affect using of climate change adaptation strategies positively. The result is consistent with the findings of a study by Aymone (2022), which suggested that expanding smallholder farmers' access to off-farm and non-farm sources of income increases the probability that they will invest in farming activities.

Distance to the nearest market (DMAR): It is a continuous explanatory variable and measured in kilometers from home of the households to the nearest market. Distance to the nearest market is used as proxy for availability of input and output markets. It is hypothesized that when the farmers are located far from the nearest market, their preference of farmers to adaptation practices are negatively related with like improved varieties, fertilizers, livelihood diversification strategies, and irrigation technologies. The result in Table 10 shows that, availability distances nearest to the market had a positive and statistically high significance at < 0.000 level of significance [B=0.842, P <0.000]. The odd ratio result depicts that those farmers who have access to distance to the market were increase in the ratio of 2.321 times to adopt adaptation option than those who do not have contact with distance to the nearest to the market in the study area. The result is consistent with the findings of a study by Aymone (2022), which suggested that expanding smallholder farmers' access to off-farm and non-farm sources of income increases the probability that they will invest in farming activities.

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Farm income: The BLR model result indicates that households farm income is positive and statistically significance at 5% level of significance [B=1.468, P-value= 0.000] for adoption of adaptation strategy or option. The result of positive logit coefficient shows that farmers who have more farm income have more probability to adopt adaptation adaptive capacity option than those who have lesser farm income. The implication of the result was that availability of farm income improves farmers' financial position, which in turn, enables them to purchase farm inputs such as, drought resistance, legume crop and short duration crop varieties. The result of this study is consistent with the findings of Zhou and Zhang (2022), who reported that the adoption of new crop varieties requires more financial resources than the adoption of other adaptation strategies (Schaaf et al, 2021).In this study, farm income is considered an important variable for smallholders to adopt adaptation option because use of drought resistance and short duration crop varieties requires financial resources to purchase and hence increased income was encourage the investment capacity on adoption of climate smart adaptation option.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

Climate variability is causing the greatest environmental, social and economic threats to all of mankind and across borders in many nations. Climate change or variability highly affects smallholder farmers‟ agriculture as the consequence of climate variability; higher temperature; drought and increased rainfall variability reduce crop yield and quality. The high exposure of the country is because high dependence of the economy on rained agriculture, which had failed to meet the growing food demands of the population. Moreover, the past trends of climate variability reduces agricultural production will be probable to continue in the future. This indicates that the country agriculture must adapt further warming, low rainfall patterns and frequent climate extremes such as drought and flood. As a result, understanding smallholder farmer response to climatic change at grass roots level is important in designing suitable supportive policy to adaptation strategies of climate variability for smallholder farmers who are highly vulnerable to the adverse effects of climate variability. Therefore, this study was undertaken to examine the variability of observed rainfall and temperature, as well as the effect of climate variability (temperature and rainfall variation) on the livelihoods of smallholder farmers. It also assessed smallholder farmers' perception, determinant factors and adaptation strategies or option in response to climate variability in West Hararghe Chiro District.

Few studies have been conducted to analyze the different climate adaptation options used by farmers, to what extent each options is considered climate-proofing strategies and what factors are there that determines in adoption of Adaptation options among smallholder farmers of the study area, this study mainly focused and fills this gap. To answer the research questions Household survey conducted on 164 randomly selected household heads from three kebeles of the Chiro wereda, Western Hararghe, Oromia regional state, Ethiopia. Climate data for this study was obtained from National Meteorological Agency (NMA) of Ethiopia; secondary data was obtained from West Hararghe, Chiro wereda District Agriculture and Natural Resource Development office. On the other hand, questionnaires and interviews from three kebeles in West Hararghe Chiro District were designed to determine the perception of farmers towards climate variability and Determinants of adaptation strategies. Furthermore, observation was made to get first-hand information on the ground. During data analysis, statistical tools such as descriptive inferential statistics, Econometric method, correlation and regression analyses were used to analyze quantitative data with help of SPSS version 20 and Micro soft excel.

The study result depicts that a number of adaptation strategy were adopted by smallholders on different farmlands to scale up and maximize agricultural output. These Adaptation options include the combination or integration of Agroforestry, Soil and conservation, crop diversity, irrigation, and Agricultural input or technology option considered as the best strategic option ‘’the Adopt’’. The small holder farmers that partially practice or one of the adaptation option or strategy options ‘’Non-Adopt’’ was also the options of the study area. In this study, (92) 56% of the total sample households adopted the ‘’the Adopt’’ option. On the other hand, (72) 44% of the total sample households was practiced the Not Adopt option.

The result of this study revealed effectiveness of each adaptation strategy practices in the study area based on the full integration of the five adaptation strategies. These include combination or integration of Agroforestry, Soil and conservation, crop diversity, irrigation, and Agricultural input /technology practices. In this study result, out of the total respondent that majority of the households102 (62.2%) were benefited from the effectiveness of smart practices under soil and water conservation on both private and communal land, rehabilitation of degraded land in the study area like contour farming, conservation tillage, cover crops, soil bund, hillside trace which physical soils management practices while adopting the one adaptation option. Secondly the result of study shows that out of the total respondents 92 (59.1%) smallholder farmers benefited from smartness of Agricultural input or technology like artificial fertilizers, improved seeds, pesticide, crop variety which one of adaptation option. For the third result of the study shows specifically, out of the total 89(54.3%)of respondent was benefited from Crop diversity to reduce the negative effect of climate change in this study, which the intercropping system is commonly practiced in the study area where a combination of perennial bush crop “Khat”, cereal crop (sorghum), legume crop (haricot bean) are grown together. For the fourth smart result of study shows that from total respondent, 88(53.7%) 0f smallholder farmers benefited from smartness of Agroforestry or plantations option in communal and around their farm land, afforestation /reforestation was used as adaptation practice by the respondents to reduce the negative effect of climate variability. In the study area, farmers strongly associate planting trees with rain and they believe that planting trees can increase rainfall in addition to its high contribution in soil conservation. For the last one but not most result of study shows that from total respondent, 79(48.2%) of smallholder farmers benefited from irritation option in their Owen farm land farmers that around the existing river, practice of irritation with existing rivers dominantly for the production of "Khat" in all sample Kebele.

Finally, the main factors that determine Adaptation strategy in the study area were distance nearest to the market from farmers resident, access to extension, family size, training, off-farm income, ,smallholders area of farm parcels, credit services, house hold income and family size were significant influence household heads decision to adopt best adaptation option for adaptation strategy. All the above variables had positive influence except family and land size were significant and positive influenced household heads decision to adopt adaptation strategies or option. To sum up, it is logical to confirm that high attention for the above variables may have huge contribution to maximize adoption and scale up of the best adaptations strategy or option in the study area.

5.2. Conclusion

Based on the result, the study show that Climate variability highly affects smallholder farmers' agriculture as the consequence of climate variability; higher temperature; drought and increased rainfall variability reduce crop yield and quality. As a result, understanding smallholder farmer response to climatic variability at grass roots level is important in designing suitable supportive policy to adaptation strategies of climate variability for smallholder farmers who are highly vulnerable to the adverse effects of climate variability. It also assessed smallholder farmers' perception, determinant factors and adaptation strategies or option in response to climate variability in West Hararghe Chiro District.

The study also assessed farmers' perceptions towards climate variability with changes in rainfall and temperature. According to the result of this study, from total house hold respondent, 164(100%) and 160(97.6%) interviewed households respondent perceives that temperature and drought increase respectively over the last two decades in the study area. Among the impacts, droughts or longer dry-spells were mentioned by several farmers as being their greatest challenge which imply that decline of soil fertility or productivity, and decreased available water.

According to this study , there are different determinant factors that determine adaptation strategy which were Distance nearest to the market from farmers resident, access to extension, training, off-farm income, credit services and house hold incomes are significant factors that positives influence farmers' adoption of adaptive strategy or option. Farmers who were nearest to the market, house hold income, access to credit, off farm income with extension services and training did not face the constraint of input and labor to adopt the adaptation strategy to improve their adaptation option. Therefore, strengthening existing off farm income benefit schemes and creating others benefit related to the agriculture product based income generating activities, which helps to diversify incomes of households and in turn to increase the adoption of adaptation strategy to strength their adaptation option.

5.3 Recommendations

Based on the results of this study the following recommendations are for warded: Farmers are made aware that they need to know the various aspects of their farming conditions, constraints and opportunities for the improvement livelihoods systems and sustainable management of their farmlands. Different types adaptations options are employed on smallholder's farm land to improve agricultural production. Hence, the concerned government bodies of different level (nation, region and/or woreda) should help farmers by showing appropriate adaptations options by considering environmental condition and cost effective methods based on research findings. Different studies should be under taken on the effectiveness of CSA practices.

The majority of smallholder's adopt the best adaptation option to improve their adaptive climate smart practices but there is considerable number of households who did not adopt it. Therefore, creating awareness on farmer's attitude through awareness raising programs is vital for changing the attitude of farmers and improves farmer's participation in the study area. To increase smallholder's adaptation strategy by adopting of the best adaptation option practicing, the agricultural and rural development office of West Hararghe Zone, Chiro Woreda, NGOs and the concerned bodies could create awareness and encourage farmer's collaborations in adoption option practices. Distance nearest to the market from farmers resident, access to extension, training, off-farm income, credit services and house hold incomes are significant factors that positives influence farmers' adoption of adaptive strategy or option. Farmers who were nearest to the market, house hold income, access to credit, off farm income with extension services and training did not face the constraint of input and labor to adopt the adaptation strategy to improve their adaptation option. Therefore, strengthening existing off farm income benefit schemes and creating others benefit related to the agriculture product based income generating activities, which helps to diversify incomes of households and in turn to increase the adoption of adaptation strategy to strength their adaptation option.

The influential factors for the adoption of the best adaptation option is distance nearest to the market from farmers resident, training, off farm activity, house hold incomes, credits access and extension access of smallholder household heads. This implies that the intervention will be successful if it incorporates and make use of extension on adaptation strategy practices. Nevertheless, in order to make extension more successful, result based training methods need to be employed. The extension and training should focus on scientific and technical practice of adaptation option at grass root level. The extension agents should regularly contact with farmers as much as possible and live within the farming community they are serving. An extension agent could be contact farmers individually and in the group. Because of Farmers with access to extension services are likely to perceive changes in the climate. Even, extension services provide information about climate variability.

Therefore, training and extension services should be delivered to the households through providing information and free selection bias of farmers to improve adoption of adaptation strategies option

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7. APPENDICES

7.1. Appendix I: Household Survey Questionnaire

Dear Respondents

The objective of this questionnaire is to collect data as partial fulfillment of MA Thesis entitled on' determinants of adaptation strategies to climate variability by smallholder farmers of chiro woreda on determinants of adaptation strategies to climate variability by smallholder farmers of chiro woreda kebele. Your full support and willingness to respond to the question is very essential for the success of the study. Therefore, you are kindly requested to answer all questions and give clear and reliable information on the issues. Thank you in advance for your cooperation.

General information:

Name of interviewer: …………………………………….Code: ……………

Date: ………/………/……………. Village ……………… Kebele: ………………

Appendix I. Demography, Socio-Economic, institutional Characteristics

1. Sex of the respondent: Female ☐ Male ☐
2. Age of the HHH: ______
3. Marital Status: 1) Married; 2) Single; 3) Divorced; 4) Widowed;
4. Family size including HHH: Male: ………. Female…………. Total………..
5. Educational Level

Level	Male	Female	Total
Cannot read and write			
Write and Read (Non-formal)education			
Primary (1-8 grade)			
Secondary (8-12)			
certificate and Above			

6. Active family members aged between 15- and 64-years Male: Female Total…
7. Sources of livelihood income: Crop production: ………. Livestock production………. Mixed Farming …… If any Other……………..
8. Do you have your own land? 1. Yes 2. No
9. If yes to question no. 8, what is the total size of your land holding?
10. How much of the total land size is irrigated in hectares? _________

11. How much income do you get from your farmland?

Monthly: ………. Annual ………….

12. Do you have any off-farm Income? Yes: ………. No………….

13. If yes the answers for question No. 10, how much on average do you get?

Monthly: ………. Annually:

14. Do you have Access to agricultural extension services in your locality?

Yes: ………. No………….

15. Do you get credit from financial institution? 1) yes-------- 2) no-------

16. Do you have any access to irrigation water? 1) Yes ----------2) no-------

17. Do you get any weather information of your area? 1) yes------2) no-------

18. Did climate variability impacted your overall household income and well-being?1) yes--, 2) no----

19. If yes the answer for question No. 18, how it impacted ----------------------

20. Have you had to seek alternative sources of income due to climate-related challenges in farming? 1) yes------2) no-----

21. If yes the answer for question No. 20, List the type of sources incomes__________________

22. How do you perceive the long-term sustainability of stallholder farming in the face of climate change?

23. Are there any additional support or resources you believe would help improve your adaptive capacity and livelihood resilience? 1) yes------ 2) no--------

24. If yes the answer for question No. 23, List the type of resources/ support__________________

Part II: HHs perception on climate change and variability

18. Do you perceive of climate variability in your area? 1) yes----2) no------

19. Have you perceived change/variability on climate presently compared to climate condition before 30 years ago? **Yes: ………. No………….**

20. How do you perceive the following climate change and variability indicators from your experience over 30 years?

Indicators	Increased	Decreased	Not Sure
Climate is changing			

Temperature trend			
Rainfall trend			
Amount of rainfall			
Duration of rainfall			
Intensity of rainfall			

Part III: HHs perception on effects of Climate variability

21. Do you perceived the impact of climate change and Variability Yes: ………. No………….

22. If you answer for question no 21 yes what is your view the trend for following effects?

Effects	**Increased**	**Decreased**	**No change**
Water shortage			
Crop yields			
Production cost			
Frost incident			
Crop Pest and disease			

Part IV. HHs Adaptation Strategies to Climate Variability

23 Have you employed any of the following climate variability impact adaptation strategies in your farm in past decades?

	Adaptation Strategies	Response		If no, please specify the reason
		Yes	No	
1	Use of improved crop varieties			
2	Changing planting dates			
3	Agro-forestry/Planting trees			
4	Crop diversification			
5	Soil and water conservation techniques			
6	Use of irrigation			
7	Mixed farming			
8	Off-farm activities			
9	Others (specify if any)			

Part –v Adaptive Capacity Determinants

1. List What are the determinants of adaptive capacity? ______________________

   ____

2. List What are the major's factors that determine adaptive capacity are? _______________

____

No	Determinants factors of adaptive capacity	Responses		If no, please specify the reason
		Yes	**No**	
1	Technology access (like impute,			
2	Knowledge, Information access (market, climate information,			
3	Financial services credit services….			
4	Infrastructure (roads,…			
5	Others (specify if any)			

Appendices: II

Key Informant Interview: *Government* officials, Development Agents and other Experts

1. How do you understand climate variability?

2. In your opinion, how would you describe the climate variability trends in this area over the past decade?

3. How do you observed climate variability and its indicators in woreda? Would you explain the indicators of climate variability you observed?

4. Could you explain the major hazard experienced in the woreda as a result of CV?

5. Could you explain the measure that farmers in the woreda are undertake to adapt CV hazard?

6. What are the experienced of effects CV on Agricultural production of smallholder farmers (the woreda)?

7. Which group of crop type is severely affected as a result of CV in the woreda? (Cereals, pulses, oil crops, fruit or vegetable)?

8. Which type of agriculture system (farming practice) is severely affected due to climate variability 1. monoculture, 2. mixed farming, 3. Agroforestry 4. All

9. Would do explain the major types of agricultural adaptation practices that farmers in the woreda are practicing?

10. Could you explain major local level reasons that cause and aggravated CV in the woreda?

11. From your experience, what are some common adaptive strategies that stallholder farmers employ to cope with climate variability?

12. How effective do you perceive these adaptive strategies to be in enhancing stallholder farmers' resilience to climate variability?

13. What are some of the key factors that influence stallholder farmers' ability to adapt to climate variability?

14. Are there any differences in adaptive capacity among different groups of stallholder ?

15. As a professional what further strategies do you suggest (work to be done) to adopt CV effect and achieve food security in the woreda?

16. In your view, what your recommendation would you suggest and improvements or additional resources, are needed to enhance stallholder farmers' adaptive capacity?

17. How do existing policies and institutions address climate variability and its impacts on stallholder farming?

Appendices: III.

Focused Group Discussion (FGD)

1. What does climate Variability mean?

2. Do you think there is climate variability in your area?

3. What do you think the local indicators of climate variability?

4. What are the main causes of climate variability?

5. What are the major impacts of climate variability on crop production?

6. Who are more vulnerable to the effects of climate variability? __________________

7. Do you think climate variability affect your livelihood security and overall household income? If the answer is yes how?

8. What are the barriers to cope with the impact of climate variability?

9. What adaptation measures do people in your area took when confronted with climate variability related shook?

10. Local government and non-government institution supported your effort to adapt climate variability? (Who are they, what support?)

11.How effective do you find this support in enhancing your adaptive capacity?

12. What strategies or practices have you implemented to cope with climate variability in your farming activities?

13. Have these strategies been effective in mitigating the impacts of climate variability? Why or why not?

14. Are there any barriers or challenges you encounter in adopting or implementing adaptive strategies?

15. Are there any long-term implications of climate variability on the sustainability of stallholder farming in your community?

16. Are there any community-based initiatives or practices that contribute to resilience-building among stallholder farmers?

17. What sources of climate information or forecasts do you rely on to make farming-related decisions?

18.What are the major’s factors that determine adaptive capacity local smallholders in the study are?

29.What are the determinants of adaptive capacity of small holder farmers in the study area?

7.2. Appendix IV: Appendix Tables

Appendix Table 1 Binary logistic regression model analysis results

Appendix 1: Omibus test of model coefficient

		Chi-square	Df	Sig.
Step 1	Step	149.563	13	.000
	Block	149.563	13	.000
	Model	149.563	12	.000

Source: Own computation result, 2024

Appendix 2: Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	71.505[a]	.598	.808

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

Source: Own computation result, 2024

Appendix 3: Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	59.082	8	.000

Source: Own computation result, 2024

Appendix 4: Contingency Table for Hosmer and Lemeshow Test

		Economic resources = yes		Economic resources = no		Total
		Observed	Expected	Observed	Expected	
Step 1	1	18	17.996	0	.004	18
	2	19	18.945	0	.055	19
	3	18	17.831	0	.169	18
	4	18	17.497	0	.503	18
	5	18	15.109	0	2.891	18
	6	0	5.739	14	8.261	14
	7	0	2.804	16	13.196	16
	8	7	.964	7	13.036	14
	9	0	.723	14	13.277	14
	10	0	.393	15	14.607	15

Source: Own computation result, 2024

Appendix 5: Classification Table

	Observed		Predicted		
			Economic resources		Percentage Correct
			yes	No	
Step 1	Economic resources	Yes	91	7	92.9
		No	0	66	100.0
	Overall Percentage				95.7

a. The cut value is .500

Source: Own computation result, 2024

Appendix 6: Multicollinearity test for continuous variable

Model		Collinearity Statistics	
		Tolerance	VIF
1	Age of house hold	.374	2.673
	Family size including HHH	.375	2.665
	total size of your land holding	.657	1.522
	Active family members	.512	1.954

Source: Own computation result, 2024

Appendix 7: correlation test for dummy variable

Correlations

		House hold sex	TRAINIG FOR HOUSE HOLDES	Accees of agricultural extention services	Off farm activity	Credit services
House hold sex	Pearson Correlation	1	.044	.183*	.394**	.118
	Sig. (2-tailed)		.578	.019	.000	.133
	N	164	164	164	164	164
TRAINIG FOR HOUSE HOLDES	Pearson Correlation	.044	1	.621**	.697**	.611**
	Sig. (2-tailed)	.578		.000	.000	.000
	N	164	164	164	164	164
Accees of agricultural extention services	Pearson Correlation	.183*	.621**	1	.698**	.375**
	Sig. (2-tailed)	.019	.000		.000	.000
	N	164	164	164	164	164
Off farm activity	Pearson Correlation	.394**	.697**	.698**	1	.687**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	164	164	164	164	164
Credit services	Pearson Correlation	.118	.611**	.375**	.687**	1
	Sig. (2-tailed)	.133	.000	.000	.000	
	N	164	164	164	164	164

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Own computation result, 2024