ADDIS ABABA UNIVERSITY

POSTGRADUATE PROGRAM

COLLEGE OF SOCIAL SCIENCES

DEPARTMENT OF GEOGRAPHY AND

ENVIRONMENTAL STUDIES

ASSESSING CLIMATE CHANGE IMPACTS AND ADAPTATIONS STRATEGIES AMONG SMALLHOLDER FARMERS: THE CASE OF CHIRO WOREDA, WEST HARERGHE, OROMIA REGION, EAST ETHIOPIA

BY: Belay Gurmessa Tafa

Advisor: Aklilu Amsalu(PhD)

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A THESIS SUBMITTED TO THE COLLEGE OF SOCIAL SCIENCE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF ARTS IN GEOGRAPHY AND ENVIRONMENTAL STUDIES.

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ADDIS ABABA

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APPROVED BY THE BOARD OF EXAMINER

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External Examiner	Signature	Date
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Internal-Examiner	Signature	Date

DEDICATION

I dedicated this thesis manuscript to my parents and my friends for their partnership in the success of my life.

STATEMENT OF THE AUTHOR

I so certify that this thesis is entirely my own, and I sign below to that effect. The preparation, data gathering, data analysis, and thesis compilation have all been done in accordance with all ethical and technical scholarly criteria. A citation has been used to acknowledge any academic material that is part of the thesis.

This thesis is being submitted to Addis Ababa University as a partial fulfillment of the requirements for a Master of Geography. The thesis is placed in the Addis Ababa University library, where it can be borrowed subject to the policies of the establishment. As long as the source is properly and fully acknowledged, brief quotes from this thesis are permitted without the need for additional permission. In all other instances, however, permission must be obtained from the author of the thesis.

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Date of Submission: August 10, 2024

Place: Addis Ababa University, Addis Ababa

BIOGRAPHICAL SKETCH

The author was born in wine-Rogge *kebele* Gindeberat district, West Shewa, Oromia Regional State of Ethiopia, on December 19, 1979 E.C., to his mother Kifle Tirge and his father Gurmessa Tafa. He attended his elementary education in Abuye Rogge elementary school. He also attended his junior education at Kachis secondary school. Then, he joined Ginchi Comprehensive Secondary School and completed his secondary education in 1997 E.C. In 1998 E.C., the author joined Bahir Dar University and graduated with a BA degree in geography in July 2000 E.C. After his graduation, he was employed in Chiro town. Meanwhile, he joined the School of Graduate Studies of AAU in August 2009 E.C. with an MA degree in geography.

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ACRONYM AND ABBREVIATION

AEZs:	Agro-Ecological Zones
CWLAO:	Chiro woreda Land Administration Office
CWMS:	Chiro Woreda Metrological Station
CSA:	Central Statics Agency
FAO:	Food and Agricultural Organization
GHG:	Greenhouse Gas
IPCC:	Intergovernmental Panel for Climate Change
M.A.S.L:	Meter above Sea Level
NAPA:	National Adaptation Program of Action
NGO:	Non-Governmental Organization
NMA:	National Metrological Agency
NMSA:	National Metrological Service Agency
PANCSOE:	Poverty Action Network of civil society organizations in Ethiopia
SSA:	Sub-Saharan Africa
UNDP:	United Nations Development Program
UNFCCC:	United Nations Framework Convention on Climate Change

ABSTRACT

Small-scale farmers in poor countries, particularly in Africa, that depend on rain-fed crops for a living have been impacted by climate change. Climate change adaptation and mitigation are critical in this environment. This study was to assess the impact of climate change and adaptation strategies among smallholder farmers in Chiro Woreda. The selection of the kebeles were done purposefully based on the agroecology. For the study, one group in each kebeles was formed composed of male and female to collect primary data. The main methods used to gather the data were interviews with kebeles administrators', woreda managers', and development team leaders' peoples and local elders; questionnaires; focused group discussions (FGDs) with selected farmers; and reviewing secondary data from different unpublished sources. Descriptive ways of analysis methods was applied. Farmers had adopted various climate change adaptations; the respondents had income source diversification; early and late planting, shifting from cattle to small ruminants, practicing soil and water conservation, having planted drought-resistant crops, practicing decreased livestock, practicing forestation and reforestation, practicing mixed farming, practicing irrigation, and practicing daily labor. The study was focused on major problems of crop production. Farmers also sorted out their major challenges for their failures to adapt, which include lack of irrigation, inadequate of money to finance their adaptation strategies, inadequate of knowledge concerning appropriate adaptation strategies, unavailable of information about long-term climate change, lack of extension services, insufficient infrastructure, shortage of land, insecure property rights and land tenure issues, and lack of credit service.

Key words:*, climate change, adaptation strategy, adaptation, smallholder farmers.*

CHAPTER ONE

1 INTRODUCTION

1.1 Background of Study

Empirical data indicates that the Earth's climate is changing quickly as a result of rising greenhouse gas emissions. Global temperatures have increased and rainfall patterns have changed as a result of higher GHG concentrations. For instance, warming in sub-Saharan Africa is expected to be greater than the global average, and some areas of the region may experience decreasing rainfall. Evidence suggests that extreme weather events, such as droughts and floods, are happening more frequently (Anderson, 2010).

Small-scale farmers in poor countries that depend on rain-fed crops for a living have been impacted by these effects. Particularly in Africa, social and environmental systems have been impacted by climate change. People's lives and livelihoods that rely on the natural environment are being disrupted by rising temperatures, shifting precipitation patterns, and increasingly intense weather (Amsalu, 2010).

Semi-arid and dry regions typically experience more severe effects from climate change (Anderson, 2010; Boko, 2007; Otto, 2015). The international community is facing a challenge in limiting the damage caused by climate change (McCarthy, 2011). Climate change adaptation and mitigation are critical in this environment (McCarthy, 2011). On its own, adaptation cannot stop climate change; it can only mitigate its effects. There will always be lingering expenses, notwithstanding adaptation. Smallholder farmers might, for instance, convert to crop varieties that are better suited, but their productivity might suffer as a result (Adger, 2003).

For impoverished communities in developing nations to maintain their standard of living, the agricultural sector must adapt to the changing climate (IPCC, Part B 2014). A variety of stakeholders, including legislators, extension agents, NGOs, researchers, communities, and farmers, will need to be involved for adaptation to be effective. Adaptation to climate change is frequently site-specific, and its success is influenced by the socioeconomic environment and local institutions (Morton, 2007). It is necessary to have a deeper comprehension of smallholder farmers' perspectives on climate change and their adaptation tactics in order to guide policies and initiatives that support successful agricultural sector adaptation. Farmers' decisions to use specific adaptation tactics and their perceptions of climatic unpredictability are influenced by a number of factors (Deressa, 2009; Hassan, 2008).

Farmers are becoming increasingly concerned about climate change, particularly those in tropical places such as Africa. Precautions are required to prevent the detrimental effects of climate change on agriculture in Africa, as stated by Deressa (2008) and Kurukulasuriya and Mendelsohn (2006). Deressa et al. (2009) reported that the agricultural production of rural household farmers in Ethiopia was being negatively impacted by rising temperatures and variations in rainfall in different regions. Strategies for adaptation are essential if smallholder farmers are to reduce the effects of climate change. Climate change can be better understood and adapted to by smallholder farmers with the support of social, economic, technological, and environmental trends. Furthermore, understanding adaptation techniques and the variables affecting farmers' strategy decisions might directly improve efforts to address the effects of climate change.

With a thorough understanding of these elements, efforts ought to concentrate on figuring out how smallholder farmers might lessen issues and improve their ability to adapt to climate change. In general, it is thought that improving the resilience of the agricultural sector requires smallholders' agricultural activities to be adapted to climate change. This can be accomplished by identifying ways for smallholder farmers to lessen problems and enhance their attempts to fortify their climate change adaptation. In general, it is believed that improving the resilience of agricultural sectors depends on smallholder adaptation techniques for agriculture in response to climate change (Deressa et al., 2009).

This can be accomplished by governments enacting laws targeted at encouraging suitable and effective adaptation measures or by smallholder farmers themselves conducting adaptive actions. According to several studies, the most common adaptation tactics in African nations are agricultural ones, including using improved crop varieties, planting trees, conserving soil, adjusting planting dates, and providing irrigation. Numerous socioeconomic, environmental, and institutional elements, along with the economic structure, have been identified by other studies as important factors influencing farmers' decisions to select particular practices throughout Africa and in a few particular SSA countries (Mideksa, 2009; and Bryan et al., 2009).

Smit and Skinner (2002) have shown that in the absence of adaptation, climate change will have a significant impact on agricultural production, increasing farmers' vulnerability. Numerous socioeconomic considerations, farm features, and changes in climate have an impact on farmers' decisions to use or not employ climate change adaptation measures. Designing successful strategies to support climate change adaptation in the agricultural sector requires an understanding of the factors that influence farmers' adaptation decisions.

Farmers' decisions about adaptation are influenced by a variety of factors, including their livelihood strategies, farm characteristics, land management techniques, and sociodemographic traits. Based on these variables, some farmers are more adaptive and flexible than others. Developing intervention approaches to enhance farmers' adaptable skills requires an understanding of the fundamental factors influencing their decision-making about climate change adaptation tactics. Since context can greatly affect susceptibility and adaptation strategies, each nation must comprehend the precise elements impacting adaptation among its smallholder farmers as well as the local scope of the repercussions of climate change. It takes this specific awareness to create effective policy responses (Deressa et al., 2009).

To put it briefly, the sentence highlights how crucial it is to look at the many factors that influence farmers' decisions about how to adapt to climate change. Only then can policy interventions be made that will actually help smallholder agricultural communities become more adaptive.

Thus, using Chiro woreda as a case study, this study aimed to explore barriers to adaptation to climate change and variability as well as actual adaptation at the farm level and the factors that seem to be driving them.

1.2 Statement of the Problem

On global basis, climate variability and change may have an overall negligible effect on total agricultural production. However, the regional impacts are likely to be substantial and variable, with some regions benefiting from an altered climate and other regions adversely affected.

Generally, agricultural production is likely to decline in most critical regions (e.g. subtropical and tropical areas), whereas, in developed countries it may actually benefit where technology is more available and if appropriate adaptive adjustments are employed (Parry and Rosenwieg, 1994).

Different studies indicated that over the past years, mean temperature level in Africa has increased whereas precipitation level has decreased (IPCC, 2001). Spatial and temporal variability, more intense and widespread drought and aggravated flooding have been experienced in Africa over the past few decades in addition to the decreasing trend in the level of rainfall (Deressa et al., 2007).

Economic growth has been negatively impacted by climate change. All climate-sensitive economic sectors are impacted, but agriculture is particularly so. Ethiopia is a developing nation whose economy is primarily based on agriculture, which has not been able to keep up with the rising demand for food. This is because agricultural production is negatively impacted by climate change (World Bank, 2007). Furthermore, Deressa (2007) asserts that climate-related calamities like drought and flood, which are serious problems, have a detrimental effect on Ethiopia's agricultural industry. In order to help farmers deal with the negative effects of climate change and variability, adaptation is a crucial tactic that can help impoverished farm households boost their agricultural output (Yesuf et al., 2008). Similar to this, smallholder farmers' familiarity with adaptation strategies may aid in more effectively addressing the issue of climate change (Deressa et al., 2009).

Since climate change is a natural process that changes depending on location, socioeconomic status, and environment, it is an unexpected effect. The ability of societies to adjust to climatic change varies. This suggests that in order to get accurate data and suitable policy, adaptation strategies at the micro-level farm household are crucial. Based on where they live, farmers have varying propensities to adapt, claims Maddison (2007). When it comes to the effects of and ability to adapt to climate change, farmers in different regions or agricultural zones have distinct tendencies and capacities.

While some researchers have looked into climate-related concerns in Ethiopia, the majority of their studies (Deressa et al., 2010; Rengler et al., 2009; Hassan et al., 2008; and Yesuf et al., 2008) used farmers in the Nile Basin as a case study. Particularly for farmers in areas with socioeconomic and climatic characteristics comparable to those of the Nile Basin, their findings are valuable for micro-level policy interventions. However, considering the variations in agro-ecologies, a universal suggestion is inappropriate. Since adaptation is a local endeavor, different groups and even individuals have different strategies for adjusting. Fussel (2007) suggests that adjusting adaptation strategies to the needs of particular civilizations or communities could help mitigate the negative effects of climate change.

Extreme weather conditions, particularly drought and flooding, are not new to Ethiopia historically. Drought poses a threat to most of the nation (NMA, 2007). Despite a lengthy history of drought, research indicates that in recent decades, drought frequency has increased, particularly in lowlands (Lautze et al., 2003). In the past, frequent droughts have caused significant property and human migration losses. For example, millions of people were affected and thousands of people died as a result of the famine-driven droughts in 1973–1974, 1983–1984, and 2000–2003 (Quinn and Neal, 1987; Degefu, 1987; Nicholls, 1993; Webb and Braun, 1994, as referenced in NMA, 2007).

The deaths throughout the years were not only attributable to heat stress; rather, they were also the result of long-term food insecurity brought on by major crop failure, livestock losses, and a lack of water. Flash floods and seasonal river floods are other climate-related dangers that Ethiopia experiences on a regular basis. Significant floods that claimed lives and destroyed property happened in various sections of the nation in various years (NMA, 2007). For instance, the floods in Dire Dawa and Omo in 2006 claimed numerous lives, as well as crops, animals, and wildlife. Climate change and variability in Ethiopia are expected to have a significant negative impact on smallholder farmers' agricultural productivity and food security, particularly their ability to obtain food.

According to research reports, the Ethiopian agriculture sector is suffering from and will continue to suffer from both temperature increases and precipitation declines (Temesgen, D., et al., 2008; Temesgen, D., 2007). According to the results, all SRES model scenarios show that by

2050 and 2100, net revenue per hectare will decrease due to climate change. The harm that climate change does to Ethiopian farmers' well-being is reported to have increased over time and to have varied effects on different regions. Like farmers everywhere else in Ethiopia, the Chiro woreda farming community in Western Hararghe is suffering from climate change-related natural disasters. First, rising temperatures disrupt the soil, microclimate, and crop physiology. Second, droughts and floods have a regular negative impact on crop and livestock productivity. Third, there is far less water available and yearly river runoff. Food insecurity is a significant problem in the area, and as poorer farm households are less able to adjust to changes in the environment, the effects of all these climate shocks have been more detrimental to their food security (Baseline survey, 2010). It was crucial to create suitable policies and adaptive measures as a result.

Climate change is having a negative influence on agriculture in this research area, which is leading to smallholder farmers producing fewer agricultural products. As a result, the region is severely impacted by weather unpredictability and climate change. As far as the researcher is aware, no prior research has been done in this study region on the methods used by smallholder farmers to adapt to climate change. In light of this knowledge gap, the researcher investigated how smallholder farmers in Chiro woreda were adapting to climate change at the grassroots level.

1.3 Objectives

1.3.1 General Objective

The general objective of this study was to assess the impact of climate change and adaptation strategies among smallholder farmers in Chiro Woreda.

1.3.2 Specific Objectives

The specific objectives of this study were:

1. To describe the factors that affect the smallholders’ choice of climate change adaptation strategies.
2. To assess household perceptions towards climate variability in the study area.

3. To identify the existing adaptation strategies used by smallholder households to reduce the impact of climate change in the study area.

1.4 Research Questions

In order to achieve the above objectives, this study attempts to address the following research questions:.

1. What are the factors that influence farmers' choice of adaptation strategies to climate change in the study area?
2. How can the household perceive the variability of climate in the study area?
3. What kinds of adaptation strategies do farmers' use in response to climate change in the study area?

1.5 Significance of the Study

The findings of this study can provide valuable insights for local administrators to better understand the adaptation strategies employed by farmers, as well as the key factors influencing their adaptive capacities to climate change. The examination of indigenous/traditional agricultural practices adds important knowledge about how smallholder farmers are adapting to climate change and variability. This local knowledge can complement scientific understanding of climate change adaptation.

The study can serve as a useful guideline for conducting further research in similar climatic, socioeconomic, and geographical contexts. The results could have significant contributions for informing the efforts of local and national governments, NGOs, and bilateral donors.

Specifically, the findings could aid in the development of targeted policies and interventions at the local level to help minimize the impacts of climate change. This includes understanding the locally utilized adaptation strategies and the determinants of farmers' adaptive abilities.

Overall, the study has the potential to provide important insights that can guide the design of more effective, context-specific policies and programs by local and national authorities, nonprofit organizations, and international development partners. The integration of traditional knowledge with scientific analysis can lead to more holistic and responsive climate change adaptation strategies for smallholder agricultural communities.

1.6 Scope and limitations of the Study

The scope of study was conducted on smallholder farmers' adaptation strategies to climate change impact by taking only three kebeles of Chiro woreda representing lowland, midland, and highland agro-ecological zones due to financial limitations. So the result obtained from the study is not enough to give an abroad conclusion about Chiro woreda farmers' adaptive strategies, as data in the other agro-ecological zones of Chiro woreda is not collected.

1.7 Organization of the thesis

Chapter one is the introduction that consists of the background of the study, a statement of the problem, the objectives of the study, research questions, the significance of the study, the scope of the study, and the organization of the study paper. Chapter two: is underlying theory which consists of previous study and literature review. Chapter three is the methodology of the study. Discuss the study area, geographical location, research design, data sources, sample size and sample technique, data collection instrument, procedure of data collection, and method of data analysis. Chapter four presents and discusses the results of the analysis. Conclusions and recommendations for policy formulation adaptation strategies are presented in chapter five. Finally, the necessary appendices are attached at the end of the paper.

1.8 Definitions of Conceptual Terms

Smallholder: Alludes to small-scale farming, which includes subsistence, family agriculture, smallholder farming, tiny farmers, and peasant farming, among other meanings. Family farmers, pastoralists, herders, landless rural laborers, forest dwellers, fishermen, gardeners, indigenous peoples, and traditional groups are among those involved. In order to implement policies, governments must operationalize qualitative ideas about small-scale farming into formal definitions.

Exposure: A key component of vulnerability, exposure describes the kind, length, and/or intensity of disturbances that a system encounters or is exposed to.

Sensitivity: The extent to which changes in the climate have a favorable or negative impact on a system. Both direct and indirect effects are possible, such as damages from increasing coastal flooding brought on by sea level rise or changes in crop output owing to temperature differences.

Resilience: The capacity of a system to bounce back from shocks. The biophysical and social factors that determine exposure to climate risks must be addressed in response to climate change. These reactions and adjustments can be made on their own or through collaborative public and private planning.

Climate change: Any change in climatic conditions persisting over decades, whether stemming from natural variability or human activity.

Adaptation: adjustments in natural or human systems in response to actual or anticipated climate influences or their effects, lessening harm or exploiting benefits.

Adaptive capacity: A system's potential ability to adjust to climate change, variability, and extremes to moderate damages, utilize opportunities, or cope with consequences.

Adaptation strategy: broad action plans implemented through policies and measures to address climate change.

CHAPTER TWO

2. Literature Review

2.1 Concept and definition of climate change

Long-term variations in temperature, precipitation, wind, and other facets of the Earth's climate are collectively referred to as climate change (IPCC, 2007). It comprises measuring changes in these qualities' mean values or variability statistically over extended periods of time. Climate change is described by the World Meteorological Organization (WMO) as a shift in the climate that lasts for several decades or longer and can be detected by variations in the mean or variability of its attributes (WMO, 2014).

Both natural phenomena, such as shifts in the earth's orbit, and human activity, like the release of greenhouse gases into the atmosphere, may be to blame for climate change. IPCC (2007) states that human activities, such as burning fossil fuels, deforestation, and industrial agriculture, among other things, release greenhouse gases into the atmosphere, such as carbon dioxide and methane, which are the main causes of the recent fast climate change.

The phenomenon known as the greenhouse effect occurs when greenhouse gases build up in the lower atmosphere. There, they absorb and reflect heat, trapping it there and ultimately raising global temperatures. Rising sea levels, altered precipitation patterns, a persistent increase in global temperature, and a rise in the frequency of extreme weather events are examples of how this has shown itself (IPCC, 2014).

To put it briefly, climate change pertains to statistically significant long-term variations or trends in climatic measures, such as temperature, precipitation, or wind patterns, resulting from a combination of natural and human-caused processes that modify the composition of the atmosphere over large geographic areas.

2.2 Effects of climate change on agriculture

Climate change poses serious risks to agriculture and global food security. Because of rising temperatures, changed rainfall patterns, and a rise in the frequency of extreme weather events, climate change has a significant impact on agricultural production globally in many locations (IPCC, 2014).

High temperatures alter the stages of plant development, affect agricultural physiology, and decrease yield. Cattle and crops require more water as a result of climate change. Variations in rainfall patterns: Different rainfall patterns in terms of time, intensity, and distribution can cause havoc to agricultural activities. Both excessive and insufficient rainfall during critical periods reduce crop productivity. An increase in harsh weather: Floods and droughts are increasingly frequent and severely harm crops and cattle. Droughts have a negative impact on agricultural growth and harvests, whereas floods harm crops.

Sea level rise: Increasing sea levels saline farmlands and wetlands along the coast, rendering the region unsuitable for farming. It also leads to the loss of agricultural land. Pests and disease outbreaks: Climate change affects the distribution of both pests and diseases. Moreover, it increases the possibility of pest and disease outbreaks, which have the potential to destroy whole harvests of crops.

Reduced soil moisture, increased soil erosion, lower soil fertility, and decreased water availability are further effects that restrict agricultural output. Because of heat stress and restricted availability to water and nutrition owing to climate change, livestock have a tough time living. It generally increases the risks and expenses of production for farmers. Global food security is expected to suffer as a result of climate change's effects on livestock and crop production systems, according to the IPCC.

2.3 Strategies of climate change implementations

Climate change implementation strategies are concerted efforts to reduce greenhouse gas emissions and boost resilience to better survive the consequences of climate change. The two primary strategies are climate change reduction and adaptation.

2.3.1 Mitigation

The aim of mitigation is to lessen the impact of human activity on the climate system. The primary means of accomplishing this is by lowering greenhouse gas emissions that fuel global warming. Transitioning from fossil fuels to clean, renewable energy sources, such as hydropower, wind, and solar power, is one of the most often used mitigating strategies.

- Improving the energy efficiency of industry, agriculture, transportation, and buildings.
- Enhancing the amount of carbon stored or sequestered in farms, forests, and coastal wetlands through the use of sustainable agricultural and land management practices.
- Implementing emission reduction strategies, behavior modification initiatives, and low-carbon technologies.
- Reduce greenhouse gas emissions by utilizing financial instruments such as emissions trading programs and carbon levies.

2.3.2 Adaptation

The actions taken to minimize the effects of actual or anticipated climate change are referred to as "adaptation". As a result, both natural and human systems become less susceptible and more resilient. One of the primary alternatives for adaptation is to use climate-resilient building practices and infrastructure to withstand natural calamities.

Employing livestock, agricultural, and fish species that are more adaptable to changing environmental conditions.

- Diversifying revenue streams to spread the risk of the effects of climate change.
- Setting up backup plans and early warning systems for crises like floods and droughts.
- Maintaining naturally occurring buffers like wetlands, forests, and coastal mangroves that help build climate resilience.
- Enhancing the availability of funding, insurance, and climate information for disadvantaged groups.

Mitigation and adaptation strategies must be coordinated in order to lessen harm and seize possibilities brought about by climate change at the global, national, and local levels.

2.4 Agricultural Adaptation Strategies

Smallholder farmers employ a range of strategies to lessen the risks related to climate change and enhance the sustainability of their agricultural livelihoods (Morton, 2007; Bryan et al., 2013). The principal tactics comprise the search for crop varieties that demonstrate adaptability to changes in patterns of precipitation, temperature increases, and heightened occurrences of droughts and flooding (Abid et al., 2015; Lal et al., 2011). Try new seed kinds or native cultivars that are suitable for the shifting local environment to achieve this (Mwale et al., 2020).

The risks associated with climatic hazards that could influence any one product can be diversified by raising a number of livestock species and growing a diverse mix of food and cash crops (Tsegaye et al., 2020; Molua, 2010). This helps to sustain output and revenue levels in the face of extreme events (Rosenzweig and Hillel, 2008). When techniques like rangeland restoration, agroforestry, watershed management, and soil and water conservation are used, farmland ecologies are more resilient (Kumar et al., 2019; Negash and Snyman, 2013). They improve soil health, retain moisture, stop erosion, and increase the production of fuelwood and feed (Amede, 2014; Paul et al., 2013).

Farmers search for alternative or additional livelihood streams, such as petty commerce, casual labor, crafting production, etc., to stabilize overall family economics in the face of climate instability and agricultural uncertainty (Mburu et al., 2017; Osbahr et al., 2008). Farmers adjust planting and harvest dates in response to changes in precipitation timing and patterns in order to enhance crop yields (Gbetibouo, 2009; Seo et al., 2008). According to Antwi-Agyei et al. (2012), planting can help avert dry spells and periods of heavy rainfall.

Farming communities use both outside knowledge and internal ecological expertise to develop innovative adaptation techniques that are suitable for their socio-ecological setting (Ingram et al., 2002; Angassa and Oba, 2008). The available resources, local context, and vulnerabilities all influence the best mix of strategies. Developing long-term resilience usually calls for a coordinated strategy.

2.4.1 Crop Diversification

Growing a range of crops on the same plot of land is known as crop diversification (Asfaw and Admassie, 2004). It entails growing several crops in succession or coexisting in the same field with differing maturity dates, temperatures, and rainfall needs. Farmers can lower their chance of crop failure entirely by diversifying their crops in response to climate change impacts like drought (Mulugeta, 2014). Because other crops may yield properly, it guarantees food supply and access even in the event of a crop failure (Below et al., 2012).

Diversifying crop species and kinds boosts households' tolerance to changing climatic conditions (Below et al., 2010). Planting crops with varied ecological and maturity requirements spreads risks compared to reliance on a single crop species (Lobell et al., 2008). For example, growing both drought-resistant and high-yield potential cultivars together provides safeguards against total production failure (Kebede et al., 2018). By fixing nitrogen and reducing pest and disease infestations, crop rotation also contributes to increased soil fertility (Kassie et al., 2014).

In the developing world, crop diversification is a common practice among smallholder farmers as an indigenous adaptation strategy to improve food security in the face of climate uncertainty (Makate et al., 2016). Empirical studies conducted recently in East Africa have revealed higher rates of crop diversification among farmers who perceive stronger impacts from climate change (Below et al., 2012; Tambo and Abdoulaye, 2012).

2.4.2 Mixing Crop Production with Pastoralism.

Mixing crop production with livestock husbandry, usually known as agro-patronalism, is an important adaptation method for many farmers in semi-arid environments. It involves synergistic management of both crop and livestock enterprises within the same agricultural system.

Crop growers can reap several advantages from raising cattle. According to Kurukulasuriya and Rosenthal (2013), livestock act as "living banks" and can generate revenue through sales as needed. Their provision of meat, milk, and draft power acts as insurance during times of agricultural failure or adversity (Ogalla et al., 2020). According to Mutekwa (2009), livestock manure is also utilized to keep the soil fertile, which is essential for continuing agricultural productivity.

However, by integrating crops and livestock, agro-pastoralism reduces farmers' risks from climate extremes like drought that may affect one component (Mutekwa, 2009). Combining the two livelihood sources also makes use of each farming system's strengths and dependencies, which enhances household food and income security under changing conditions (Ogalla et al., 2020). This makes it a prominent adaptation strategy among mixed farmers in Sub-Saharan Africa. Conversely, growing fodder and staple crops supports animal nutrition; crops help diversify diets and provide fallback food options during periods of pasture and water shortages (Kurukulasuriya and Mendelsohn, 2008).

2.4.3 Tree Planting

For smallholder farmers, planting trees on fields is a crucial adaptation method. It offers several advantages that strengthen agriculture's resistance to the effects of climate change. The shade that trees provide is one of its main advantages in reducing the effects of rising temperatures. Shade trees shield grassland, cattle, and crops from extreme heat as a result of increasing heat stress brought on by climate change (Mbow et al., 2014).

Additionally, trees are essential for conserving water and soil. Their root systems prevent soil erosion by retaining soil in situ. Furthermore, leaf litter increases soil organic matter and moisture retention (Konuche et al., 2019). Additionally, deep tree roots can penetrate lower soil layers for moisture, accessing subsurface water sources that are inaccessible to crops. They are therefore an important crop that can withstand drought (Amede, 2011). By absorbing rainfall, trees also contribute to the replenishment of groundwater levels, increasing the total amount of water available for agriculture and grazing areas (Rao et al., 1998).

Beyond their positive effects on the environment, trees help farmers diversify their sources of revenue and livelihood. When agricultural yields decline, products from trees, such as lumber, firewood, fruits, and fodder, produce additional revenue and lower risk exposure (Mbow et al., 2014). In comparison to monoculture agricultural systems, which are extremely susceptible to climate shocks, agroforestry systems with a range of tree species also provide higher biodiversity and ecological resilience (Kimetu et al., 2008). Furthermore, by supplying people with food during times of drought and crop failure, fruit and fodder trees provide a vital buffer (Konuche et al., 2019).

Africa has seen a widespread adoption of tree planting on farms, boundaries, fallows, and homesteads due to the numerous environmental, economic, and social benefits. It is an affordable, practical adaptation tactic for smallholder farmers who are dealing with rising climate concerns.

2.4.4 Off-farm Income Generation

Farmers can augment and diversify their sources of income by engaging in non-agricultural activities that provide off-farm revenue (Mudombi et al., 2018; Kiboi et al., 2017). (Mburu et al., 2017; Rahman, 2013) This is a crucial adaptation technique to help deal with the effects of climate change on agriculture:

When farming output drops because of drought, flooding, or other climate-related pressures, off-farm income might serve as a buffer (ibid.). In the event that crops grown on the farm are unsuccessful, it offers backup revenue streams (Wossen et al., 2017).

According to Kassie et al. (2015), some non-farm professions, such as labor, carpentry, tailoring, etc., can be done on a seasonal or sporadic basis to accommodate agricultural cycles. This gives farmers the opportunity to increase output while having other career options (McSweeney, 2005). In order to maintain food security and smooth household consumption, earnings from off-farm labor are used to buy food and other necessities during lean times (Rahman, 2013).

By spreading the risk of climatic shocks that impact a single sector, non-agricultural income diversification reduces vulnerability (Mutekwa, 2009). According to Deressa et al. (2009), it lessens a household's vulnerability to overall agricultural losses. Financial support and safety nets are provided by remittances from family members working outside the farm (Eakin et al., 2014). Acquiring knowledge and resources from non-agricultural jobs might be helpful when starting new farming ventures or branching out into related industries (Kassie et al., 2015).

2.4.5 Soil and Water Conservation Practices

Farmers can adjust to the effects of climate change, such as uneven rainfall distribution, by using soil and water conservation practices (Thomas, 2008). Rainwater collection and storage can be enhanced by using techniques like terraces, stone bunds, mulching, farm ponds, infiltration trenches, etc. (Nhemachena and Hassan, 2007). According to Shiferaw and Holden (1998), they improve soil moisture retention, lower runoff, and stop soil erosion.

Rain-fed agriculture can become more resilient to climate variability by using conservation practices for both soil and water (Kato et al., 2011). These actions optimize the scarce rainfall, which is particularly important during the prolonged dry spells predicted by climate change (Mutekwa, 2009). Farmers typically use government-sponsored watershed programs and community-based initiatives to carry out soil works (Liniger et al., 2011).

2.4.6 Selling of Livestock and Other Assets

During instances of severe drought or crop failure brought on by climate pressures, farmers occasionally sell productive assets like animals as a coping mechanism (McSweeney, 2005). When agricultural outputs are sparse, households can obtain cash by selling their animals on time and use the proceeds to buy food and other essentials (Mutekwa, 2009). Destocking, however, is typically used as a temporary response tactic when alternative options are constrained by the severe effects of climate change (Kurukulasuriya and Awkal, 2004).

2.4.7 Shifting to New Farming Techniques

According to Thomas et al. (2007), some farmers adjust by switching from traditional farming practices to innovative ones such integrated soil fertility management, conservation agriculture, and climate-smart agriculture. According to Nyangena (2009), these other methods seek to increase soil organic matter, enhance yields under water stress, and trap carbon. Smallholder-friendly climate-resilient farming practices are supported by farm trials and extension initiatives (Kassie et al., 2015).

2.5 Challenges to Building Agricultural Resilience

Farmers' ability to adapt to the effects of climate change is nevertheless hampered by major obstacles, even in spite of the fact that they have chosen localized techniques. For many rural populations, access to timely climate information is still limited. It is challenging to effectively plan future farming operations without a thorough awareness of expected weather trends (Thornton et al., 2017). Budgetary restrictions also make adaption difficult. Upfront costs associated with new seed, animal breeds, and soil management techniques are sometimes unaffordable for smallholders. Farmers are susceptible to production shocks if they do not have access to loan or risk-sharing programs (Tadesse & Biademo, 2019).

Resilience construction is further undermined by technical shortcomings. More education on climate-smart techniques that work in regional agro-ecologies is required. Increasing the number of farmer field schools and extension services could assist farmers in gaining the necessary expertise (Rurinda et al., 2014).

Decisions made in the long run are hampered by degraded soils and unstable land ownership. Investing in soil carbon or agroforestry seems dangerous when land is of poor quality and land rights are unclear. Natural resource buffers against climate pressures are also reduced by overstretched resources (Thenya & Agong, 2019). Many places lack public policies and services that are supportive. More robust legislative frameworks may encourage the community level adoption of systematic adaptation on a large scale (Ndambiri et al., 2012).

Complicating matters are socioeconomic considerations as well. High population density encourages unsustainable farming, whereas poverty restricts opportunities for diversification (Tambo & Abdoulaye, 2012). Integration across sectors is necessary to overcome these multi-dimensional restrictions.

2.6 Conceptual Framework

This study used the conceptual framework to evaluate the effects of climate change and household adaption strategies. Figure 1 outlines the conceptual framework that will be developed under the presumption that there exist several driving forces behind the impacts of climate change and techniques for adapting to its variability and change. The socioeconomic level, farming features, and household demographics are some of the influencing elements that determine the adaptation techniques to climate fluctuation and change. Furthermore, there is a relationship between those driving forces and household food security. These studies are typically conducted at large scales, using equilibrium or statistical models to predict impacts both with and without adaptation. The goal is to answer the following question: to what extent are particular climate change scenarios "dangerous"?

Socioeconomic areas like energy, infrastructure, tourism, health, agriculture, forestry, fisheries, and aquaculture will probably also be impacted by these changes. The effects of climate change will worsen quickly if nothing is done, and some changes will be permanent.

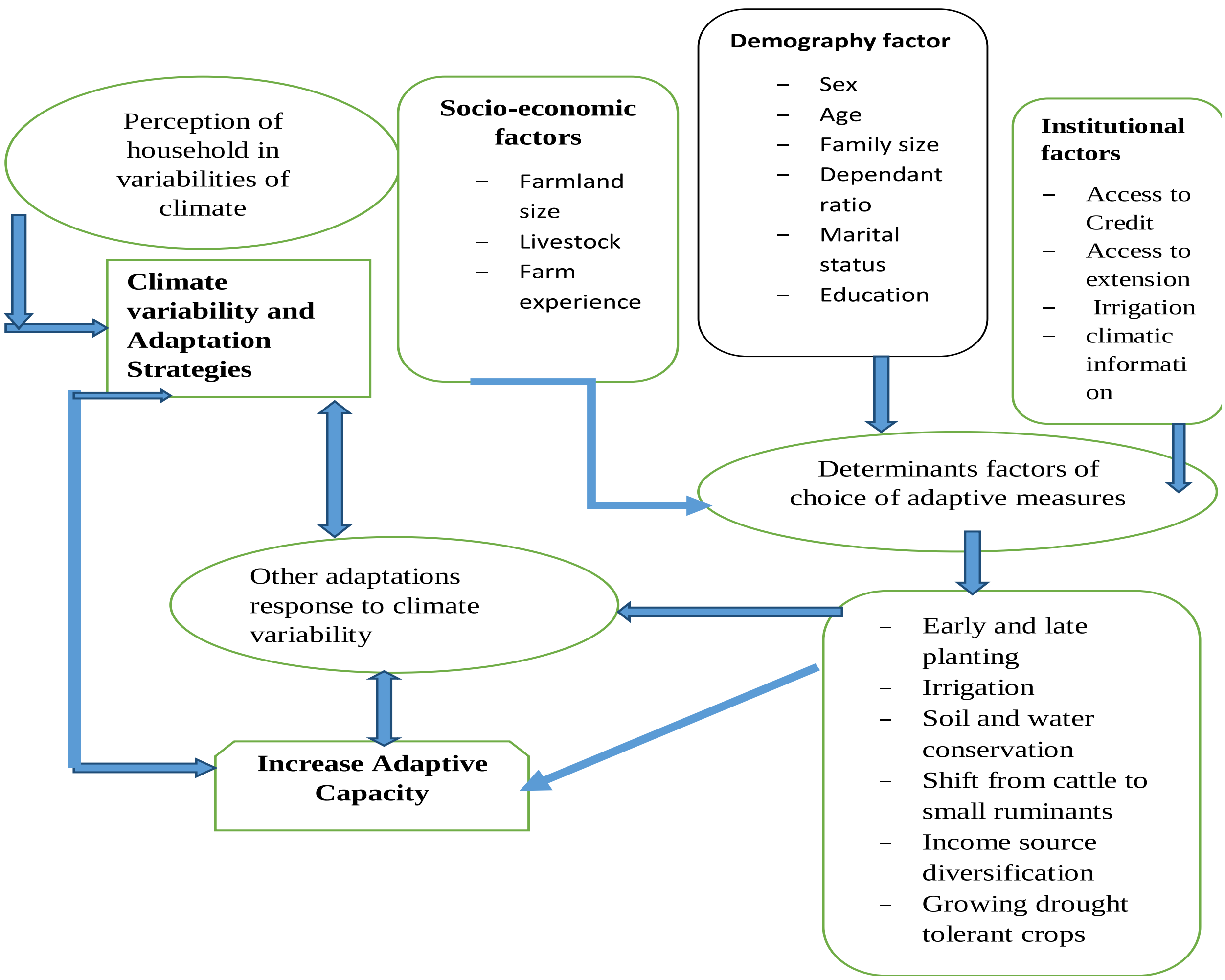

Figure 2.1: Conceptual frame work of the study.

CHAPTER THREE

Methodologies

3.1 Description of the study area

3.1.1 Location

Chiro woreda is located in the West Hararghe Zone of the Oromia Region in Ethiopia, approximately 324 km east of the capital city of Addis Ababa. Covering an area of 1,787 km^2, Chiro town serves as both the woreda and zone capital. Geographically, the woreda lies between 8° 50′ 0″ to 9° 20′ 0″ N latitude and 40° 40′ 0″ to 41° 0′ 0″ E longitude. To the south borders with Gamechis District, west borders Guba-Koricha District, northwest borders Mieso District, north borders Doba District, and northeast borders Tulo District (CWLAO, 2023).

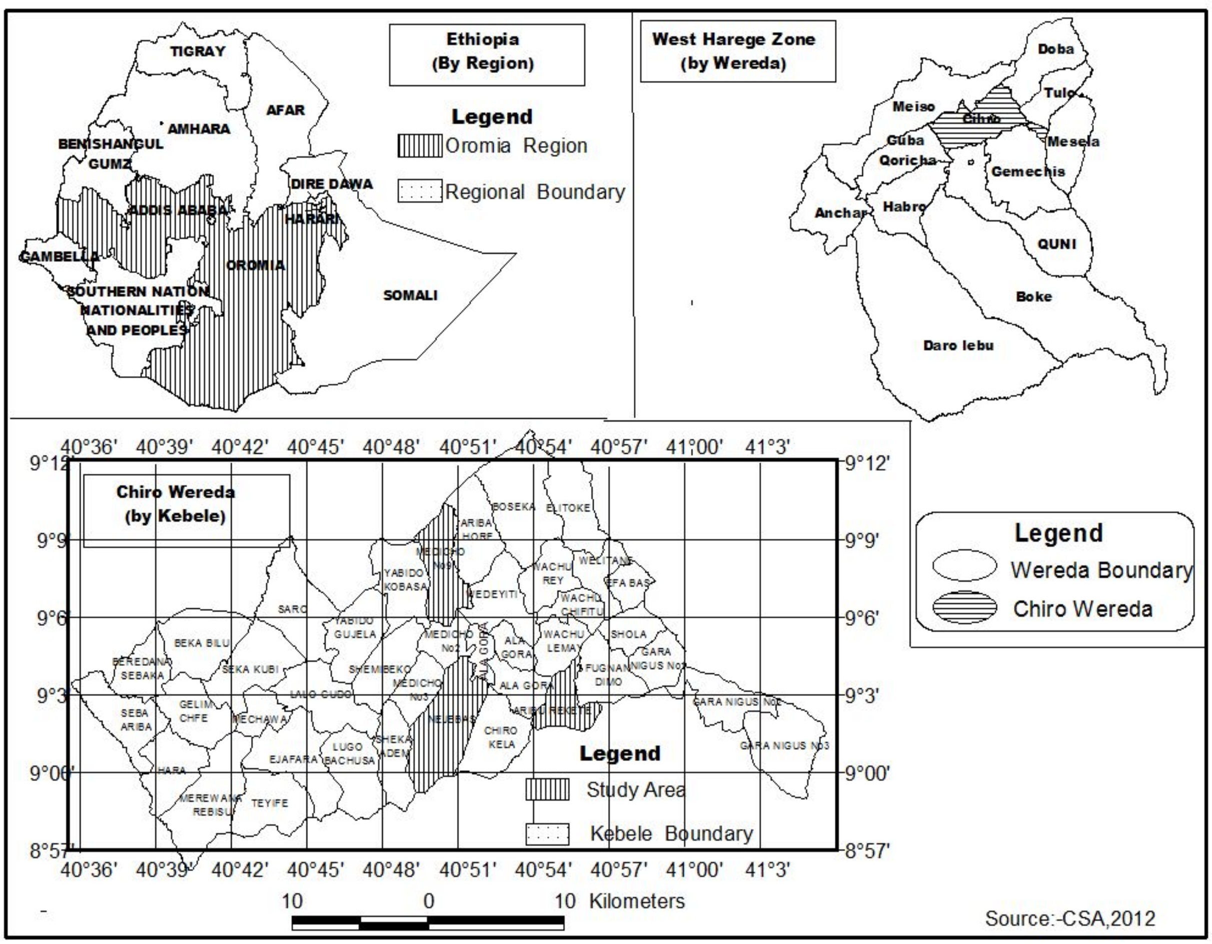

Figure 3.2: Map of the Study Area (source developed using Arc/GIS, 2023)

3.1.2 Topography

Chiro woreda is typically divided into three main agro-ecological zones. The lowland (Kola) zone contains 22 kebeles, the midland (Woina dega) zone contains 13 kebeles, and the highland (dega) zone contains 4 kebeles. The woreda has an average altitude of 1,800 meters above sea level. According to data from the Office of Agriculture and Rural Development, 45% of the total land area/topography is plain, while 55% has steep slopes. The woreda is mainly characterized by steep slopes and mountains, giving it a rugged topography that is highly vulnerable to erosion problems. The district has an undulating, mountainous terrain with low vegetation cover. Erosion is severe as cultivation increasingly expands into more marginal areas.

3.1.3 Climate

The average yearly temperature is between 23.5°C and 29.5°C. The range of annual rainfall is 770–1528 mm (CWMS, 2023). The nature of rainfall is unpredictable and bimodal. For highland and midland regions, the major rainy season runs from June to September; for lowland areas, it runs from March to April. For the highlands and midlands, the brief wet season lasts from March to May, while for the lowlands, it ends around July. In comparison to the lowlands, the highlands and midlands receive comparatively higher rainfall. The Woreda's soil types, which make up 25.5%, 32%, and 42.5% of the total, are sandy soil, clay soil (black soil), and loamy soil. Topography affects the types of soil; black soils are mostly found in the highlands and midlands, while red soil can be seen in the lowland areas.

Due to the high surface temperatures in the winter and spring, the volume of many local rivers is decreasing, and some are dry. The impacts of climate variability and change including predicted increases in extremes are likely to add water stress as a result of insufficient and unreliablerainfall. It has high pressure on water resources and small scale farming of rural comm unity. As a result, shortages of water resources and food insecurity have been more evident in the study areas.

Table 3.1 Descriptive Statistics of monthly and Seasonal rainfall in mm (2005 -2022)

Rainfall	Mini.	max.	Mean	SD	CV(%)
January	0.0	114.0	36.5	30.6	83.8
February	0.0	172.0	37.5	46	122.7
March	0.0	238.6	92.6	69.9	65.6
April	10.4	271.2	105.2	65.6	62.4
May	0.0	199.0	45.5	45.3	100.4
June	0.0	150.8	38.6	34.8	90.2
July	113	351.3	231.8	78.8	34.0
August	134.2	413.0	263.3	75.6	34.0
Sept.	17.1	202.3	96.7	35.6	37.1
October.	0.0	229.8	73.7	66.8	90.6
November.	0.0	161.6	37.6	44.9	36.1
December.	0.0	132.7	33	36.1	109.4
Spring	117.9	472.6	243.32	116.43	47.85
Summer	286.4	645.9	515.1	116.71	22.66
Autumn	91.9	483.9	207.89	111.16	53.21
Winter	28.0	286.0	122.5	74.85	61.1
Annual	770.2	1528.2	1091.77	197.26	18.07

Source: CWMS, 2022

It was discovered that the summer was the season with the highest amounts of rain and the least volatility, as table 3.1 illustrates. The primary rainy season (JJA) was the one that contributed significantly to the overall rainfall totals. The degree of variability can be categorized as less (CV < 20%), moderate (20% <CV <30%), high (CV > 30%), very high (CV > 40%), and extremely high (CV>70%) using the coefficient of variation (Hare, 2003). Consequently, the months with the lowest degrees of variability are July and August, at 34%, whereas February had a CV of 122.7%. Summer has the lowest CV of all the seasons (22.66%). Winter had the highest CV in the investigated area, at 61.1%.

Table 3.2: The Variability of Mean Max. And Mean Minimum Temperature Measured in SD and CV in chiro woreda (2005 – 2022)

Months													
Temperature	J	F	M	A	M	J	J	A	S	O	N	D	Yearly
Mean Max. Temp (^{0}c)	27.2	27.5	27.8	28	28	26.5	23.4	22.2	25.1	25.81	25.9	26.6	26.2
SD	2.6	2.6	2.8	2.8	2.7	1.6	2.8	2.8	2.0	2.0	2.6	1.8	1.8
CV	9.6	9.5	10	10	9.6	6	12	12.6	8	7.7	10.0	6.8	6.9
Mean Min. Temp (^{0}c)	13.9	13.7	14.7	14.3	13.7	13.8	12.9	13	13.2	13.4	13.3	13.6	13.6
SD	4.2	2.4	2.2	1.5	1.7	0.9	1.1	1.2	1.5	1.5	2.5	1.5	1.0
CV	30.2	17.5	15	10.5	12.4	6.5	8.5	9	11.4	11.2	18.8	11.0	7.4

Source: Chiro woreda Meteorological Station

3.1.4 Demography

Chiro woreda had a total population of 207,553 people as of survey date (2023), comprising 106,277 men and 101,276 women. At 116.15 persons per square kilometer, the area has a higher population density than the zonal average of 108.6 persons per square kilometer. The area coverage of the zone is 1,723,145 ha (17,231 km2), comprising 15 districts with a combined population of 1,871,706 persons, of whom 912,845 are women. 83.68% of the population identified as Muslims, 13.4% as Ethiopian Orthodox Christians, and 2% as Protestants.

3.1.5 Socio-Economic Activities

Ninety-eight percent of the population farms both crops and livestock, with the remaining two percent practicing pastoralism. Crop cultivation, which includes the production of maize, sorghum, barley, sweet potatoes, and cultivated corn, is the primary source of income and economic activity. Food insecurity is a serious issue that needs long-term fixes (CDANRO, 2023). The primary methods of land preparation are physical labor and oxen (OLR, 2006). Cattle, sheep, goats, horses, mules, donkeys, and camels are among the livestock that are raised (Chiro District Animal Development Office, 2023).

3.2 Research Design

The study evaluates smallholder farmers' adaptation techniques and the effects of climate change in three kebeles in Chiro Woreda. The primary source is primary data. Questionnaires, focus groups, interviews, and observation are some of the techniques used in data collection. The research area population will be represented by local farmers chosen through simple random sampling. A mixed methods approach that is based on pragmatic knowledge claims, particularly consequence-oriented, problem-centered, and pluralistic grounds, would be employed.

The quantitative approach would be used for really identifying determinants that influence farmers' decisions to adapt to climate change in the study area.

A qualitative approach will be used for qualitatively addressing and stating issues related to the details of trends in temperature and rainfall at the study site. Data analysis, both qualitative and quantitative, would be done.

3.2.1 Selection of Study Area

The three kebeles - Aberaket, Medhicho and Nejabas - were purposely selected from 39 based on agro-ecological zones and climate change/variability intensity.

3.2.2 Data source

Secondary data from online sources, documents, research, reports, books, and offices will supplement primary data collected directly from sampled populations through observation, questionnaires, focus groups, and interviews.

3.2.3 Sample size and Sampling procedures

A two-stage sample of 133 households was selected from three kebeles 3100 total households. Stage one chose the three kebeles. Stage two used systematic sampling proportional to kebele populations, introducing randomness via random start numbers. This helps ensure even representation of the overall population. Therefore, the representative sample households from the total household have been selected using the KOTHARI (2004) formula.

The formula given as

$$n = \frac{Z^2 P.Q.N}{e^2(N-1) + Z^2.P.Q}$$

Where, n= sample size

Z= value of standard variant at 95% confidence level (1.96)

P = sample proportion 0.1 = 10%

Q = 1-p

e = the estimation allowable error (0.05) = 5%

N=number of households (3100)

$$n = \frac{(1.96)^2 .\ 0.1 .\ 0.9 .\ 3100}{(0.05)^2(3100-1)+(1.96)^2 .\ 0.1 .\ 0.9}$$

$$n = \frac{1072}{8.09} = 133$$

A total of the sample size of 133 household heads will be sampled from the three kebeles using systematic random sampling technique on the basis of probability proportional to size.

Table 3.3. Sample size of household

Rural Kebeles	Argo-ecological zone	Total household heads			Sample household heads		
		Male	Female	Total	Male	Female	Total
Aberaket	*Highland*	1260	140	1400	54	6	60
Nejabas	Midland	906	101	1007	39	4	43
Medhicho	Lowl*and*	624	69	693	27	3	30
Total		2790	310	3100	120	13	133

Source: Own computation from secondary data (2023)

3.3 Methods of Data Collection

This study employed both qualitative and quantitative methods of data collection. Primary data was gathered through field observations, key informant interviews, focus group discussions, and questionnaires.

3.3.1 Field Observation

The researcher directly observed the study area through transect walks. This allowed documentation of challenges faced by farmers, impacts of climate change, and existing adaptation practices through photos and notes.

3.3.2 Key Informant Interviews

Both structured and unstructured interviews were conducted with key informants to gather necessary information. These included kebeles administrators (3), woreda managers and development team leaders (12), and local elders (15). Their insights helped understand the objectives of the study.

3.3.3 Focus Group Discussions

Additional data on climate impacts and adaptation was collected through focus group discussions with men and women farmer groups from sample kebeles. Open-ended question guides designed around research issues facilitated the discussions. 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 six 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.

3.3.4 Questionnaires

Questionnaires in Afaan Oromo and English were administered to sample farmers. This allowed the collection of quantitative data on climate change impacts, adaptation practices, and related socioeconomic information in a format respondents could easily understand.

3.4 Methods of Data Analysis and Presentation

3.4.1 Descriptive statistics

The study would include a qualitative and quantitative description and discussion of the primary and secondary data that were gathered. Tables, graphs, and percentages are examples of quantitative data presentation techniques that are used to succinctly display numerical results. The social groups most affected by climate change, the barriers to adaptation, and the methods smallholder farmers are now doing to adapt to it were all examined or evaluated using the chi-square test. A descriptive statistic to examine the variables affecting the choice of various methods for adapting to climate change.

The purpose of this research was to shed light on the various socioeconomic traits of the home respondents that were questioned. Studying adaptation strategies and influencing variables was made possible by quantitative techniques such as frequency, tables and percentages.

3.5. Ethical Consideration

Every study that involves human subjects raises ethical concerns that need to be well thought out. The collection of personal data for this research makes it imperative to give ethical procedures first priority. By refraining from using any abusive or psychologically damaging language, the researcher will encourage participants in the study to communicate in an open and courteous manner. By doing this, individuals should be able to freely and voluntarily disclose information without worrying about unfavorable consequences. Encouraging voluntary and informed participation upholds fundamental ethical principles for research involving human subjects by respecting the autonomy and rights of individual.

3.6. Reliability and Validity

As indicated by the consistency of replies, observed scores are measurements devoid of mistakes. On the other hand, validity describes the suitability and significance of the conclusions drawn from a specific measurement (Golafshani, 2003).

Prior to the complete data collection, respondents from Chiro Town participated in a pre-test (pilot test) of the data collection instruments utilized in this study. The final analysis does not include the data that was gathered during the pre-testing stage. In addition to assisting in identifying and resolving any problems to enhance the validity and reliability of the conclusions that will be drawn based on the measurement scores, this kind of pre-testing helps demonstrate that the instruments are consistently measuring what they are intended to measure.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

The data gathered from respondents addressing the effects of climate change and smallholder farmers' adaptation strategies will be analyzed, presented, and interpreted in this chapter. Access to information about climate change, farmer demographics (including education level), household size, and farm characteristics (including farm size) are just a few of the areas covered by the results. In order to make conclusions about the goals of the research, which center on the effects of climate change and the tactics used for adaptation, key findings will also be interpreted.

4.2 Questionnaires return rate

From the 133 questionnaires issued, 133 were successfully filled out and returned. Therefore, 100% as considered adequate for analysis. According to Frankel and Wallen (2004), a response rate of above 95% of respondents adequately represents the study sample and offers adequate information for the study analysis.

4.3 Demographic characteristics of the respondents

This variable was investigated by the researcher to determine the influence of age, gender, and marital status of the farmer on climate change adaptations.

Table 4.1 Respondents Distribution by Age.

Age of the HH	Frequency	Percent	Valid percent	Cum. Percent
20 – 30	10	7.68	7.68	7.68
31- 40	25	18.8	18.8	26.5
41 – 50	51	38.3	38.3	64.78
>51	47	35.3	35.3	100.0
Total	133	100	100	

Source: Own survey, 2023

According to the results, 51 (38.3%) of the respondents were between the ages of 41 and 50, 47 (35.3%) were over 51, and 25 (18.8%) were between the ages of 31 and 40. According to the findings, (73.6%)many farmers were over 41 years old, and very few were owned by young adults who were in their 20s-30s. The probability of adopting climate change adaptations rises with farming experience (Maddison 2006; Nhemachena and Hassan 2007; Deressa et al. 2009). A household's head's age can be utilized to determine their farming experience (Deressa et al. 2009).

Table 4.2. Shows results obtained from the respondent's gender and occupation.

Sex of the HH	Frequency	Percent (%)	Valid percent	Cum. Percent
Male	120	90.2	90.2	90.2
Female	13	9.8	9.8	100.0
Total	133	100.0	100.0	
Occupation of HH				
Farmer	130	98	98	98.0
Other	3	2	2	100.0
Total	133	100.0	100.0	

Source: Own survey, 2023

In terms of sex, the largest share, 120 (90.2%) of the participants, were males, and the rest, which is about 13 (9.8%), were females. Regarding the occupational structures of the population, almost all 130 (98%) out of 133 respondents were farmers.

Family labor is the main source of work force for the region's agricultural operations, with some hiring of labor occurring on occasion. In the communities, men carry out the majority of agricultural tasks such as clearing land, planting, weeding, harvesting, threshing, storing, tending to animals, and marketing, while women are primarily involved in reproductive tasks such as gathering firewood, cooking, tending to children and the elderly, obtaining water, and cleaning clothes. Women are also involved in some productive tasks such as weeding, harvesting, threshing, moving harvested crops from the field to the house, setting up a threshing ground, and, to a lesser extent, harvesting.

While female children learn and participating in household activities, male children assist their family on the farm by herding livestock. There is a local labor shortage during certain seasons. There was a labor deficit throughout the busiest months for agriculture, which were primarily April, March, June, July, December, and January. There are strategies to deal with labor shortages, such as local labor arrangements like "Debo" and labor exchange, as well as some degree of hiring of labor.

Table 4.3. Shows results obtained from respondents on their marital status.

	Variable : marital status	Frequency	Percentage (%)
1	Single	0	0
2	Married	98	73. 65
3	Divorced	30	22.6
4	Widowed	5	3.75
	Total	133	100

Source: Own survey, 2023

The respondents interviewed, the majority 98 (73.65%) were married, 30 (22.6%) were divorced, and 5 (3.75%) were widowed. This reveals that most of the farmers are married farmers.

4.4 Level of education of the respondent farmers

This variable was investigated to determine its influence on climate change adaptations. Education has been analyzed under: level of education and the extent to which it has helped adapt to climate change.

Table 4.4. Shows results obtained on respondent's level of education.

T/L	Educ. of HH	Frequency	Percent (%)	Valid percent	Cum. Percent
1	Illiterate	30	22.6	22.6	22.6
2	Read and write	39	29.3	29.3	51.9
3	Primary(1-8)	35	26.3	26.3	78.2
4	Secondary (9-12)	19	14.3	14.3	92.5
5	Diploma and above	10	7.5	7.5	100
	Total	133	100	100	

Source: Own Computed result, 2023

By educational backgrounds, majorities attended only read and write 39 (29.3%), while those who have primary school 35 (26.3%), 30 (22.6%) were illiterate people, and 19 (14.3%) completed secondary school. Those respondents who completed diploma and above in general rank last with a total of 10 (7.5%). According to the research, the majority lack formal education, with more than 75% not having completed secondary school or above. This has been attributed to the respondents' strong statements about how they are farmers. Evidence from a number of sources suggests that farmers' educational attainment, their use of new technology, and their ability to adjust to climatic change are positively correlated (Igoden et al. 1990, Lin 1991, Maddison 2006). As a result, farmers who have received more knowledge are probably better able to adjust to changing climate conditions (Deressa et al. 2009).

Table 4.5. Influence of education on climate change adaptation

Whether education has helped adapt to climate change	Frequency	Percentage (%)
Yes	120	90
No	13	10
Total	133	100

Source: Own survey, 2023

Whether education had helped them adapt to climate change, 120 (90.2%) of the respondents thought education helped in adaptation to climate change, whereas 13 (9.8%) had not been helped by education. The results indicate that education has greatly affected climate change adaptations among the farmers in the Chiro area.

4.5 Size of farm and household on climate change adaptation.

There is frequently a land shortage in the district. Among the primary causes is the startling rate at which population density is growing and the fragmentation of land brought about by large household numbers of children. Melaku (2016) reported that the Oromo people refer to their land as "Dachee haadha Margoo," which translates to "mother earth" in English. According to Oromo wisdom, the mother earth is revered and appreciated. We all die and pass away; not only do humans pass away, but also plant and animal species do as well. She raises her offspring in the same way that a mother raises her own.

In the area, land holding status ranges from 2 to 6 "qindi" (0.25-0.75 ha), where 8 "qindi" equals 1 hectare. The average land holding status is 4 "qindi" (0.5 ha). In addition to causing low yields and low incomes, land fragmentation also results in a shortage of grazing land, overcrowding of the land, which severely reduces the fertility of the land, and deforestation because farmers are searching for new land and consequently deplete the forest. The researcher examined the researcher examined the impact it had on farmers' decisions to adjust to the effects of climate change.

Table 4.6. Shows the results obtained from the respondents on the land sizes and HH size

Land area/HH	Frequency	Percent	Valid percent	Cum.Percent
<0.5ha	70	52.6	52.6	52.6
1-2ha	45	33.9	33.9	86.5
3-4ha	18	13.5	13.5	100
Total	133	100.0	100.0	
HH size	Frequency	Percent	Valid percent	Cum.Percent
1-2	17	12.7	12.7	12.7
3-4	51	38	38	50.7
5-6	38	28.5	28.5	79.2
7-8	17	12.8	12.8	92
9-10	4	3	3	95
11 and above	6	5	5	100.0
Total	133	100.0	100.0	

Source: Own survey, 2023

When asked about the size of farms under crops, the majority of the respondents, 70 (52.6%), were found to be small-scale farmers who had 0.5 ha of crop in their farms, whereas 45 (33.9%) were large-scale farmers who had 1 ha–2 ha of crop in their farms and 18 (13.5%) who had 3 ha–4 ha farm land. It was found that most farmers operated on a small scale, with very few operating on a large scale. The results also show that each respondent had some land set aside for other crops and some that was either uncultivated or covered in woods. Just 4 (3% of the respondents) had a family size of 9–10, whereas the majority of respondents had a household size of 3–4 family size. Large family households should be better able to adjust to climate change (Deressa et al. 2009).

4.6 Access to information on climate change adaptation.

This variable was examined in an attempt to answer the research question on its influence on climate change adaptations. The research analyzed the following sub-thematic areas: attendance of field observation, involvement of media, and attendance of training on climate issues.

Table 4.7. Shows the results obtained from respondents their attendance to field observations and organizations that conducted field observations.

Variable: **Attended any field observations**	**Frequency**	**Percentage (%)**
Yes	94	70.68
No	39	29.32
Total	133	100

Source: Own computed result, 2023

The respondents interviewed, 94 (70.68%), had attended some field observations, which were mainly organized and conducted by smallholder farmers. From the findings, the majority of the farmers have been to field observations that were organized by smallholder farmers in Chiro woreda.

Table 4.8. Other sources of information on climate change.

T/L	**Variable**	**Frequency**	**Percentage (%)**
1	Radio	25	18.8
2	Television	20	15
3	Fellow farmers	50	37.6
4	Extension Officers	30	22.56
5	None	8	6
	Total	133	100

Source: Own survey, 2023

The research revealed that 50 (37.6%), climate change information was obtained from fellow farmers, 30 (22.56%) from Extension Officers, Radio 25 (18.8%), and Television 20 (15%) The findings reveal that smallholder farmers in the area get information on climate change through television and radio. The majority of small farmers in the area have gotten information on climate change impacts and adaptation through fellow farmers. The role of extension officers in the area is large.

Table 4.9. Shows results obtained respondents on training on climate change adaptation.

Variable: Received any training on climate change adaptation.	Frequency	Percentage
Yes	12	9
No	121	91
Total	133	100

Source: Own survey, 2023

The respondents interviewed, 12 (9%), had received training on climate change adaptation, while 121 (91%) had not received any training on climate change adaptation. Findings of the study reveal that the majority of the smallholder farmers have not received any training on climate change adaptation.

4.7 Farmer's perception on climate change

Although there had been more hot days and less rainfall, all respondents, including the farmers, were aware of the effects of climate change. The decomposing rains, crop drying, sorghum, and maize disease were mentioned by the respondents as signs of a changing climate. Additionally, every respondent linked human activity to climate change, citing the careless falling of trees and the removal of vegetation to make way for human activity.

Table 4.10. Long-term temperature, rainfall and precipitation changes

Variables	Climatic variables	Frequency	Percent
Temperature	Temperature increase	100	75.2
	Temperature decrease	25	18.8
	No change in temperature	8	6
	Total	133	100.0
Rainfall	Rainfall increase	10	7.5
	Rainfall decrease	110	82.7
	No change in rainfall	13	9.8
	Total	133	100.0
Drought	drought Increased	120	90
	drought Decreased	4	3
	drought No change	5	4
	drought I don't know	4	3
	Total	133	100.0
Flood	Flood Increased	68	51.1
	Flood Decreased	65	48.9
	Flood No change	0	0
	Flood I don't know	0	0
	Total	133	100.0
crop disease	crop disease Increased	112	84.2
	crop disease Decreased	21	15.8
	crop disease No change	0	0
	Total	133	100.0

Source: Own survey, 2023

Table 4.10 presents the results of farmers' perceptions of long-term temperature, rainfall, precipitation, drought, flood, and crop disease changes during the questionnaire to be filled by farmers.

The analysis indicated that 100 (75.18%) of the smallholder farmers observed increasing temperature over the past 20 years, whereas 110 (82.7%) have observed that they noticed decreasing rainfall over the past 20 years, 120 (90%) drought increased, and 112 (84.2%) crop disease increased. This result was from information gathered from the respondent. Farmers' perceptions of decreasing rainfall could be accredited to noticeable changes in their environment like the drying of rivers (that usually flow all year round), delayed rainfall, and drought. Those farmers who asserted to have observed changes in climate over the past 20 years were afterwards asked how they had responded to the situation.

Impact of climate change on production and productivity of their land.

Fig Figure 4.1: Photos taken from Medhicho kebele,2023(maize cultivation)

4.8 Farmers perception on trends of climate variability & its effect

Understanding farmers' perception on climate is very important to overcome the problems of rural livelihood in the study area. In order to design appropriate climate adaptation and coping strategies to minimize the impact of climate variability and change in the rural area, it is important to know more about the level of perception of local community on climate variability and change.

Table 4.11 ***Source of water and climate variability***

Source of water & effect of climate		Sample Kebeles							
		Aberaket		Medhicho		Nejabas		Total	
		N	%	N	%	N	%	N	%
Sufficient water is available	Yes	20	33	5	17	11	26	36	27
	No	40	67	25	83	32	74	97	73
	Total	60	100	30	100	43	100	133	100
RF affects water availability	Yes	53	88	26	87	36	84	115	86
	No	7	12	4	13	7	16	18	14
	Total	60	100	30	100	43	100	133	100

Source: own survey result, 2022

Table 4.11 reveals that almost 67%, 83%, and 74% of the farmers who responded, hailing from Aberaket, Medhicho, and Nejabas, respectively, expressed their belief that the water resource in the region is insufficient. This suggests that the study location does not receive enough rainfall. When asked why there was a lack of water, roughly 86% of the respondents said that they thought the area's "rainfall variability" was the cause of the "scarcity of the water resource." The outcome showed that farmers' lives are being impacted by rainfall unpredictability; thus, agriculture which depends on available rainfall for healthy yields is the farmers' main source of income.

Table 4.12. Trends of Temperature distribution in the study area (2005 – 2022)

T/L	Years	Maximum Temperatures(^{0}c)	Minimum Temperatures (^{0}c)	Average Temperature(^{0}c)
1	2005	26	21.7	23.85
2	2006	27	23.4	25.5
3	2007	27	23	25
4	2008	28.5	23.2	26
5	2009	29	21.3	25.15
6	2010	30	24.5	27.125
7	2011	29	23.7	26.35
8	2012	31	23.8	27.4
9	2013	31.5	23.2	27.35
10	2014	32.5	23.9	27.85
11	2015	27	24.3	25.65
12	2016	33	23.7	28.35
13	2017	34	23	28.5
14	2018	31	21	26
15	2019	29	23	26
16	2020	30	25	27.5
17	2021	31	24	27.5
18	2022	31	23	27

Source: CWMS, 2022

According to the climatic data of chiro woreda District, the mean minimum temperature and from the period 2005 – 2022 was 23.26^{0}c while the mean maximum annual temperature 29.86^{0}c.

The annual average of temperature of the study area fluctuated from time to time. Therefore, temperature is one of the key factors for the decline and fluctuation of yearly cereal crop production in the study area.

Table 4.13 Trends of rainfall compared with that of before 20-25years ago

Trends of rainfall		Sample *Kebeles*							
		Aberaket		Medhicho		Nejabas		Total	
		N	%	N	%	N	%	N	%
Current rainfall vs that of 20-25 years ago	Increasing significantly	-	-	3	10	3	7	6	5
	Increasing	5	8	2	7	5	12	12	9
	Decreasing Significantly	5	8	5	17	5	12	15	11
	Decreasing	50	84	20	66	30	69	100	75
	Total	60	100	30	100	43	100	260	100

Source: result survey,2022

Additionally, respondents were questioned about their perceptions of changes in other climate characteristics, such as rainfall. According to Table 4.13, 84% of respondents in Aberaket, 66% in Medhicho, and 69% in Nejabas believe that there has been less rainfall in the previous 20 to 25 years. A little over 8% of respondents in Aberaket, 17% in Medhicho, and 12% in Nejabas stated that they felt the amount of rainfall had drastically decreased from 25 years ago to the present. In the district the amount of rainfall is declining overall.

Over a 20-year period, Chiro *Woreda's* total annual rainfall patterns varied from year to year. This demonstrates that the studied area experiences climatic variability. The following Table 4.13 shows the mean monthly and total annual rainfall distribution between 2005 and 2022.

Table 4.14: Annual Rainfall Distribution in chiro woreda district

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
2005	84.10	65.2	52.80	26.80	47.2	7.50	189.4	281.8	48.8	48.8	62.00	47.9	962.3
2006	29.40	87.00	34.20	145.40	0.00	64.0	152.2	134.2	137.9	93.3	11.4	0.00	889
2007	.00	.00	74.60	52.20	37.9	55.5	299.5	413.0	115.00	1.7	5.80	44.4	1099.60
2008	.00	125.8	62.00	271.2	32.1	44.30	280.3	275.0	69.9	24.6	97.1	0.00	1282.3
2009	78.60	.00	157.7	115.90	199.0	52.10	113.0	329.2	60.0	37.1	16.30	51.5	1208.4
2010	32.20	3.80	219.9	85.60	71.5	150.8	234.6	157.3	132.7	229.8	104.0	0.00	1422.20
2011	114.0	172.00	110.0	57.20	35.9	0.00	311.5	334.4	65.5	57.0	0.00	0.00	1257.5
2012	32.50	3.80	215.5	84.40	71.5	99.2	229.8	203.6	104.3	379.6	0.00	104.0	1528.20

2013	.00	.00	8.40	66.80	33.9	34.40	346.4	338.5	100.4	130.8	25.2	49.7	1134.50
2014	6.90	21.70	238.6	10.40	19.8	32.8	351.3	205.9	91.6	26.3	5.4	5.00	1015.70
2015	87.10	6.20	47.00	71.60	0.60	7.90	219.5	295.3	132.0	17.7ii	104.9	0.00	989.8
2016	64.90	60.40	68.2	115.5	4.90	36.90	168.9	256.4	202.3	0.00	48.3	10.8	1037.50
2017	.00	11.00	37.10	114.8	2.70	26.2	167.4	214.8	66.7	57.7	7.90	63.9	770.20
2018	25.60	7.8	99.00	103.80	101.5	26.70	284.4	283.9	55.6	36.3	0.00	71.1	1095.70
2019	1.60	36.2	145.2	245.10	40.40	8.30	157.0	283.9	117.8	38.6	26.2	2.6	1102.90
2020	34.80	73.30	44.70	108.10	35.10	33.80	348.7	245.8	86.9	48.2	0.00	5.00	1064.40
2021	42.80	.00	0.00	96.10	21.80	56.90	131.0	341.2	134.3	48.4	1.00	132.7	1006.20
2022	23.20	.00	51.40	122.80	0.00	21.60	186.9	145.5	17.10	50.4	161.6	4.80	785.30

Source: CWMS, 2022

As indicated on table 4.14, the annual minimum and maximum rainfall from 2005- 2022, was 770.2 mm and 1528.2 mm respectively. Therefore, rainfall variability is one of the major causes of crop failure in the study area. Inter and intra rain-fall variability and rainfall amount with in the cropping season is one of the characteristics of climate variability and change affecting the rural livelihood in the study area.

The primary rainy season (JJA) was the one that contributed significantly to the overall rainfall totals. Inter and intra rain-fall variability and rainfall amount with in the cropping season is one of the characteristics of climate variability and change affecting the rural livelihood in the study area.

4.9. The Most Affected Social Groups

From the respondent, most of them agreed that the poor and the landless were the most vulnerable social groups in their locality.

Table 4.15*: Show *most affected social groups by climate change

T/L	Variable	Frequency	Percentage (%)
1	Children	90	67.7
2	Elders	31	23.3
3	Women	12	9

Source: Own survey, 2023

Accordingly, 90 (67.7%), 31 (23.3%), and 12 (9%) of the respondents agreed that the most affected social group were children, elders, and women, respectively. The participants of the respondents also reported that children, elders, and women were the main social groups that are affected by climate-related hazards as they have poor adaptive capacity due to various biological, economic, and social factors. The vulnerability of women and children to the existing climate-related hazards can be related to factors like lack of ownership over productive assets, low social status, and being overburdened in raising and caring for children. On the other hand, one of the main elderly-related factors identified in the study was the migration of elders during flood and drought seasons to nearby cities to escape the effects and to search for a better future.

4.10 Source of income

Farm income word derived from crop production and rearing and selling of animals. This includes income earned from commercial woodlots and beekeeping. We regard increases in farm income as a neutral adaptation strategy.

Off-farm income**:** As mentioned, this article uses Ellis's (2000) classification system and classifies as off-farm income any money received from the sale of natural goods, temporary wages, or labor exchanged on another farmer's property. These natural goods include wild fruits, charcoal, and fuel wood.

Non-farm income**:** This includes earnings from commerce, services, small-scale manufacturing, crafts, rent, remittances, and the processing of food and beverages in addition to salaried work. It is thought of as a useful adaptation tactic. Remittance and migration income are not included. Public service income is kept apart from other non-agricultural revenue streams.

Table 4.16: Shows the results of sources of income

Source of income	Frequency	Percentage
Farm	70	53
Off-farm	15	11
Non-farm	40	30
Other (public work)	8	6

Source: From Key informant interview, (2021)

The amount of income derived from farm activities exceeds other types of income 70 (53 %), the contribution of non-farm income 40 (30 %) to total household income is off-farm income 15 (11 %), and the remaining is other income or public work 8 (6%).

4.11 Climate change adaptation activities

A previous study surveying farmers in the Ethiopia's Nile River Basin found that those who noticed climate changes were employing adaptations like planting trees, soil conservation practices, testing new crop varieties, adjusting planting dates, and setting up basic irrigation systems in order to mitigate impacts. Additionally, research in eastern Ethiopia noted crop diversification along with conserving soil/water and collecting rainfall were commonly utilized strategies for climate change adaptation.

In the current study, some adaptation activities received lower adoption rates. Few farmers engaged in agroforestry, off-farm work, mobile livestock practices, irrigation, or minimal tilling. The findings revealed most grew supplemental crops such as sorghum, maize, coffee, millet, and potatoes alongside their primary harvests. Many also raised livestock like cows and goats. Large-scale adoption of drought-resistant crops occurred as well as diversifying livelihoods, managing soil/water, mixed farming, planting trees, and rotating crops.

Adaptation approaches can vary between regions depending on the extent and nature of local climate impacts as well as community socioeconomic factors. However, prior analyses of different Ethiopian locations described similar general adaptations emerging, matching those observed in the present study area. Strategies are adapted to regional sensitivities and vulnerabilities as well as socioeconomic circumstances.

Table 4.17 Climate change adaptation strategies

T/L	Variable	Frequency	Percentage
1	Income source diversification	126	94.7
2	Early and late planting	121	91
3	Shift from cattle to small ruminants	40	30
4	Soil and water conservation	125	93.98
5	Planting drought resistant crops varieties	128	96.24
6	Decrease livestock	80	60.15
7	Forestation and reforestation	54	40.6
8	Mixed farming	124	93.2
9	Irrigation	40	30
10	Daily labor	120	90.2

Source: Own survey data, 2023

Most farmers in the survey have already adopted various climate change adaptations. An overwhelming majority, nearly 95% (126 people), earn income from multiple sources now. Over 90% (121 people) adjust planting times earlier or later depending on rains. Around 90.2% (120 people) do daily labor when needed.

Many practices focus on conserving soil and water, which over 93% (125 people) do. Nearly all, 96% (128 people), grow drought-resistant crops too. Half, 40% (54), have replanted trees. Mixed farming is popular as well, at 93% (124).

Some other adaptations include the 30% (40) who raised smaller livestock when cattle struggled, 30% (40) using irrigation when possible, and 10% (40) shifting to forestry.

Diversifying crops helps spread the risks of unreliable rainfall, as a previous study found. These adjustments show how farmers try various strategies within their community's agrarian way of life. Being able to adapt means surviving changes and taking advantage of opportunities amidst an uncertain climate. Understanding local adaptations can help create policies that strengthen communities' resilience going forward.

Indicated Diversifying crops

Figure 4.2: Photo showing some to diversifying crops used in the study area (Source: Own survey, 2023).

4.12 The factors that affect the community from combating climate change.

The farmers in the district are faced with different problems that can make the adaptation mechanisms ineffective. The sampled households reported that they had various interrelated constraints that can make their life very difficult in the presence of climate change and climate change adaptation. Farmers also list out their major challenge for their failures to adapt. Households surveyed had encountered more than one problem for a given adaptation option that they favor.

Table 4.18 Problems of adaptation strategies faced by farmers in response to climate change and variability (%)

T/L	problems to adoption adaptation strategies	Frequency	Percentage
1	Inadequate of money	41	30.8
2	Not sufficient of infrastructure	39	29.3
3	unavailable of information about long term climate change	68	51.13
4	Inadequate of knowledge concerning suitable adaptation strategies	71	53.4
5	Lack of extension services	45	33.83

6	Lack of irrigation	52	39
7	Lack of credit service	72	54.14
8	Insecure property rights and land tenure issues	26	19.54
9	Shortage of land size	64	48.12

Source: Own survey result, 2023

Accordingly, from the total sampled households, 72 (54.14%) faced Lack of credit service, 71(53.4%) inadequate knowledge concerning suitable adaptation strategies, 68(51.13%) inadequate information about long-term climate change, 64(48.12%) shortage of land, 52(39%) lack of irrigation, 45(33.83%) lack of extension services, 41(30.9%) inadequate of money, 39(29.3%) not sufficient of infrastructure, and 26(19.54%) insecure property rights and land tenure issues (Table 4.18). Farmers in Ethiopia mentioned a lack of land, manpower, credit, knowledge of adaptation techniques, low irrigation potential, and financial restraints as the key obstacles to adaptation (Bryan et al. 2009, Deressa et al. 2009: 1). Moreover, ineffective policy institutions, unresponsive governments, and low adaptive capacity may act as obstacles to adaptation (Salehyan 2005). One known obstacle to adaptation is a lack of available land.

4.13 Climate Related Hazards in the District

Table 4.19. Major problems in the district

S. No	Hazards/major problems	Rank	Frequency or Percentage
1	High temperature	1	121(90.9%)
2	Drought	2	115(86.5%)
3	Very short rain	3	110(82.7%)
4	Death of livestock	4	91(68.4%)
5	Human diseases	5	80(60.15%)
6	Crop diseases	6	70(52.6%)
7	Erratic rain fall	7	61(45.8%)
8	Heavy rainfall	8	20(15%)
9	Land degradation	9	15(11.27%)
10	Heavy hailstorm	10	11(8.27%)

Source: Own computed result, 2023

The primary climate-related risks to smallholder farmers were high temperatures, droughts, brief downpours, livestock deaths, crop diseases, human illnesses, and unpredictable rainfall. When asked to rank the primary climate hazards that smallholder farmers face, 121 respondents, or 90.9%, indicated that high temperatures were the top hazard. Other top-ranked hazards included drought (86.5%), very short rain (82.7%), livestock death (68.4%), human diseases (60.15%), crop diseases (52.6%), erratic rain fall (45.8%), heavy rainfall (15%), land degradation (11.27%), and heavy hailstorm (8.27%).

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATION

5.1 Summary

This study was conducted in chiro woreda district of west Hararghe Oromia regional state. The study mainly focused on the smallholder farmers' adaptation strategies towards climate change. The specific objectives of the study were to identify the existing adaptation strategies, assessing household perception and factors that could influence the choice of adaptation strategies of smallholder farmers in response to climate change impacts.

Systematic sampling technique was applied to select the study sample kebeles and households. In the first stage, chiro woreda district was selected purposely and the kebeles in the district were into three groups, based on their agro-ecological zones. Therefore, Dega, Woina Dega and Kola, having 4, 13.and 22 kebeles were defined as strata respectively. In the second stage three out of 39 kebeles from each agro-ecological zone. In the third stage a total of 133 household heads were selected by randomness via random start numbers. From Kola (Medhicho 30), Dega (Aberaket 60), and Woina Dega (Nejabas 43).

Both primary and secondary data were used for this study. Primary data were collected from 3 kebeles selected 133 sample household in the district through observation, interview, focus group discussion and questionnaires whereas secondary data was collected from online sources, documents, research, reports, books, and office. Descriptive statistics were used to provide insights about the most affected social groups by climate change, types of adaptation strategies to climate change, perception and to explain problems facing farmers not to adapt and to assess the different socio-economic characteristics of the sample respondent households.

5.2 Conclusions

Small-scale farmers in poor countries, particularly in Africa, that depend on rain-fed crops for a living have been impacted by climate change. Climate change adaptation and mitigation are critical in this environment. The main objective of this study was to assess the climate change impacts and adaptation strategies among smallholder farmers: the case of Chiro Woreda, West Harerghe, Oromia Region, East Ethiopia. Its aim was to understand farmers' perceptions of climate variability, existing adaptation practices, and analyze factors influencing the choice of strategies. The study used purposive sampling techniques to select the kebeles. The selections of the kebeles was done purposefully based on the agroecology. Descriptive ways of analysis methods was appllied. Farmers had adopted various climate change adaptations; Early and late planting, shifting from cattle to small ruminants, practicing soil and water conservation, having planted drought-resistant crops, practicing decreased livestock, practicing forestation and reforestation, practicing mixed farming, practicing irrigation, and practicing daily labor.

Farmers in the area have firsthand experience with rising temperatures, an increase in the frequency of floods and droughts, and erratic rainfall patterns. Official climate records match the observed shifts, but farmers are pulling from their own firsthand experiences on the soil. The perception of variations in rainfall varies depending on the location. Compared to younger farmers, older farmers appear to have seen more noticeable variations in rainfall and temperature.

The hotter, drier weather has prompted farmers to make some changes to their farming schedules and methods. Conservation of land and water, diversification of sources of income, irrigation, planting drought-tolerant crops, and mixed farming were common adaptations. Across many agro-ecological zones, there was a notable uptake of new crop types, crop diversification, altering planting dates, soil conservation, irrigation, and other adaptive activities. However, rather than being thorough, well-thought-out strategies, the adjustments were frequently merely necessary, reactionary actions. Farmers believed their modifications would not be enough to completely mitigate the effects of climate change.

Farmers' adaptive capacity was increased by elements such as greater education, more years of farming experience, improved access to loans, extension services, and climate data. Lack of irrigation, funding, long-term climate data, infrastructure, land limits, and access to technologies/inputs were among the obstacles to more effective adaptation. Compared to farmers with lesser or greater resources, those with medium-resources faced the greatest challenges from poverty and labor shortages.

This offers a thorough grasp of the various adaptations being used, the major influences and obstacles influencing these communities' ability to adapt, and the direct effects of climate change on nearby farming communities. The insights have the potential to direct more focused and knowledgeable policy interventions.

5.3 Recommendation

The study findings indicate that certain household and farm-level factors significantly increase farmers' adoption of climate change adaptation measures, including: more labor capacity, higher frequency of extension service visits, greater farming experience, and more resources and assets. Based on these insights, the passage suggests that policies aimed at improving these factors could help bolster on-farm climate change adaptation among smallholder farmers.

In contrast, the findings show that lack of mass media and credit access discourage climate change adaptation. Therefore, may need to re-examine and reform policies in these areas to make them more effective tools for supporting private climate adaptation.

The passage then outlines several ways could help mitigate climate impacts on agriculture:

- Investing in drought resistance crops research
- Promoting soil conservation practices
- Improving farm technology and irrigation
- Expanding markets and crop insurance programs
- Increasing farmer training/education
- Enhancing weather data/forecast services
- Supporting non-farm income sources and enterprises

  Finally, the passage suggests that future studies should:

- Examine institutional effects on adaptation.
- Evaluate the merits of different adaptation options.
- Guide location-specific, criteria-based policy choices.

This comprehensive set of insights can help inform more effective, evidence-based policy interventions to support agricultural adaptation to climate change.

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ADDIS ABABA UNIVERSITY

COLLEGE OF SOCIAL SCIENCES

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

APPENDIX: 1 questionnaire to be filled out by farmers.

I am conducting research as a requirement for the master's degree at Addis Ababa University. The research theme covers aspects of climate change impacts and adaptation strategies among smallholder farmers; the case of Chiro woreda, West Harareghe zone, Oromia region, Ethiopia.

Your genuine participation by responding patiently to the questionnaire is highly appreciated, and we thank you for giving your time and willingness to participate in filling out this questionnaire.

General direction:

- Do not write your name.
- Please follow the instructions carefully.
- Use a tick **(**√**)** mark to answer the items.
- for questions that require your opinion or completion
- Write clear and short.

Part One: Personal information of respondents [Put a tick mark (√) in the box in front of your choice: Household head identification number **____________**

Enumerator name: **_______**

Date **___________________**

1. **Socio-economic profile of households**

Below are some statements about the household farmers. Please choose the statement that describes your experience and put this "✔" symbol correspondingly in the options of your level of agreement on the questions.

Variable	Response	
1. Gender	Female	
	Male	
2. Age	20-30	
	31-40	
	41-50	
	51 and above	
3. Marital status	Single	
	Married	
	Divorced	
	Windowed	
4. Household Size	2-6	
	7-10	
	>10	
5. Educational level	Illiterate	
	Read and write	
	Primary(1-8)	
	Secondary (9-12)	
	Diploma and above	
6. Annual income	Below 900 ETB	
	1000-10000 ETB	
	10,001-31000 ETB	
	31,001-51,000 ETB	
	Above 51,001ETB	
7. Farm size	<0.5	
	0.5-1ha	
	2-3ha	

8. Farming experience (Years):	1-15	
	16-30	
	31-46	
	>47	
9. Land tenure	Owned	
	Rented	
10. Livestock ownership	<4	
	5-8	
	>9	
11. Market distance (km):	<5	
	5-10	
	>11	
12. Climate Information	Access	
	No access	

PART II: ABOUT THE CLIMATE CHANGE

1. Have you observed any climate change your locality in the last 20 years?

   1. Yes 2. No.

2. If yes in Q 1, how do you characterize the climate change of your area in the last 20 years?

   a) In terms of temperatures:

   1. Increased 2. Decreased 3. No change

   b) In terms of Rainfall amount:

   1. Increased 2. Decreased 3. No change

   c) In terms of rainfall distribution:

   1.Erratic 2. Constant 3. I don't know

d) In terms frequency of drought:

1. Increased 2. Decreased 3. No change 4. I don't know

e) In terms frequency of flood

1. Increased 2. Decreased 3. No change 4. I don’t know

f) In terms of crop disease/insect infestation

1. Increased 2. Decreased 3. No change

3. Have you observed any change in the length of hot period in your life time?

   1. Yes 2. No

4. If your answer is yes in Q. 3, how do you see it? 1. Becomes shorter 2. Becomes longer

5. Have you observed any change in the onset (start) of rainfall in your life time?

6. If your answer is yes in Q.5, how do you see it?

   1. It becomes before the perceived period

   2. It comes late than the perceived period 3. Both

7. Have you observed any change in the dry season precipitation? 1. Yes 2. No

8. If your answer is yes in Q.7, how do you see it?

   1. Increased in amount 2. Decreased in amount

9. Have you observed any change in the length of cropping calendar? 1. Yes 2. No

10. If your answer is yes in Q. 9, how did you see it? 1. It becomes shorter 2. It becomes longer

11. Is the amount of rainfall enough to support your crop production? 1. Yes 2. No

12. Have you observed any change in cropping season within a year (Meher & Belg)?

l. Yes 2. No

13. Have you received any training on climate change adaptation?

1. Yes ☐ 2. No ☐

If yes above, give details of the training ……………………………………

14. What do you think is the major cause of climate change?

1.____

2.____

15. Do you think that climate related shocks are creating a problem in your locality?

l. Yes 2. No

16. If yes in Q. 15, to what extent did climate change and variability affect your livelihood?

1. No impact 2. Low 3. Medium 4. High

17. Who do you think is the most harmed people by the climate change?

1. Women 2. Children 3. Elders 4. Others____________________

18. Where else do you get information on climate change? Tick where appropriate Extension Officer ☐ Fellow farmers ☐ Television ☐ Radio ☐

19. What are the main climatic shocks (hazards) affecting livelihood in your locality? Rank based on their severity (1 highest to 6 least)

S. No	Hazards	Rank
1	Drought	
2	Land degradation	
3	high temperature	
4	death of livestock	
5	Human diseases	
6	Heavy rainfall	
7	Very short rains	
8	Erratic rain fall	
9	Heavy hailstorm	
10	Crop diseases	

PART III: CLIMATE CHANGE ADAPTATIONS

Tick in the boxes where appropriate,

1. What adjustments in your farming have you made in response to climate change?

    a) Income source Diversification ☐

    b) Daily labor ☐

    c) Decrease livestock☐

    d) Growing drought tolerant crops☐

    e) Forestation and reforestation ☐

    f) Mixed farming☐

    g) Early and late planting ☐

    h) Irrigation/ Water harvesting☐

    i) Shift from cattle to small ruminants☐

    j) Soil and water conservation ☐

2. The factors that affect the community from combating Climate change

    a) Inadequate of money /economic factor/☐
    b) Unavailable of information about long-term Climate change ☐
    c) Inadequate of knowledge concerning Appropriate adaptations strategies/options ☐
    d) Limited access to agricultural extension services ☐
    e) Not sufficient of infrastructure☐
    f) Lack of irrigation ☐
    g) Lack of credit services ☐
    h) Insecure property rights and land tenure issues ☐
    i) Shortage of land size ☐

Appendix 2: Key informant interview

Section 1: Interview for Chiro Woreda Manager, administrators, development team leaders, and Kebele elders, Climate change impacts and its adaptation among smallholder farmers.

1. How do you make your life?
2. What type of agriculture do you practice?
3. What kinds of farming methods are you using mostly?
4. Why do you do farming?
5. What are the factors that affect the community from combating climate change?
6. In which season of the year is the is the problem more severe?
7. Do you take part in climate change impacts and its adaptation?
8. How do you see the role of woreda, DA's, and Kebele administrators in climate change impacts and its adaptation?
9. How do you perceive climate change impacts?
10. What are your main sources of income (in order of importance, 1 for main and 3 for least)?
11. Farm income b. off farm income c. nonfarm income d. other (specify)

Appendix 3: For FocusGroup Discussion/FGD/

Check list questions for focus group discussion to be held at Chiro District.

1. How did you find your total grazing area over the last 10 years?

   1. Decreasing 2. Increasing 3. Constant change

2. If your answer is decreasing, what do you think are the reasons for the decreasing grazing land size? (Rank it) ________________

   1. Decreasing livestock population
   2. Using the land for crops
   3. Using the land forest
   4. Increased land rent values
   5. Climate change
   6. Others specify _________________

3. What are the local indicators of climate variability in your *region*?
4. Which rain season is your dependent on?
5. What looks like the productivity of crops for the previous 10 years.?
6. What is the relation between climate variability and crop production?
7. What are the main barriers to the use of adaptation strategies for combating climate change, and how do you think they can be improved?
8. What are the major limiting factors of crop production?
9. What are the major local coping mechanisms (adaptation strategies) used to reduce the adverse impacts? Rank (simple or pair-wise) and determine their effectiveness.
10. For the last two decades, at what time drought or flood occurred?

Afaan Oromoo Version of the Questionnaires and Interviews

Yuuniversiitii Finfinneetti

Kollejjii Saayinsii Hawaasaa

Muummee Gi'oogiraafii fi Qo'annoo Naannoo

Appeendeeksii 1: Gaafannoo Qonnaan Bulaan Gaafatamu.

Jaallatamaa Qonnaan Bulaa, Gaaffilee Gaafannoo armaan Gaditti dhiyaatan kunniin mata duree: **Assessing Climate Change Impacts and Adaptations Strategies Among Smallholder Farmers: The Case of Chiro Woreda, West Harerghe Zone, Oromia Region, East Ethiopia** irraatti qo'annoo fi qorannoo gaggeessuuf qofa kan oolu raga sassaabuuf itti yaadamee kan dhiyaatedha. Kaayyoo kana immoo galmaan ga'uuf tumsi keessan iddoo olaanaa kan qabudha. kanaaf Gaafannoo kana haala gaafatameen deebisuun tumsa keetiin ana waliin akka dhaabattu kabajaan isin gaafadha.

Tumsa keessaniif Galatoomaa!.Qajeelcha Waliigalaa:

- Maqaa barreessun hin barbaachisu.
- Ajaja kenname sirriitti dubbisaa.
- Deebii keessan kennuuf mallattoo raayitii (√) fayyadamaa.
- Gaaffilee yaada keessan barbaadaniif deebii ifaa fi gabaabaa kennaa.

Kutaa 1: Odeeffannoo Waliigalaa

1. Maqaa Aanaa----------------------

2. Ganda-------------------------------------

3. Maqaa garee misoomaa-------------------------------

4. Itti gaafatammummaa irra jirtan--

Variable	Response	
1. Saala	Dubara	
	Dhiira	
2. Umurii Waggaan	20-30	
	31-40	
	41-50	
	51Fi isaa oli	
3. Gaa'ela	kan hin fuune	
	Kan Fuudhe	
	kan wal hiikan	
	kan abbaa /haadha warraa hin qabne	
4. Baayina Maatii	2-6	
	7-10	
	11 fi isaa oli	
5. Sadarkaa barnootaa	Illiterate/kan hin barane	
	Dubbisuu fi barreessuu kan dandaa'u	
	Kutaa 1-8	
	kutaa (9-12)	
	Dippiloomaa and isaa oli	
6. Gali waggaa	< 900 ETB	
	1000-10000 ETB	
	10,001-31000 ETB	
	31,001-51,000 ETB	
	Above 51,001ETB	
7. Lafa qonnaa hektaaraan	<0.5	
	0.5-1ha	
	2-3 ha Ol	
8. Muxannoo qonnaa	1-15	

qaban(Waggaan):	16-30	
	31-46	
	>47	
9. Mirga qabiyyee lafa	Kan dhunfa	
	Kan kireefame	
10. Qabeenya horii	<4	
	5-8	
	>9	
11. Fageenya gabarraa qaban(km):	<5	
	5-10	
	>11	
12. Odeeffannoo qileensa baramaa	Gahaa	
	Gahaa miti	

Kutaa 2: Odeeffannoo dhimma jijjirama qileensa wajjin walqabatu

1. Jijjiramni qileensa waggaa 10 asi ni jiraa? 1. Eeyyee☐ 2. lakkii☐
2. Gaaffii.1[ffaa]Eeyyee yoo jetee, amala haala qileensa naannoo waggaa 10 asi akkamiti hubattee?
   a) Gamaa teempireecheeratiin: 1. Ni dabalee☐ 2.ni hir'isee ☐ 3. Jijirama hin qabu☐
   b) Gamaa hanga roobaatiin: 1. Ni dabalee ☐ 2. Ni hir'isee ☐ 3. Jijirama hin qabu☐
   c) Gamaa facaa'isan roobaatiin: 1 .jijjirama☐ 2. dhabbatadha ☐ 3 .hin beeku☐
   d) Gamaa goginsaan: 1. Ni dabalee☐ 2. Ni hir'isee☐ 3. Jijirama hin qabu☐ 4. hin beeku☐
   e) Gamaa lolaatin: 1. Ni dabalee☐ 2. Ni hir'isee☐ 3. Jijirama hin qabu ☐4. hin beeku☐
   f) Gamaa dhukkuba midhaanitiin 1. Ni dabalee☐ 2. Ni hir'isee ☐ 3. Jijirama hin qabu☐
3. Jireenya kee keessa ho'insaa yeroo dheeraa argitee beekittaa? 1. Eeyyee☐ 2.lakkii☐

4. Gaaffii 3ffaa Eeyyee yoo jettee, akkamin ilaaltee? 1. Gabaabbacha deema☐ 2. Dheeracha deemaa☐

5. Jireenya kee keessatti yeroo jalqaba Arfasaa roobu argitee ni beekittaa? 1. Eeyyee ☐ 2.lakkii ☐

➢ Gaaffii 5ffaa Eeyyee yoo jettee akkamiti hubatee?

1. Jalqaba irratti☐

2. Dhumaa irratti ☐ 3.lachu ☐ 4. Yaada biroo-------------------------

6. Yeroon ho'insaa naannoo keessan ni jiraa? 1. Eeyyee☐ 2.lakkii☐

➢ Gaaffii 6ffaa Eeyyee yoo jettee, akkamiti ilaaltee?

1. Haalaan ni dabalee ☐ 2. Haalaan ni hir'isee ☐

7. Jijjirama yeroo oomishaa dheeraachuu argitee ni beekitaa? 1. Eeyyee ☐ 2.lakkii☐

➢ Gaaffii 7ffaa Eeyyee yoo jettee akkamiti hubatee? 1. Gabaabbacha deema ☐ 2. Dheeracha deemaa ☐

8. Hangi Rooba oomishaa keessaniif gahaadhaa? 1. Eeyyee ☐ 2.lakkii ☐

9. Jijjirama kamiyuu watiilee oomishaa waggaa keessatti mul'ataan argitee beekitaa? (Ganna fi Birraa)?

1. Eeyyee ☐ 2.lakkii☐

10. Leenjii Maloota jijjirama qileensa irratti fudhaatan ni qabda?

1. Eeyyee ☐ 2.lakkii☐

➢ Yoo Gaaffii 10ffaa "Eeyyee" jettee, waa'ee leenjicha ibsi ………………………

11. Sababootni gurgudoon jijjirama haala qileensa maali jettee yaadaa?

1. ____

2.____

12. Naannoo keessaanitti wantootni haala qilleensa wajjin walqabatu rakkoo ni uumuu jettee yaada?

1. Eeyyee ☐ 2.lakkii ☐

13. Gaaffii 12ffaa "Eeyyee" yoo jettee, Jijjiramni haala qileensa fi garagaagumaa isaa jireenya kee irratti miidhaa hammam qabaa?
1. Miidhaa homaa hin qabu ☐ 2. Gadi anaa ☐ 3. Gidduugaleesaa ☐ 4. Oli anaa☐

14. Irraa caalaa jijjirama haala qilleessatii eenyuutu miidhaamaa?
1. Dubartii ☐ 2. Ijoollee ☐ 3. Jaarsolii ☐ 4. Kan biroo___________________

15. Odeeffannoo jijjirama haala qileensa eessaattii argattaa?

a. Biiroo ogeessa qonnaa irraa ☐ b. Qonnaan bulaa adda duree irraa ☐

c. Teelivijiina irraa ☐d. Radoonii irraa ☐

16. Rakkoo gurgudoon haala qilleensa naannoo kee keessatti miidhaa fiduu dandaa'an Ni jruu? Haala miidhaa isaanittin tartiibeesi (1 guddaa irraa 6 xiqqatti kahi)

Lakk.	Rakkoo			Sadarkaa
1	Hoongee			
2	Harama lafaa			
3	Ho'a guddaa			
4	Du'a beeladaa			
5	Dhukkuba namaa			
6	Rooba cimaa			
7	Rooba baay'ee gabaabaa			
8	Jijjirama rooba			
9	Rooba jandoo			
10	Dhukkuba midhaani			

Kutaa 3ffaa: dandaamanna jijjirama haala qilleensa.

Deebii keessanii sanduqaa keessatti mallattoo raayitii (√) kenni

1. Jijjirama qilleensa qonnaa kee keessatti akkamiti dandaamachuu dandeessaa?

   a) Madda galii baay'isuu ☐

   b) Hojii guyyaa ☐

   c) Horsiisa loon xiqeesuu☐

   d) Sanyiiwwan hoongee dandaamachuu dandaa'an facaasuu ☐

   e) Bosoona dhaabuu fi bakka bosooni cirame deebisan dhaabuu ☐

   f) Qonna wal makaa fayaadamuu☐

   g) Jalqabaa fi turanii facaasuu ☐

   h) Jallisii fayaadamuu☐

   i) Loon irraa gara bushayyee jijjiruu ☐

   j) Biyyee fi bishaan kunuunsuu ☐

2. Rakkowwan hawaasni jijjirama haala Qilleensa akka hin ittisne dhiibbaa godhani:

   k) Hir'ina maallaqa/☐
   l) Hir'ina Odeeffannoo haala Qilleensa ☐
   m) Hir'ina beekumsaa ☐
   n) Hanqina ogeessaa qonnaa ☐
   o) Hir'ina ijaarsaa ☐
   p) Hanqina jallisii ☐
   q) Hir'ina tajaajila liqaa fi qusaanna ☐
   r) Rakkoo mirgaa qabeenyuma fi abba lafumaa ☐
   s) Hanqina lafaa

Appendix 2: AF- GAAFFII ODEEFFANNOO

Section 1: af-gaafii To'ataa aradaa, duraa ta'aa, bulchitoota goxiif, and jarsoolii aradaaf, miidhaa jijjirama qilleensa fi malaa ittisa isaa qonnan bultoota xiqaa gidduutti.

1. Jireenya kee akkamin gaggeesaa jirta?
2. Gosa qonnaa kam hojiirraa oolchaa jirtaa?
3. Irraa caalaa mala qonnaa isaa kam fayyadamta?
4. Maaliif qotta?
5. Rakkoowwan hawaasni jijjirama haala qilleensa akka hin ittisne dhiibbaa godhani maal faadha?
6. Waqtiilee waggaa isaa kam keessa rakkoon bay'ata?
7. Miidhaa jijjirama qilleessa fi ittisa isaa keessa qooda ni qabdaa?
8. Gaheen aanaa, ogeessa Qonna, fi bulchitoota aradaa miidhaa jijjirama haala qilleensa fi mala ittisa isaa akkamitti ilaaltee?
9. Miidhaa jijjirama haala qilleensa akkamiti hubattee?
10. Maddi galii kee inni guddaan maalii? (Wal dura dubaan 1 hangaa 3 tartibeesi)?

    a. galii Qonna b. gurgurtaa adda addaa c. Qonnaa ala d. kan biroo -------

Appendix 3: WALIIN MARII GAREE /FGD/

- **Gaaffilee waliin marii gareef dhiyaata.**

1. Waggootaa 10 darban wali bira qabde yoo ilaaltu bal'inni lafa margaa argatuu hangam?
    a. Hir'isa jira
    b. Dabala jira
    c. jijjirama hin qabu
2. Yoo hir'isaa jira jetee sababi hir'isuu bal'inni lafaa margaa malii jetee yaadda? (Sadarkeesi)
    a. Baayina loon Hir'isuu
    b. Lafa qonnaa fayadamu
    c. Lafa Bosoona fayyadamu
    d. Gatiin lafa dabaluu
    e. Jijjirama haala qilleensaa
    f. Kan biroo __________________
3. Akka naannoo keetti ibsituun jijjirama haala qilleensa maal fa'i?
4. Waqtiilee roobaa isaa kam irratti hundooftaa?
5. Oomishaa waggaa 10 darbani akkamittii ilaaltee?
6. Waliitti dhufeenya jijjirama haala qilleensa fi oomishaa maalii fakkaata?
7. Rakkowwan dandaamanna jijjirama haala qilleensa maalii fi akkam fooya'a jettee yaadda?
8. Rakkowwan jajjaboon oomishaa keenya xiqqeesuu danda'a maal fa'i?
9. Akka naannoo keetti Maloonni gurgudoon miidhaa jijjirama haala qilleensa hir'isuu danda'an maali? Faayidaa isaa adda baasi.
10. Waggootaa digdamman darban gosoonni hoongee ykn lolaa mul'achaa turee?