



Farmers coping and adaptation strategies to Climate variability in Central Highlands of Ethiopia

Kefelegn Chernet^{1*}, Arragaw Alemayehu², Amanuel Mulualem³

¹Department of Geography and Environmental Studies, College of Social Science and Humanities, Dire Dawa University, Dire Dawa, Ethiopia, Phone: +251920857694, P.O. Box 1362, Email: Kefelegn.chernet@gmail.com

²Department of Geography and Environmental Studies, College of Social Science and Humanities, Debre Berhan University, Debre Berhan, Ethiopia, Phone: +251911314036, Email: arragawalex@gmail.com

³Department of Sociology, College of Social Science and Humanities, Dire Dawa University, Dire Dawa, Ethiopia, Phone: +251917621981, P.O. Box 1362, Email: amanyahoo541@gmail.com

*Corresponding Author

Abstract

Farmers in the central highlands of Ethiopia face increasing challenges from declining rainfall and reduced crop productivity. This study examined the coping and adaptation strategies employed by farming households in response to rainfall variability and yield reduction, and identified key factors shaping these responses. A survey of 138 randomly selected farmers from three kebeles in Merhabete woreda was conducted using structured questionnaires, complemented by key informant interviews and focus group discussions. Results showed that farmers adopted multiple strategies, including cultivating short-maturing crops, crop diversification and intercropping, storing harvests, practicing small-scale irrigation, reducing livestock numbers, changing livestock types, rainwater harvesting, selling firewood and charcoal, seasonal migration, reducing meal frequency, borrowing grain, selling livestock, and renting land. Farmers with better access to resources, credit, climate information, agricultural technologies, and disaster preparedness were more likely to implement these strategies effectively. Major barriers to adaptation included lack of irrigation land, poverty and land scarcity, limited administrative support, feed and forage shortages, inadequate agricultural inputs, and insufficient climate information. These constraints weaken farmers' adaptive capacity, underscoring the need for targeted interventions and supportive policies to strengthen resilience to climate variability in the region.

Keywords: Adaptation, Climate variability, Coping, Farmers

*Corresponding author: Kefelegn Chernet, email: kefelegn.chernet@gmail.com Phone: +251920857694

1. Introduction

Climate change and variability have become critical global concerns, with disproportionate impacts on vulnerable populations, particularly smallholder farmers in developing countries. In Ethiopia, where agriculture contributes significantly to employment and GDP, smallholder farmers are especially susceptible to climatic shocks such as erratic rainfall, prolonged droughts, and rising temperatures. The central highlands of Ethiopia, a region highly dependent on rain-fed agriculture, are particularly vulnerable. These changes threaten not only agricultural productivity but also food security and the livelihoods of rural communities (Alemayehu et al., 2017; Megersa et al., 2022).

To cope with these challenges, Ethiopian farmers have adopted a variety of strategies, including selling livestock, adjusting planting dates, diversifying crops, and implementing soil and water conservation practices. For instance, studies indicate that about 85% of farmers in the central highlands sell livestock during extreme conditions, 89% adjust planting dates, and 76% alter their consumption patterns in response to climate-related risks (Alemayehu et al., 2017). These practices highlight the resilience and resourcefulness of farmers in adapting to changing environmental conditions.

The adoption of adaptation strategies is shaped by a range of socio-economic and environmental factors. Access to extension services, land tenure security, perceived soil fertility, education levels, and household demographics play important roles in determining the choice and effectiveness of adaptation measures. Secure land tenure encourages long-term investments in sustainable practices, while extension services enhance the capacity of farmers to adopt innovative techniques (Etana et al., 2023). Similarly, farmers' awareness of climate variability and access to reliable climate information strongly influence their responses (Darabant et al., 2020).

Regional differences also shape adaptation responses. For example, farmers in the Central Rift Valley and Konso commonly adopt agroforestry, terracing, and water harvesting techniques, whereas those in the central highlands emphasize planting date adjustments and soil conservation. These differences highlight the importance of tailoring adaptation strategies to specific agro-ecological contexts (Kassie et al., 2013; Gashure et al., 2023). A localized approach ensures that interventions respond to the unique challenges and opportunities facing farmers in different areas.

Despite these efforts, farmers continue to face major barriers to effective adaptation. Limited access to resources, weak institutional support, and inadequate dissemination of climate information services are persistent challenges. Insecure land tenure, poverty, and insufficient infrastructure further exacerbate vulnerability, limiting farmers' ability to invest in sustainable practices (Alemayehu et al., 2017; Megersa et al., 2022). Overcoming these barriers requires coordinated action by policymakers, researchers, and development organizations.

Perceptions and cultural norms also influence adaptation decisions. Farmers' willingness to adopt new practices is often shaped by long-standing cultural traditions and local beliefs. For example, some prioritize traditional methods over modern technologies, reducing the effectiveness of adaptation responses (Darabant et al., 2020). Climate adaptation policies must therefore incorporate culturally sensitive approaches to ensure both acceptance and sustainability.

Furthermore, the effectiveness of adaptation strategies is closely linked to their economic feasibility. High-return measures such as adopting improved crop varieties and climate-resilient technologies are often underutilized because of financial constraints. Expanding access to credit, subsidies, and markets can enhance farmers' adaptive capacity. Similarly, investments in training and community-based extension programs can empower farmers to make informed, sustainable decisions (Etana et al., 2023).

In light of these challenges and opportunities, assessing the adaptation strategies employed by smallholder farmers, as well as the socio-economic and environmental factors that shape their decisions, is essential for developing effective interventions. This paper examines the coping and adaptation mechanisms adopted by farmers in the central highlands of Ethiopia and analyzes the factors influencing their implementation.

2. Materials and Methods

2.1. Description of the Study Area

Merhabete is one of the 24 rural woredas in the North Shewa Zone of the Amhara Region, Ethiopia. It was purposively selected for this study due to its high vulnerability to climate change and variability, particularly recurrent droughts and erratic rainfall, which significantly affect the livelihoods of the local population. The aim of the study was to assess the coping

and adaptation strategies employed by the community in response to these climatic challenges.

The administrative center of Merhabete woreda is Alem Ketema town, located approximately 189 km northwest of Addis Ababa (the national capital), 589 km from Bahir Dar (the regional capital of Amhara), and 142 km west of Debre Berhan (the capital of North Shewa Zone). Geographically, the woreda lies between 9°50' and 10°10' N latitude and 38°42' and 39°20' E longitude. Merhabete covers a total land area of 99,540 hectares and is composed of 23 rural kebeles and 4 urban kebeles.

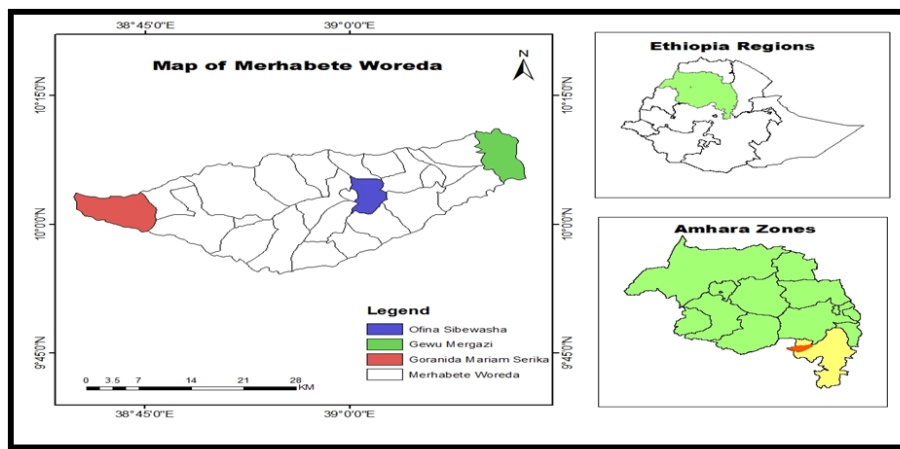


Fig.1 Location map of the study area

Merhabete Woreda, located in the North Shewa Zone of the Amhara Region, is characterized by a mountainous and dissected landscape with slopes ranging from steep to flat. The elevation varies between 1,300 and 3,200 meters above sea level, encompassing diverse agro-ecological zones, of which Woyna-Dega is dominant (approximately 70%). The woreda experiences three distinct seasons: the dry season (*Bega*), the main rainy season (*Kiremt*), and the short rainy season (*Belg*). Annual rainfall ranges from 700 to 1,200 mm, while average temperatures vary between 14.4°C and 23°C.

The woreda has a population of 119,614, with a population density of 134.1 persons per km², which is higher than the regional average. The vast majority of residents (95%) live in rural areas, where mixed farming—combining crop cultivation and livestock production—is the primary livelihood. Crop production is predominantly rain-fed, although small-scale irrigation is practiced in some areas for vegetable farming. Livestock, including cattle, sheep, goats, poultry, and beehives, play a vital role in the local economy. However, agricultural productivity is constrained by land degradation, limited grazing land, water scarcity, and

livestock diseases. Seasonal migration to urban centers for wage labor is also common, driven largely by land scarcity and low agricultural returns.

2.2. Data and Methods

2.1. Data Collection and Methods of Analysis

A multi-stage sampling technique was employed in this study. In the first stage, the kebeles of Merhabete Woreda were stratified into three agro-ecological zones—highland, midland, and lowland. From each zone, one kebele was selected using simple random sampling (lottery method): Gewu Mergazi (highland), Ofina Sibewasha (midland), and Goranida Mariam Serika (lowland).

The total population of the three kebeles is 12,249, comprising 2,311 households. From this, 138 households were purposively selected for the questionnaire survey, taking into account income status and the proportion of male- and female-headed households.

To complement the quantitative survey, focus group discussions (FGDs) were held with knowledgeable elders, religious leaders, and community members. In addition, key informant interviews were conducted with development agents, local leaders, model farmers, and representatives from the woreda agricultural development office, each with more than 10 years of residence and experience in the area.

The quantitative data from the survey were analyzed using the Statistical Package for the Social Sciences (SPSS) and Stata software. To examine whether farmers' perceptions of climate variability differed significantly based on variables such as education level, age, and sex, several statistical tests were applied, including chi-square tests, one-way ANOVA, and bivariate correlation analysis. These tests allowed for the identification of significant relationships and differences between the variables and farmers' perceptions of climate variability.

Qualitative data collected through FGDs, open-ended questions, and interviews were analyzed thematically. Attention was given to identifying common patterns, emerging themes, and community insights. To ensure reliability, inconsistencies and errors were corrected during the data cleaning phase, thereby strengthening the robustness and credibility of the findings.

3. Results and Discussion

3.1. Characteristics of Sample Households

The survey of 138 households revealed that 21.7% were female-headed, mainly by widowed or divorced women, while 78.3% were male-headed. The majority of household heads were between 41 and 60 years of age (54.3%), followed by those aged 20–40 (26.8%), suggesting that most households are economically active and possess considerable experience with local environmental conditions. Although younger farmers are often assumed to be more perceptive of climate variability (DeJonge, 2010; Semenza et al., 2011; Temesgen et al., 2008), the dominance of middle-aged respondents suggests that accumulated experience also provides valuable insights into climate-related challenges.

Household size varied, with 60.9% having medium-sized families (5–8 members), 23.2% small families (≤ 4 members), and 15.9% large families (> 8 members). In terms of marital status, 76.1% of household heads were married, 13.8% widowed, and 7.2% divorced, with widowed households more common in the lowland kebele, Goranida Mariam Serika.

Table 1. Age and sex composition of the sample household heads

Variables		Sample kebele						Total	
		Gewu Merigaze		Ofina Sibiwash		Goranda Mariam Serika			
		Freq.	%	Freq.	%	Freq.	%	Freq.	%
Sex	Male HHHs	34	79.1	37	78.7	37	77.1	108	78.3
	Female HHHs	9	20.9	10	21.3	11	22.9	30	21.7
Age	20-40	10	23.3	13	27.7	14	29.2	37	26.8
	41-60	25	58.1	26	55.3	24	50	75	54.3
	>60	8	18.6	8	17	10	20.8	26	18.8
Marital status	Single	1	2.3	2	4.3	1	2.1	4	2.9
	Married	33	76.7	37	78.7	35	72.9	105	76.1
	Divorced	3	7	4	8.5	3	6.3	10	7.2
	Widowed	6	14	4	8.5	9	18.8	19	13.8
Household size	≤ 4 (Small)	7	16.3	9	19.1	16	33.3	32	23.2
	5-8 (medium)	31	72.1	28	59.6	25	52.1	84	60.9
	>8 (large)	5	11.6	10	21.3	7	14.6	22	15.9
Educational status	Illiterate	23	53.5	25	53.2	29	60.4	77	55.8
	Read & write	15	34.9	17	36.2	12	25	44	31.9
	Primary	5	11.6	3	6.4	6	12.5	14	10.1
	Secondary	0	0	2	4.3	1	2.1	3	2.2

Educational attainment was generally low: 55.8% of respondents were illiterate, 31.9% could read and write, 10.1% had completed primary education, and only 2.2% had attended

secondary school. Limited education may reduce the community's capacity to effectively adapt to climate change.

Land fragmentation, driven partly by the need to allocate land to younger household members, has contributed to declining crop yields over the past decade. Ten years ago, 61.6% of households produced more than 10 quintals of cereals, whereas currently, 63% produce less than 10 quintals, indicating a marked decline in agricultural productivity. This reflects the socio-economic pressures constraining adaptation to climate variability.

Climate change is a pressing global phenomenon, but adaptation and coping responses vary widely across countries, regions, and even local administrative units such as woredas. In Merhabete Woreda, both local and institutional strategies have been employed. However, increasing frequency and intensity of climate-related shocks have weakened the community's adaptive capacity.

Survey results revealed that 52.9% of respondents believed adaptation to certain climate change impacts is possible, while 47.1% considered it infeasible. When asked about responsibility for adaptation, 61.6% attributed it to government organizations, 23.9% to local communities, 11.6% to non-governmental organizations (NGOs), and 2.2% to other actors.

To assess whether perceptions of adaptation varied by education level, a one-way ANOVA test was applied. The null hypothesis assumed no significant difference in perceptions of climate change and variability (CCV) based on education.

Table 2. Perceptions of adapting to CCV by educational level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.590	3	.863	3.629	.015
Within Groups	31.881	134	.238		
Total	34.471	137			

The test yielded a p-value of 0.015 ($df = 3$), below the 0.05 significance threshold. The null hypothesis was therefore rejected, indicating a statistically significant difference in perceptions of climate change adaptation across educational groups. This suggests that education plays a critical role in shaping awareness and enhancing adaptive capacity.

3.2. Vulnerability of the Community to Climate Shocks

Survey findings indicate that 42.8% of major shocks were associated with crop pests, weeds, and diseases, including outbreaks of locusts and the spread of new invasive species, all of which pose significant threats to food security. In addition, 23.9% of respondents cited erratic rainfall, flooding, and rainfall variability as the most severe climate-related shocks leading to yield reduction. Recurrent drought accounted for 8%, while other shocks—such as lightning, snake bites, and crop damage by wild animals (e.g., foxes and monkeys)—represented 1.4%.

Community perceptions of climate change and variability are crucial for informing both mitigation policies and adaptation strategies. When asked whether they had observed long-term climate change in their area, 55.8% of respondents reported that the climate has completely changed, while 44.2% noted variability rather than permanent change.

3.2.1. Vulnerable Social Groups

The World Bank (2010) emphasizes that the poor, landless, women, children, persons with disabilities, and the elderly are among the most vulnerable groups to climate change, largely due to their limited access to resources, mobility restrictions, and marginal participation in decision-making. In line with this, survey results reveal that 42% of respondents identified the poor and landless as the most vulnerable to climate variability because of insufficient farmland and livestock. About 21.7% reported that women and children are disproportionately affected. Women bear multiple household responsibilities—including fetching water, collecting firewood, and managing domestic tasks—while children are particularly vulnerable to malnutrition and inadequate nutrition.

A further 14.5% of respondents identified households with large family sizes as highly vulnerable, while 11.6% highlighted households without alternative income sources. Additionally, 10.1% reported that the elderly and persons with disabilities are among the most affected, given their limited adaptive capacity.

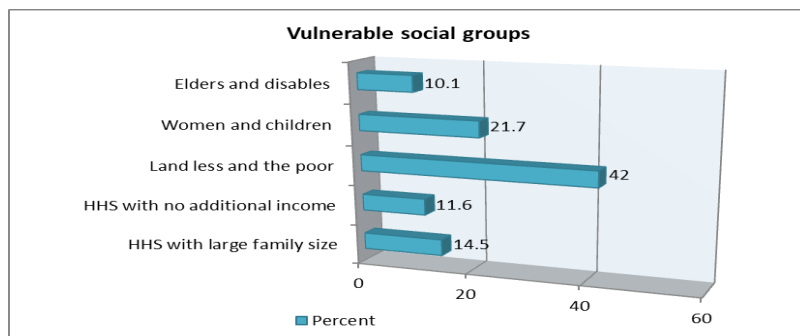


Figure 2. Vulnerable social groups by climate change and variability

3.3. Causes of Climate Change and Variability

Survey results identify deforestation as the primary driver of climate change and variability-related challenges, reported by 25.4% of respondents. Trees are often cleared for firewood and to expand farmland in response to increasing demand. Low soil fertility was cited by 24.6% as a major factor, as it exacerbates the negative impacts of climate change and drives unsustainable farming practices despite temporary reliance on chemical fertilizers.

In addition, 23.9% of respondents attributed climate change to divine will, viewing it as God’s punishment for human misconduct. About 13% reported land use and land cover change, alongside unsustainable agricultural practices, as critical contributors to climate variability.

Insights from key informant interviews supported these findings. As one kebele development agent explained:

“Low soil fertility contributes significantly to climate change because farmers cut trees around virgin lands in search of fertile soil, which in turn worsens the situation.”

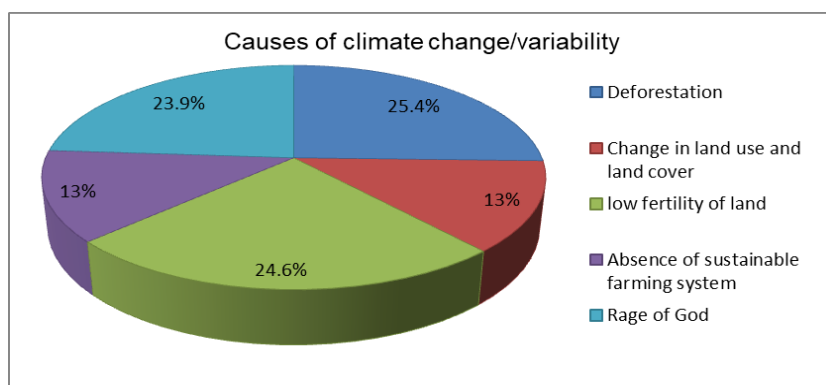


Figure 3: Main causes of climate change and variability

3.4. Coping and Adaptation Strategies

Although climate change is a global phenomenon, the ability to cope and adapt varies across countries, regions, and local communities due to differences in geography, socio-economic conditions, and institutional capacity. In Merhabete Woreda, local households employ both traditional and institutional mechanisms to cope with climate-related hazards. However, increasing frequency and intensity of climate shocks have gradually weakened the community's resilience.

According to the survey, 52.9% of respondents believed adaptation to certain climate-induced hazards is possible, while 47.1% considered it impossible. Responsibility for adaptation was attributed mainly to government organizations (61.6%), followed by the local community (23.9%), non-governmental organizations (11.6%), and other groups (2.2%).

Table 3: One-Way ANOVA Test of Perceptions of Adapting to CCV by Educational Level

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.590	3	0.863	3.629	.015
Within Groups	31.881	134	0.238		
Total	34.471	137			

The null hypothesis assumed no significant difference in perceptions of adapting to climate change and variability (CCV) across educational levels. The analysis yielded a p-value of .015 (df = 3), below the .05 significance level. Thus, the null hypothesis was rejected, indicating that perceptions of climate change adaptation differ significantly by education. This finding underscores the importance of education in shaping adaptation knowledge and practices.

3.4.1. Farmers' Adaptation Strategies

Climate change requires communities, particularly in developing countries, to adopt adaptive strategies to sustain livelihoods (IPCC, 2014). In Merhabete Woreda, households have implemented a range of measures:

Growing Short-Maturing Crops. A large proportion of households in kola (41.7%) and woyina dega (31.9%) kebeles have adopted early-maturing crops, such as masho and chickpeas. These high-yielding, drought- and disease-resistant varieties have become critical for maintaining food security. According to FGDs and key informants:

“Early-maturing crops are planted due to the shortening of the growing season. For instance, the kiremt season has shrunk from three months to just one. As a result, farmers in lowland areas have recently started cultivating masho, a crop not previously grown in the area, which matures within two months and requires much less water.”

Crop Diversification and Intercropping System

Crop diversification and intercropping are widely recognized as risk-reducing strategies (UNEP, 2006; Temesgen et al., 2014). In the study area, 22.5% of respondents reported practicing diversification and adjusting cropping patterns in response to rainfall variability. Farmers grow a wide range of crops, including cereals (teff, sorghum, wheat, barley, maize) and legumes (beans, peas, masho), alongside oilseeds (neug, shimbira, guaya, telba, selite, abish). Legumes are often rotated with cereals, particularly in dega and woyina dega areas, to enhance soil fertility through nitrogen fixation (MWADO, 2020). These strategies not only support adaptation to climate variability but also improve soil health and food security.

Wise Storage of Crops (Saving)

Wise storage of crops is an adaptation strategy that mitigates risks over time by pooling resources and safeguarding harvests. When supported by durable infrastructure, low perishability, and effective coordination among households, crop storage becomes a critical measure to prevent livelihood collapse during crises (Agrawal, 2008). It plays an essential role in ensuring household and community food security during periods of scarcity.

Survey results show that 34.1% of respondents practice wise crop storage, particularly by saving grains in garners constructed from bamboo or thin wooden planks. This strategy is more prevalent in the *dega* agro-ecology, where cooler temperatures and low insect activity (locally referred to as *Nekeze* in Amharic) enable grains to be stored for longer periods with minimal spoilage. In contrast, the *kola* agro-ecology experiences higher temperatures, which accelerate grain deterioration and pest infestations, making storage less effective without additional preservation measures. This highlights the importance of adapting storage strategies to specific ecological conditions to ensure food security and resilience.

Intensive Irrigation

Irrigation is a critical means of stabilizing agricultural production, though it remains one of the least practiced adaptation strategies in Ethiopia (Temesgen et al., 2014). According to the

survey, only 18.1% of respondents reported using small-scale irrigation, primarily in *kola* and *woyina dega* kebeles. Farmers in these areas utilize water from the Jema and Wonchite rivers to irrigate crops.

Irrigation is predominantly used to cultivate vegetables such as onions, chilies, and cabbages, which serve both household consumption and market-oriented purposes. Although limited in scope, irrigation demonstrates significant potential for expansion, offering a pathway to enhance agricultural resilience and productivity in regions highly exposed to climate variability.

Table 4: Farmers’ Adaptation Strategies to Climate Change and Variability by Kebele

Adaptation Strategy	Gewu Merigaze	Ofina Sibiwasha	Goranda Serikamariam	Total
Growing short-maturing crops	–	31.9%	41.7%	25.4%
Crop diversification & intercropping	41.9%	14.9%	12.5%	22.5%
Wise storage of crops (saving)	58.1%	34.0%	12.5%	34.1%
Intensive irrigation	–	19.1%	33.3%	18.1%
Total	100.0%	100.0%	100.0%	100.0%

Farmers’ adaptation strategies vary considerably across agro-ecological zones. In *kola* kebeles such as Goranda Serikamariam, strategies primarily include cultivating short-maturing crops and practicing irrigation. In contrast, no formal adaptation practices were reported in *dega* kebeles like Gewu Merigaze. Meanwhile, *woyina dega* kebeles such as Ofina Sibiwasha employ a wider range of strategies, including crop diversification, intercropping, and rainwater harvesting. These variations demonstrate that farmers’ adaptation choices are closely linked to their specific environmental contexts, underscoring the need for location-specific interventions.

Diversification of Income Sources

Income diversification serves as an important strategy for households to buffer against agricultural income losses caused by climate variability. By engaging in non-farm activities, households supplement earnings and build resilience.

The household survey revealed that 61.6% of respondents engaged in non-farm income-generating activities. Among them, 20.3% were involved in petty trade, such as producing and selling *tella* and *areki* or trading livestock purchased from nearby towns such as

Shewarobete and Degola. Beekeeping was reported by 15.2%, while 14.5% engaged in handicrafts, including weaving, carpeting, and pottery. Another 11.6% pursued wage labor or other livelihoods such as serving as priests. Diversifying income thus strengthens household economic stability, enabling communities to better withstand the effects of climate variability and related shocks.

3.4.2. Farmers' Coping Mechanisms to Climate Change and Variability

Coping mechanisms are immediate, short-term strategies that households employ to manage livelihood shocks caused by unforeseen events or conditions (Dawit & Habtamu, 2011). In response to climate change and variability (CCV), local communities in Merhabete Woreda have adopted a range of coping strategies. Household survey results indicate the following:

Selling Firewood and Charcoal

One of the most common coping strategies is the sale of firewood and charcoal. This practice allows farmers to mitigate the economic impacts of drought and rainfall variability. Survey results show that 39.9% of respondents rely on selling firewood, animal manure, and charcoal to urban consumers to cover basic household needs. Typically, poorer households engage in this activity. While this provides immediate financial relief, its sustainability depends on resource availability and market demand.

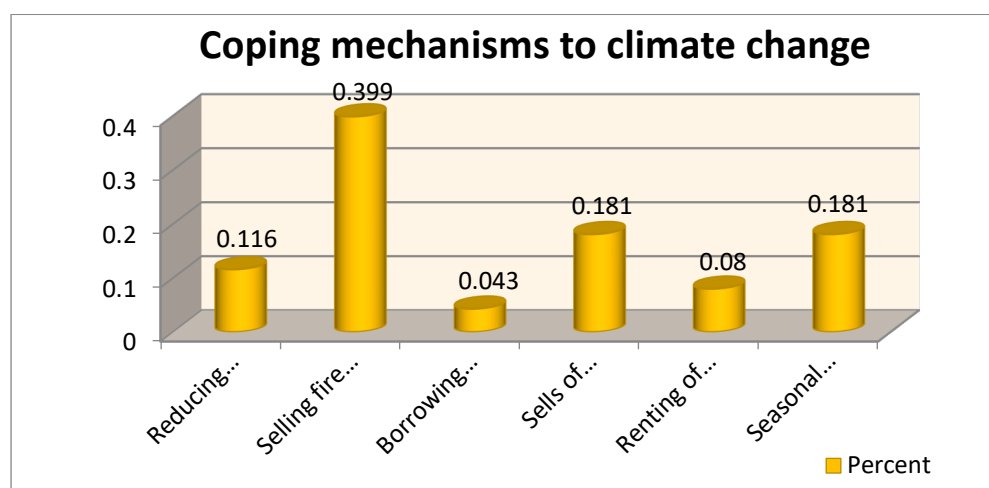


Figure 5: Coping strategies employed by farmers in response to climate change and variability

Seasonal Migration

Seasonal migration is another key coping mechanism, particularly in *kola* and *woyina dega* kebeles. Farmers often migrate to urban centers such as Addis Ababa, Alem Ketema, Mizan, Wolkite, and Wonije, as well as surrounding rural areas, to work as daily laborers or in contract farming. Approximately 18.1% of respondents reported using migration to cope with climate impacts. Typically, individuals over 30 years of age migrate to earn income and return home to support their households, thereby reducing family vulnerability.

Reducing Number of Meals

During periods of food scarcity, 11.6% of respondents reported reducing meal size and frequency. Adult household members generally consume two meals per day, often relying on low-nutrient foods such as ripened grains (*Nifiro* or *Kolo* in Amharic), while children typically eat three meals but with reduced nutritional quality. During severe food shortages, meal reduction is practiced collectively across all household members.

Borrowing Grains from Relatives

Borrowing grains from relatives is a coping strategy reported by 4.3% of respondents. Households repay borrowed grains either in kind or through labor, such as helping with daily work. This practice allows families to manage temporary food shortages while maintaining access to essential nutrition.

Selling Livestock

Selling livestock serves as a critical coping mechanism, with 18.1% of respondents reporting its use. Farmers sell sheep, goats, cows, poultry, and in extreme cases, oxen to generate cash or secure food. Livestock sales provide immediate liquidity to address food insecurity or other urgent needs.

Renting Land

Approximately 8% of respondents cope with adverse conditions by renting out farmland for 3–5 years, either for cash or in-kind compensation. However, this strategy can be problematic, as some renters are unwilling to return land at the end of the lease, potentially leading to disputes and further challenges for landowners.

These coping mechanisms highlight the resilience and resourcefulness of farmers in managing climate risks while also underscoring the difficult trade-offs and sacrifices required to sustain livelihoods.

3.4.3. Government Responses to Climate Change and Variability

Developing countries with limited infrastructure and resources are particularly vulnerable to climate change, with the poorest populations most affected. In Ethiopia, the government has implemented national policies, sector strategies, and programs to promote rural and agricultural development while addressing poverty. Although climate adaptation is often addressed indirectly in sectoral policies, it remains integral to national development objectives, particularly in natural resource management and environmental protection (NMA, 2007).

Mobilizing Communities for Mitigation Measures

Mitigation strategies aim to reduce greenhouse gas emissions and enhance the carbon absorption capacity of ecosystems. In Ethiopia, these include large-scale afforestation and soil and water conservation programs, which reduce CO₂ emissions and promote carbon sequestration. Such efforts also improve agricultural productivity by preventing soil erosion, conserving water, and rehabilitating degraded lands.

Over the past two decades, the government has mobilized communities to participate in natural resource rehabilitation initiatives, including tree planting and watershed management, to enhance local resilience to climate change. According to household surveys, FGDs, and key informant interviews, communities engage in these activities for approximately 30 days annually, particularly in February. Tasks include afforestation, terrace construction, rainwater harvesting, and reforestation of private and communal lands. Reforested areas are strictly protected from human activity to ensure the success and sustainability of these initiatives.



Fig.6 Local peoples participating on natural resource conservation (terracing)

Introducing New Agricultural Technologies

The adoption of new agricultural technologies is a crucial strategy for enhancing farm productivity while minimizing environmental degradation, thereby supporting sustainable development. Such technologies include improved soil and water management practices, enhanced seed varieties, optimized fertilizer application, and the promotion of energy-efficient tools. For example, improved cooking stoves have been introduced at the household level to reduce fuel consumption from wood and manure, helping to mitigate deforestation and soil degradation.

Training on improved livestock husbandry and the distribution of poultry have also been implemented to enhance farm productivity. Government extension agents provide on-the-ground guidance to encourage farmers to adopt these practices. Additionally, modern irrigation systems, hand pumps, water harvesting materials (e.g., *Geomemiberen*), and modern beehives have been introduced to strengthen food security and increase agricultural output. Hybrid animals and fruit seeds are distributed alongside training on fruit, vegetable, and cash crop production, with market linkages facilitated to ensure farmers can sell their products.

These technological interventions aim to diversify income sources, improve food security, and contribute to poverty reduction. The efforts of the government, particularly through the woreda agricultural office, have been instrumental in promoting climate-adaptive and sustainable agricultural practices. However, many of these initiatives are seasonal, which limits their long-term impact unless they are consistently supported and scaled up throughout the year.

Access to Credit Services

The study assessed farmers' access to institutional credit during climate-related hazards. Survey results indicate that a significant majority (72.5%) of respondents were unable to access credit due to strict eligibility criteria and high interest rates, which limited their ability to qualify. Only 27.5% of respondents reported successfully obtaining credit from the Agricultural and Social Credit Institution (ASCI); however, even these farmers faced stringent requirements and high interest rates. These findings suggest that, despite

government efforts to provide financial support, institutional barriers significantly constrain the capacity of farmers in Merhabete Woreda to adapt to climate change impacts.

Disaster Preparedness, Prevention, and Information

Regarding disaster preparedness, 50.7% of respondents reported insufficient early warning information prior to climate-related hazards. Furthermore, many respondents expressed dissatisfaction with government responses following climate shocks. Focus group discussions (FGDs) and key informant interviews highlighted concerns about inadequate preparedness and response, particularly in addressing climate variability, human and livestock diseases, pest invasions, flooding, hailstorms, and landslides, all of which adversely affect local livelihoods.

Although the Agricultural Development Office has implemented disaster prevention and preparedness programs aimed at reducing community vulnerability, many of these initiatives were found to be ineffective. Key challenges include the lack of modern weather forecasting tools and the absence of skilled personnel capable of accurately predicting future climate conditions, which limits timely and effective responses to climate-related risks.

3.5. Barriers to Climate Change Adaptation

Barriers to climate change adaptation have been widely documented in Ethiopia. For instance, Bewket (2010) identified constraints in Choke Mountain, East Gojjam, including limited access to land, water, markets, and relevant information or knowledge about appropriate adaptation strategies. Consistent with these findings, the current study revealed similar challenges in Merhabete Woreda. Access to essential resources such as land and water, as well as market opportunities and relevant information, were major obstacles hindering effective adaptation. In addition, insufficient knowledge regarding suitable and effective adaptation strategies further limits the capacity of local communities to respond to climate variability.

These barriers are compounded by additional constraints, including limited financial resources, inadequate infrastructure, and insufficient government support. Addressing these challenges is critical to strengthening the adaptive capacity of farmers and communities, ensuring long-term resilience to the impacts of climate change.

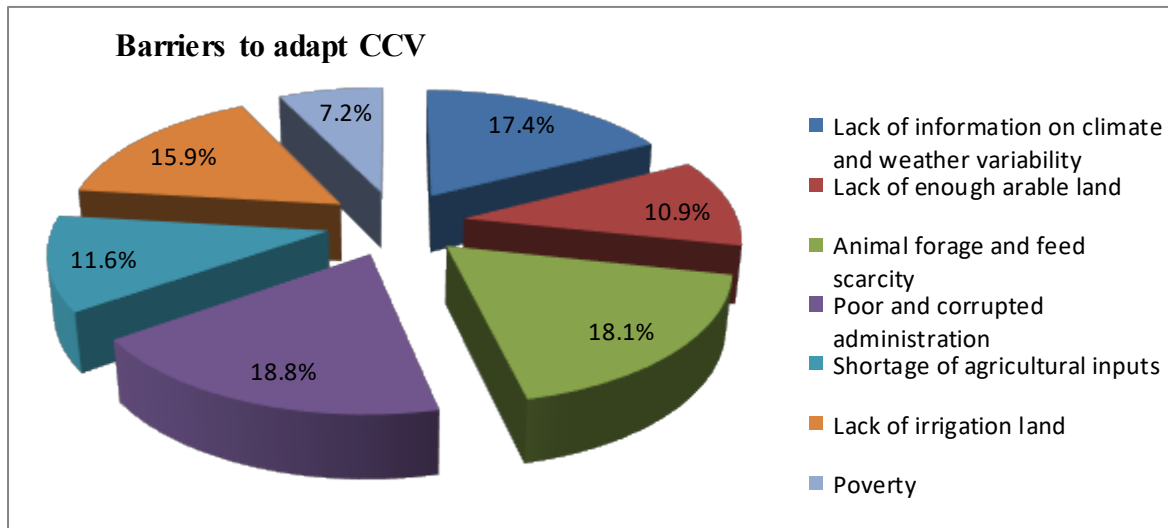


Figure 7: Household survey on barriers to adapt climate change

Barriers to Climate Change Adaptation

This survey evaluated the barriers local communities face in adopting climate change adaptation strategies. Findings from household surveys, focus group discussions (FGDs), and key informant interviews revealed several significant constraints.

A major barrier identified is the lack of timely and accurate weather information. Approximately 17.4% of respondents and FGD participants indicated that limited access to meteorological reports impedes effective adaptation. The absence of clear forecasts, particularly regarding the onset and cessation of rainfall, prevents farmers from adjusting planting schedules appropriately. Moreover, the weather information provided is often general and lacks site-specific relevance, reducing its usefulness for informed agricultural decision-making.

Land scarcity was highlighted by 10.9% of respondents as another significant constraint. Small, fragmented landholdings hinder practices such as crop diversification and rotation. Over time, decreasing land sizes and increasing fragmentation have disadvantaged households economically, limiting their ability to implement adaptation measures. Additionally, insufficient agricultural inputs exacerbate the problem. Soil degradation has increased the need for fertilizers, yet the supply is often delayed or inadequate. Fertilizers, pesticides, and herbicides are either scarce or expensive, compounding the effects of climate variability on agricultural productivity.

Although livestock possess some adaptive capacity, such as moving to wetter areas during periods of forage and water scarcity (e.g., near the Jema and Wonichit rivers), grazing restrictions imposed by government policies in certain areas limit this flexibility. Furthermore, 18.8% of respondents reported that poor governance and corruption hinder adaptation efforts. Examples include the diversion of subsidized fertilizers to merchants who resell them at inflated prices, misappropriation of food aid, unnecessary local fees, rising rent for unproductive farmland, and unemployment among educated youth, all of which exacerbate community vulnerability.

In the dega agro-ecology of Merhabete Woreda, limited access to rivers and springs restricts irrigation practices, reducing agricultural resilience to crop failure. Similarly, respondents in kola and woyina dega regions cited lack of irrigable land as a major barrier. Poverty also constrains adaptation, as the costs of implementing strategies—such as engaging in alternative livelihoods or investing in improved agricultural inputs—are often prohibitive for poor households. These financial limitations reduce the capacity of vulnerable populations to respond effectively to climate variability.

4. Conclusion and Recommendations

For many years, households in the study area have faced the impacts of various natural hazards. In response, they have employed diverse coping and adaptation strategies. However, the increasing frequency and intensity of climate change impacts have diminished their adaptive capacity. Vulnerability is particularly high among poor, landless households, those without additional income sources, and households with large family sizes.

Current coping and adaptation strategies are largely unplanned, poorly coordinated, and insufficient. Practices such as charcoal production and firewood sales, while providing short-term relief, contribute to forest degradation and may lead to desertification. Consequently, these strategies are unsustainable and do not adequately support the local population in addressing long-term climate risks. Seasonal interventions by the local government face additional challenges, including limited institutional coordination, low commitment, and issues related to equity and efficiency, reducing their overall effectiveness.

To enhance adaptation outcomes, well-planned, coordinated, and sustainable interventions are essential. Recommendations include:

1. Strengthening institutional coordination to ensure efficient, equitable, and committed implementation of adaptation measures.
2. Promoting environmentally sustainable livelihoods, such as sustainable agriculture, reforestation, and alternative income-generating activities that do not contribute to land degradation.
3. Capacity-building for vulnerable groups, including landless households and large families, to improve resilience and adaptive capacity.
4. Enhancing access to timely and localized climate information to enable informed decision-making at the farm level.
5. Expanding financial and technical support, including credit, subsidies, and access to improved agricultural inputs and technologies.

Adopting a comprehensive, collaborative, and community-informed approach can help ensure that coping and adaptation strategies effectively address the long-term challenges posed by climate change, while supporting sustainable livelihoods and food security in Merhabete Woreda.

Reference

- Agrawal, A. (2008). *The role of local institutions in adaptation to climate change*. Paper prepared for the Social Dimensions of Climate Change, Social Development Department, The World Bank, Washington, DC, March 5–6, 2008.
- Alemayehu, A., & Bewket, W. (2017a). Determinants of smallholder farmers' choice of coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Environmental Development*, 24, 77–85. <https://doi.org/10.1016/j.envdev.2017.06.006>
- Alemayehu, A., & Bewket, W. (2017b). Smallholder farmers' coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Local Environment*, 22(7), 825–839. <https://doi.org/10.1080/13549839.2017.1290058>
- Belay, A., Recha, J., Woldeamanuel, T., & Morton, J. (2017). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. *Agriculture & Food Security*, 6, 24. <https://doi.org/10.1186/s40066-017-0100-1>
- Bewket, A. (2010). *Analysis of farmers' perception and adaptation to climate change and variability: The case of Choke Mountain, East Gojjam* (M.A. thesis). Addis Ababa University.
- Darabant, A., Habermann, B., Sisay, K., Thurnher, C., Worku, Y., Damtew, S., Lindtner, M., Burrell, L., & Abiyu, A. (2020). Farmers' perceptions and matching climate records jointly explain adaptation responses in four communities around Lake Tana, Ethiopia. *Climatic Change*. <https://doi.org/10.1007/s10584-020-02889-x>
- Dawit, D., & Habtamu, T. (2011). *Climate change adaptations and induced farming livelihoods* (DCG Report No. 64).
- Etana, D., Snelder, D., Van Wesenbeeck, C., & De Cock Buning, T. (2023). Understanding the contexts of effectiveness of adaptation to climate change and variability: A

- qualitative study of smallholder farmers in central Ethiopia. *International Journal of Agricultural Sustainability*, 21(3), 1–20.
<https://doi.org/10.1080/14735903.2023.2253648>
- Gashure, S., & Wana, D. (2023). Smallholder farmers' perceptions, coping, and adaptation strategies to climate variability in the UNESCO-designated cultural landscapes of Konso, Ethiopia. *Local Environment*, 28(12), 1243–1262.
<https://doi.org/10.1080/13549839.2023.2202379>
- Getahun, A., Ayal, D., Ture, K., & Zeleke, T. (2021). Determinants of climate variability adaptation strategies: A case of Itang Special District, Gambella Region, Ethiopia. *Climate Services*, 23, 100245. <https://doi.org/10.1016/j.cliser.2021.100245>
- Gezie, M. (2019). Farmer's response to climate change and variability in Ethiopia: A review. *Cogent Food & Agriculture*, 5(1), 1613770.
<https://doi.org/10.1080/23311932.2019.1613770>
- IPCC. (2014a). *Climate change 2014: Impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- IPCC. (2014b). Pachauri, R. K., & Meyer, L. A. (Eds.). *Climate change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva, Switzerland.
- Megersa, G., Jaleta, M., Tesfaye, K., Getnet, M., Tana, T., & Lakew, B. (2022). Perceived climate change and determinants of adaptation responses by smallholder farmers central Ethiopia. *Sustainability*, 14(11), 6590. <https://doi.org/10.3390/su14116590>
- National Meteorology Agency (NMA). (2007). *Climate change: National adaptation program of action (NAPA) of Ethiopia*. Ministry of Water Resources.
- Temesgen, G., Wondie, M., Daniel, H., & Abeba, N. (2014). Climate change adaptation and mitigation measures in Ethiopia. *Journal of Environmental Science and Policy*, 4(15), 45–58.
- UNEP. (2006). *Climate change and variability in the Sahel region: Impacts and adaptation strategies in the agricultural sector*. United Nations Environment Programme.
- World Bank Group. (2010). *Economics of adaptation to climate change: Ethiopia*. DFID, United Kingdom.

Acknowledgment

The author would like to express their sincere gratitude to all individuals and institutions who contributed to the completion of this research.

Conflict of Interest

The authors declare no conflict of interest.

Funding

The authors declare that this study received no external funding.



Harla Journal of Social and Behavioral Studies gives access to this work open access and licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.
([Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/))