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Research Article

Climate Change Adaptation and Mitigation Strategies in Madda Walabu District, Bale Zone, Southeast Ethiopia

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Climate change is one of the most serious environmental challenges affecting people all over the world causing widespread agitation and having an impact on economic systems such as agricultural production. Local communities in Madda Walabu District of Bale Zone, Southeast Ethiopia, are heavily dependent on agriculture. In contrast, the agricultural activity of the local community was depressed by threats such as increased temperature, prolonged drought, and changes in rainfall distribution. To mitigate the adverse consequences of climate change, it is important to understand the local knowledge of adaptation and mitigation actions. This research was a look into the climate change adaptation and mitigation in Ethiopia's Madda Walabu District households to survive. The objective of the study was to investigate climate change adaptation and mitigation strategies for the synergy of the communities in the Madda Walabu District. A multistage stratified random sampling procedure and three villages were randomly selected. A total of 150 sample households from the three villages were interviewed. Descriptive statistics were employed to analyse data, and the Statistical Package for Social Science (SPSS) was used for analysis. The results showed that most of the respondents have perceived an increase in temperature, fluctuation in the rainy season, and a decrease in the amount of rainfall. The respondents perceived that they are vulnerable to local climate variability. This study also revealed that 78% of the respondents followed different adaptation strategies to climate change, such as irrigation intensification, agroforestry, agronomic, and cultural practices. Adaptation and mitigation measures can be developed by enhancing the adaptive and mitigating capacity of forest-dependent communities. Therefore, awareness creation on climate change, variability, adaptation, and mitigation measures should be considered toward enhancing the adaptive capacity of the local communities in line with providing seasonal weather information. More research in the domain of climate change and mitigation techniques is needed as several statistical results were not as predicted, and the amount of adaptation and mitigation synergies was low. Furthermore, the study's households were predominantly pastoralists, and their climate change adaptation and mitigation strategy for the livestock sector was an issue that needed to be addressed urgently.

1. Introduction

Climate change is one of the most significant environmental concerns that the world faces today [1]. Any changes in climate over time owing to natural changes or as a result of human activity were thought to be climate change [2]. Different scientific researchers have given many definitions of climate change, adaptation, and mitigation. Climate change is defined as a change in climate that is related directly or indirectly to human activities that modify the composition of the global atmosphere and natural climate variability observed over time [3–5]. More precisely, it is a statistical description of the mean variability of key weather patterns over time scales ranging from months to thousands of years, with the classical period being 30 years [6]. Changes in solar radiation (the angle of the sun) and volcanic eruptions are natural events that contribute to the climate system's natural variability and anthropogenic forces, such as the shift in the composition of the atmosphere that began with the industrial revolution [7, 8].

Climate change has an impact on all parts of the globe and generates broad agitation that can be transferred onto natural ecosystems, which then has an impact on economic systems [9, 10]. Developing countries, particularly those in South Asia and East Africa, are most vulnerable to climate change-related concerns, such as temperature rises and precipitation fluctuations [11–13]. Climate change has the greatest impact on impoverished and agricultural people in developing countries, due to their limited adaptation capacity and lack of access to alternative sources of income, adaptive skills, and resources, [2, 14–17]. These natural disasters are becoming more often, and they are also causing more harm [18]. Any negative consequences of climate change could jeopardize the lives of many people [19, 20]. Temperature swings, rainfall variations, and the occurrence of dangerous events are all examples of climatic events [10, 12].

Climate change will have a considerable impact on agricultural productivity resulting in significant changes in farming outcomes, and risks are expected to pose severe obstacles to agricultural development in developing countries [12, 21, 22]. Precipitation and temperature are significant factors of farm productivity; hence, climatic conditions are critical in agricultural production [23]. There is a large body of evidence [15, 22, 24–28] demonstrating the sensitivity of agriculture crops to changing climatic conditions, particularly in arid low-lying regions. Scholars have predicted that climatic inequalities will lead to an increase in the frequency of a few uncertain climatic actions [13, 29, 30]. Agriculture is a composite practice because of the risks and uncertainties associated with the agricultural sector.

It is vital to implement risk reduction measures at the global, regional, national, and local levels [29], as well as to protect their livelihoods by implementing risk reduction methods at the farm level [10, 31, 32]. Because of poor adaptive capacity, small subsistence farmers and rural inhabitants in underdeveloped countries are the most disadvantaged group that is most affected by climate catastrophes [2, 17]. Climate variability adaptation, according to Mendelsohn *et al.* [27], will necessitate changes and alterations at all levels, from the local to the national and international. It is critical to build resilience in public groups, which involves using appropriate technology to increase their awareness of traditional knowledge and diversify their livelihoods to cope with current and future climate stress [33].

Various studies have found that risk perceptions, climate change susceptibility, and adaptation at the household level are critical for reducing the negative consequences of climate change on agriculture [34]. Farmers constantly utilize many approaches to adjust agriculture to climate change susceptibility, according to previous studies [11]. Farmers utilize a variety of approaches on their farms, including modifying the timing of operations, diversity of crop practices [35], and changing farm management, such as the amount and kind of farm inputs used [10, 31, 34, 35].

Climate adaptation is the process by which people reduce the negative consequences of climate change on their health and well-being while also making use of the opportunities presented by their local climate [3, 36]. It is any modification promoted as a means of mitigating the projected negative effects of climate change, whether passive, reactive, or anticipatory [37]. In addition, it includes improving the viability of social and economic activities while minimizing their vulnerability to climate change, which includes current variability and extreme occurrences and longer-term climate change [38]. Furthermore, adaptation in human systems refers to the process of responding to current or predicted climate conditions and their implications to limit human behaviour or take advantage of beneficial opportunities [39].

Mitigation, like adaptation, is characterized in a variety of ways by different organizations and experts. Climate change mitigation is sometimes characterized as a human (anthropogenic) action aimed at reducing greenhouse gas sources or increasing sinks [40]. Mitigation is any measure made to permanently eliminate or lessen the long-term danger and hazards of climate change to human life, and property is referred to as climate mitigation [3].

Ethiopia is an agrarian country, with the agricultural sector largest share of GDP and employing the largest community of the country's total labour force, and any negative effects of climate change could have an impact on their livelihoods [41]. Ethiopia's dry lands cover roughly 63% of the country's land area. These regions have an estimated human population of between 12 and 15 million people.

Climate change as a phenomenon is a key source of concern for Ethiopia that is susceptible to climate change. Ethiopia is one of Africa's most vulnerable countries, suffering from drought and flooding as a result of climate change and fluctuation [42]. Dependence on rain-fed agriculture, land degradation, and poor institutions all contribute to the country's vulnerability to natural disasters. Ethiopia is ranked 36th most vulnerable and 40th least ready to adapt to climate change among the nations covered by the Global Climate Change Adaptation Index (GAIN) study for 2015 [43].

Food shortages caused by bad weather are nothing new in Ethiopia, and climate change vulnerability is strongly linked to poverty. Droughts have been reoccurring since the 1970s, and their extent, frequency, and intensity have all grown. According to the Deressa et al., [35], and NMA [44] research, the annual average minimum temperature in Ethiopia has grown by around 0.280 C every decade during the last 50 years. Furthermore, drought and desertification are spreading throughout the country as a result of climate change and other human-caused problems [45]. In the regional models for East Africa, rainfall has varied significantly during the last half-century and by the 2060s; the average annual temperature is expected to rise 1.1 to 3.1 degrees Celsius and 1.5 to 5.1 degrees Celsius by the 2090s.

The Ethiopian government is taking a proactive approach to disaster risk management to tackle repeated droughts and food insecurity (DRM). The government has established the Disaster Management and Food Security Agency, drafted a National Policy and Strategy on Disaster Management, and developed a DRM Strategic Program and Investment Framework for government and donor interventions in recent years. Ethiopia's government completed the first-of-its-kind "Climate-Resilient Green Economy" (CRGE) strategy in 2011. The CRGE strategy is based on the governments' ambitious growth and transformation plan (GTP), which aims to bring Ethiopia into the middle-income category by 2025 [46].

Local communities in Madda Walabu District of the Bale Zone are heavily dependent on agriculture and forest as a source of food, income generation, and medicinal herbs. In contrast, the agricultural activity of the local community was depressed by threats such as increased temperature, prolonged drought, prevalent diseases and pests, and changes in rainfall. The change in temperature and precipitation is highly affecting the adaptive and sustainability capacity of local community livelihood in the district (Bale Eco-Region Sustainable Management Program) [47, 48].

This research was a look into the impact of climate change adaptation and mitigation in Ethiopia's Madda Walabu District, Bale Zone, to realize Ethiopia's objective of eradicating poverty and improving people's livelihoods. Furthermore, studies concerning climate change adaptation and mitigation are very limited, in selected zone and districts, which is one of the most vulnerable provinces of the country. As a result, this study provides valuable evidence regarding the climate change adaptation and mitigation response of farmers to various types of agriculture risks from climate change. The general objective of the study was to investigate climate change adaptation and mitigation strategies for synergy of the communities in the Madda Walabu District of the Oromia Region in Ethiopia. The specific objectives of this study were to analyse the climate change adaptation and mitigation strategies for synergy and assessing the mitigation activities carried out by local communities in the study area.

2. Materials and Methods

2.1. Study Area. Madda Walabu District is one of Ethiopia's agriculturally promising zones, located in the Oromia regional state. The Madda Walabu District is located in the Bale Zone's southwestern corner.

Guji Zone in the west and south, Somali regional state and Delo Mena District in the east, Naseebo/West Arsi Zone in the north-west, and Harena Buluk and Delo Mena districts in the north are its boundaries. There are two types of rainfall regimes in the Madda Walabu District. The first regime is defined by a single protracted rainy season that lasts from March to August each year. June, July, and August, on the other hand, have the largest rainfall concentrations. This type of rainfall covers all parts of the district except small parts of the margin of the southeast part of the district. The second type of rainfall in the district is the one with spring and autumn maximum. In the district, the amount of temperature that receives is greatly modified by latitude and longitude extent. Based on the altitude, the districts are classified into three agroclimatic districts namely subtropical, tropical, and arid. This district contains a portion of the Bale highland forests, which are under serious human threats from resource and land-use changes such as agricultural development, forest fires, and clearing and settlement (within and outside the forest areas) [47]. Uncontrolled land-use change and unrestrained settlement growth, particularly in the study region, have been the main causes of environmental degradation since the 1990s [49]. Expanding deforestation is mostly caused by the rising population as a result of agricultural farm expansion in the forest, which is one of the main causes of deforestation and degradation of the actual forest [50, 51]. Figure 1 shows the study area location within the country, region, and zone.

2.1.1. Sampling Procedure. A multistage sampling technique was used to choose the target sample households. In the initial step, 5 kebeles were chosen from a total of 20 kebeles that had recently experienced drought. Three of the five kebeles were chosen at random in the second stage. Individual households were chosen at random from the kebeles and utilized as the unit of study. Based on HH head proportion, sample sizes for each kebeles were derived from the randomly selected kebeles. With the support of key informants, the sampling reference frame of each kebeles was subcategorized according to the HH Wealth category. To determine the required sample size at 95% confidence level, degree of variability = 0.05 and level of precision = 0.09%.

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

where "n" is the sample size, "N" is the population size (total household heads size), and "e" is the level of precision. Based on the above formula, 150 respondents (132 men and 18 women) used it.

2.1.2. Data Collection. Household surveys and focus group discussions were employed to gather the necessary information. Questionnaires would cover topics such as socioeconomic characteristics, mitigation awareness, knowledge and perceptions of climate change, and adaptation methods. The structured and nonstructured formats of the questionnaire were utilized to elicit qualitative data from the household heads. Household and farm characteristics, adaptation measure types used, mitigation action done by farmers, socioeconomic features, and institution have all been included in the survey data.

After several early questionnaire surveys, to gather in-depth information the focus group discussions took place in the fourth week of December 2010. The participants were chosen from the kebele committee, elders, and officials who were believed to actively express their opinions. Secondary data were gathered from the national meteorological service to compare it to farmers' perceptions of climate change. Data were also gathered from the Woreda food security office, the Woreda pastoralist development office, BERSMP, OFWE-BB, and other offices. During the stay in the research area, direct field observation was carried out to learn from the field study's experience and to gain firsthand knowledge regarding climate change adaptation and mitigation methods. During the visits, eleven (11) different types of adaptation measures were observed.

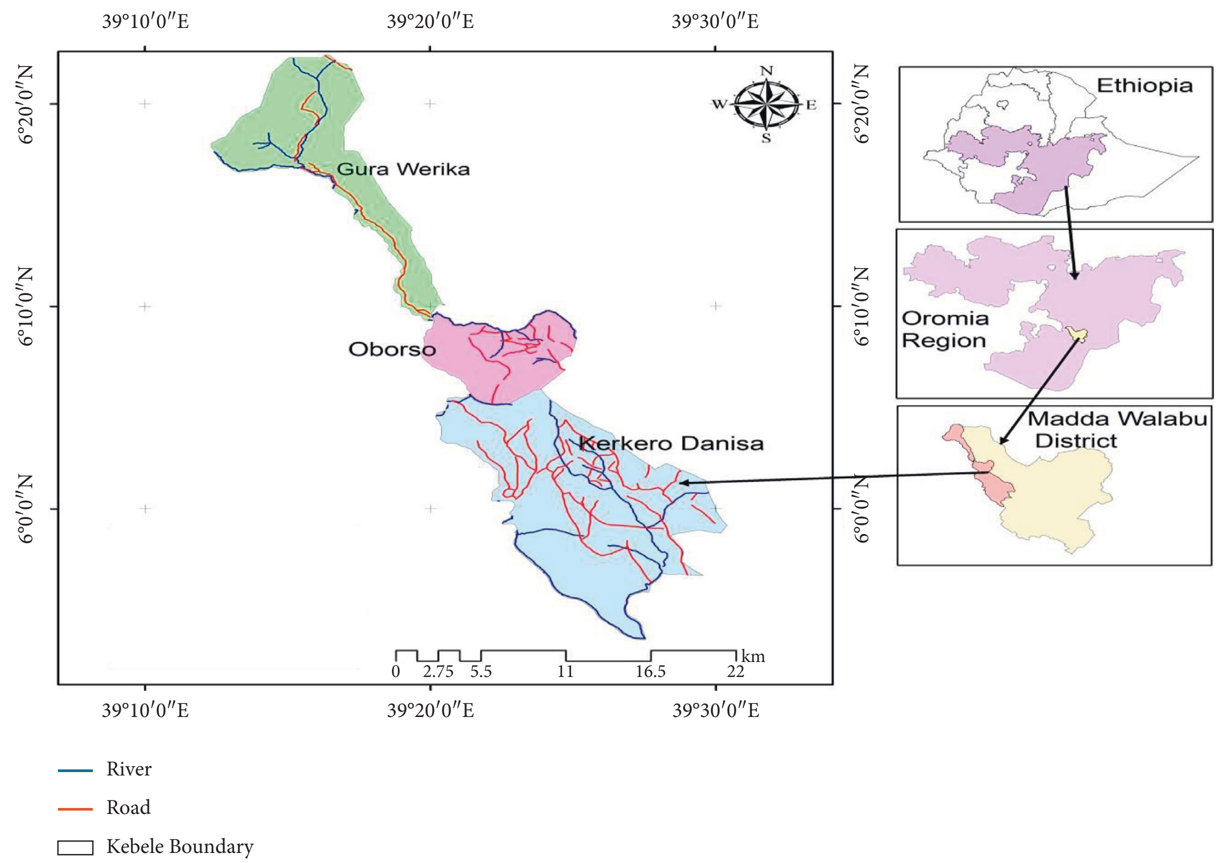

Figure 1: Map of the study area.

2.2. Data Analysis Methods

2.2.1. Analysis of Climate Change and Variability. Climate change and variability adaptation and coping measures are influenced by family perceptions of extreme occurrences and the problems they cause [52]. Individual farmer adaptation is based on their own choices, such as what to plant, how much area to cultivate, and what resources to use [53]. While the research on climate change adaptation was necessary to understand farmers' perceptions of climate change and other nonclimatic elements, farmers' perceptions of climate change and variability on an individual basis were outside the scope of this study [54].

The Delo Mena Metrological Station, which has been maintained by the Ethiopian Meteorological Agency, provided daily rainfall and temperature (max and min) data for the years 1994–2021. The information gathered allowed researchers to compare what farmers noticed about climate change and variability to how the study area's climate data evolved. By aggregating months, the climatic data collected at Delo Mena Station (1994–2021) were evaluated using descriptive statistics (annual mean and seasonal mean for temperature and total annual and total seasonal for rainfall). Indeed, farmers' perceptions of climate change were based on comparing the results of farm surveys or farm group discussions with data from meteorological stations [55]. Farmers' perceptions of climate change and variability were tested in this study by comparing changes in temperature and rainfall trends observed by farmers with changes in recorded meteorological data for those elements. Madda Walabu weather station's annual and seasonal mean temperatures, as well as total annual and seasonal rainfall records, were analysed for comparison.

2.2.2. Secondary Data Analysis on the Adaptation Side. The meteorological data in terms of yearly and seasonal records of temperature and rainfall were analysed using descriptive statistics such as frequency, mean, and standard deviation. Mean, standard deviation, frequency of occurrence, percentage, *t*-test, chi-square test, and a one-way ANOVA test were used to compare group averages to see the relationship between postulated explanatory variables and the dependent variable. The *t*-test is used to compare the mean differences between continuous adapted and non-adapted farmers. In addition, the chi-square test was used to determine the relationship between the independent variables (discrete) and the dependent variable.

2.2.3. Data Analysis on the Mitigation Side. Stata 11 was used to analyse the responses from households. Farmers who participated in FARM Africa's and SOS Sahel Ethiopia's and OFWE-natural BB's resource management training and who used upgraded stoves had their proportions analysed in percentages to discover dominating responses. To compare group means, a one-way ANOVA test was used.

3. Results and Discussion

3.1. Farmer's Perceptions on the Impact of Climate Change and Variability

3.1.1. Temperature, Rainfall, Threats, and Farmers' Observation

(1) Temperature Changes Perceived by Farmers. The majority of those polled thought the temperature had risen. The farmers' belief that temperature had increased dramatically in the study area was bolstered by the recorded metrological data at the station. This suggests that farmers have a positive attitude toward their surroundings (Table 1). The findings are consistent with prior findings elsewhere in Ethiopia, which found that temperature and humidity have increased dramatically over time [56, 57]. Furthermore, findings from key informant interviews in Zimbabwe indicated a general awareness among the village elders and other community leaders that climate change and variability have been a reality in the area [58].

(2) Rainfall Changes Perceived by Farmers. Over the years, the majority of respondents have seen changes in rainfall patterns in terms of amount, onset time, and cessation. According to their perceptions, farmers in the research region have reported late commencement and early termination of the rainy season (Table 2). Also, as shown in Table 2, average rainfall variability has grown over the last 20 years, yet there was rainfall variability between the sowing and blooming periods of different crops, which resulted in a yield deficiency in the research area. This finding is consistent with research conducted in Ethiopia's Nile Basin, which found that when predicting the impact of climate change on agriculture in low-income countries, 78.67% of respondents saw a decrease in precipitation and an increase in mean temperature during the last 20 years [59]. Furthermore, research undertaken by Abid *et al.* [34] in Pakistan's Punjab Province revealed comparable findings, with farmers reporting longer summers, decreased precipitation, and changes in the agricultural growing season. In addition in northern Ethiopia the finding of research conducted by Kahsay et al. [60] showed as wide households had not noticed climate change and undeniable majority of households perceived a notable change in climate components.

(3) Analysis of Metrological Data at Madda Walabu Station. The standard deviations for the "Belg (spring)" season, "Meher (summer)" season, and yearly temperature, respectively, were 0.851, 0.421, and 0.453 for temperature data collected at Madda Walabu Station from 1986 to 2010. This result suggested that there was little seasonal and year-to-year temperature change between the above periods. Total rainfall "Belg (spring)," "Meher (Summer)," and total annual rainfall standard deviations of 146.19, 139.99, and 292.61, respectively, had a significant variability. 146.19 SD indicates that the rainfall deviation from the mean for the "Belg (spring)" season was larger than the rainfall departure from the mean for the "Meher (summer)" season, which was 139.99 SD. Over the last 27 years, the coefficient of variation of the "Meher (summer)" season has been 37.07%. These results suggested that rainfall variability was higher in the "Meher (summer)" season than in the "Belg (spring)" season (Table 3). The findings are consistent with those of a study conducted by NMS in several parts of Ethiopia, which revealed that average annual rainfall had a high amount of variability [61]. Furthermore, Ross and his caliginous claim that rainfall has been decreasing in southern and eastern Ethiopia, including Borana [62].

As shown in Figure 2, the statistical result of temperature records between 1986 and 2010 revealed a rising trend in both the "Belg (spring)" and "Meher (summer)" production seasons. Temperature rises were found to be far bigger during the "Belg (spring)" season (March to part of June), when the primary rainfall occurred, than during the "Meher (summer)" season (August to November), with increments of 0.050 C and 0.010 C per year, respectively. The mean annual temperature in the research region has grown by +0.29 degrees Celsius during the last nine years, with an average of +0.030 degrees Celsius, according to statistical data analysis. This is in accordance with recent research in Ethiopia, which revealed temperature and rainfall variations.

Table 1: Perceptions of the respondents on change in temperature over the years.

Variable	Frequency	Percentage
Increased	138	98.6
Decreased	—	—
No change	—	—
Don't know	2	1.4
Total	150	100

Source: results of the study (2021).

Table 2: Perceptions of the respondents on change in rainfall over the years.

Variable	Frequency	Percentage
Change in rainfall		
Increased	5	3.33
Decreased	118	78.67
No change	24	16
Don't know	3	2
Onset of rainfall		
10 days before the usual time	5	3.33
10 days delay from the usual time	84	56
Varying onset season	56	37.34
No change	5	3.33
Cessation of rainfall		
Ended before the normal time	91	60.67
Stayed longer than the normal time	20	13.33
Variable cessation	35	23.33
No variability	4	2.67
Rainfall variability		
Increased	144	96
Decreased	1	0.67
No change	2	1.33
Don't know	3	2
Total	150	100

Source: results of the study (2021).

Table 3: Summary of descriptive analysis for meteorological data (1994–2021).

Description	Mean	SD	Min	Max	CV
Mean seasonal T °C Belg (spring)	23.159	0.851	21.41	25.51	3.67
Mean seasonal T °C Meher (summer)	22.27	0.421	21.47	23.22	1.89
Annual mean T °C	22.419	0.453	21.56	23.57	2.02
Total rainfall Belg (spring) (mm)	476.972	146.19	227.8	846.7	30.65
Total rainfall Meher (summer) (mm)	377.607	139.99	75.3	703.3	37.07
Total annual rainfall (mm)	1026.369	292.61	567	1355.01	21.15

Source: results of the study (2021). Note: SD: standard deviation, and CV: coefficient of variation %.

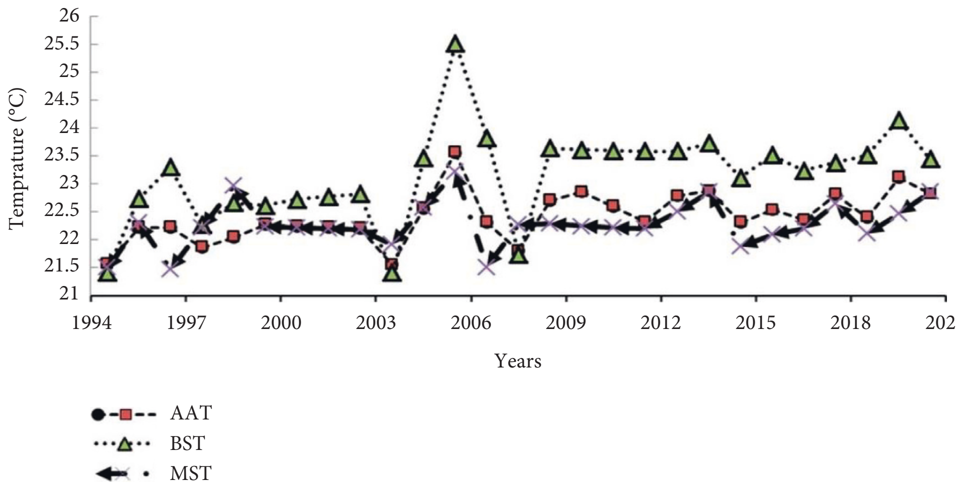

Figure 2: Average annual Belg (spring) and Meher (summer) seasonal temperature. Source: data from meteorological station data result (2021). Note: AAT: average annual temperature, BST: "Belg (spring)" seasonal temperature, and MST "Meher (summer)" seasonal temperature.

According to NMS [61], the average annual minimum temperature has risen by 0.37 degrees Celsius every ten years, whereas the average annual maximum temperature has risen by 0.10 degrees Celsius [61].

Annual rainfall data from Madda Walabu Station throughout *the* "*Meher (summer)*" *season between 1993 and 2020* indicated increasing and declining tendencies *throughout the year* (Figure 3). Rainfall during the "Belg (spring)" and "Meher (summer)" seasons is highly variable *in terms of amount and timing.* Locals that rely entirely on rain-fed agriculture have been hit the worst.

(4) Climate Change and Variability-Related Threats Observed in the Study Area. According to the findings of secondary data analysis, focus group discussions, and key informant interviews, the Woreda has experienced frequent droughts, followed by deforestation, land-use changes, livestock, and crop disease problems over the last 27 years, exposing the people to severe food shortages due to crop loss and productivity decline. The study area was one of the drought-affected areas in the region from 2008 to 2010 due to inconsistent and unpredictable rainfall and temperature rise. Since then, the population has been experiencing severe food shortages as a result of crop failure. The research conducted by Fahad and Wang [10] explained that drinking water, soil difficulties, irrigation, transportation, and animal diseases were less of a danger in these districts of Khyber Pakhtunkhwa Province as indicators of climate change.

3.2. Climate Change Impact Adaptation Strategies in the Study Area. The area relies on rain-fed agricultural systems; populations were subject to climate change and fluctuation and have implemented numerous adaptation and mitigation methods in agriculture and the forest environment to reduce the negative effects of climate change and variability.

3.2.1. Adaptation Strategies. In response to the risks to agricultural productivity from the increasing temperature and unpredicted rainfall, farmers in the study area have adopted various adaptation strategies. Farmers have taken major actions in response to the negative impact of climate change, as revealed by discussions with the focus group, interviews with farmers, agricultural extension officers, and field observation, such as increasing irrigation, increasing the use of agricultural inputs primarily chemical fertilizers and improved seeds, using crop diversification (cereals, oil crops, vegetables, and root crops), and making a shift to organic farming (Table 4). Almost in the same way, Fahad and Wang [10] reported the farmers of Punjab Pakistan practice climate change adaptations such as changes in crop

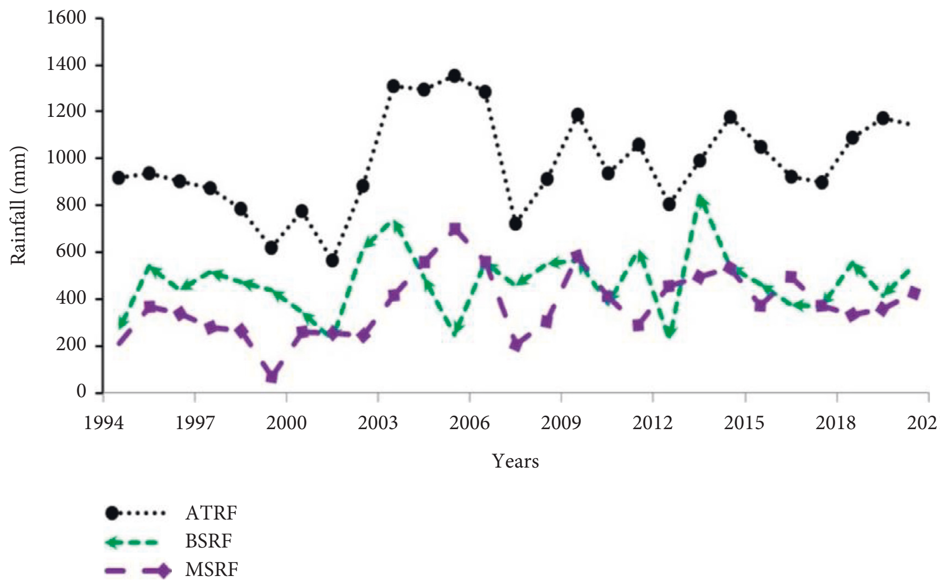

Figure 3: Analysis of annual total, "Belg (spring)" and "Meher (summer)" seasonal rainfall. Source: data from meteorological station data result (2021).

Table 4: Types of adaptation strategies practiced by the households in the study area.

Adaptation strategies	No. of respondents	Percentage
Agroforestry practices coffee in NF	92	61.33
Use of inorganic fertilizer	132	88
Use of compost to the filed	52	34.67
Use of drought-tolerant crop species	85	56.67
Use of improved crop variety	62	41.33
Adjusting on sowing time	113	75.33
Use of irrigation on accessible filed	20	13.33
Use of supplementary water sources on inaccessible filed	19	12.67
"Increase plowing land in response to CC"	35	23.33
Temporary migration to the forest (with livestock during prolonged drought)	52	34.67
No adaptation (business as usual)	33	22

Note: results of the study (2021).

type and variety, fertilizer, seed quality, pesticide, shade trees, water storage, and farm diversification.

As indicated in Table 5, agroforestry methods, agricultural inputs, and agronomic practices were used in combination by 20.7% of the sampled respondents. Farmers, on the other hand, use agricultural inputs to the tune of 2%. Farmers who were not adapted made up 22% of the total respondents, while the remaining 78% used various adaptation tactics.

3.2.2. Comparison of the Choice Climate Change Adaptation Strategies. The results of the econometric analysis for the variables utilized in the study showed that households' adaptation strategies differed. For IRAFAINAP for example, extension contact and availability of weather information were shown to be important, although the distance from the forest and livestock holding was not. The independent variables, on the other hand, have a positive or negative impact on farmers' decisions about which adaptation method to choose. This means that a variable that has a good impact on one strategy may not have the same impact on the other strategies. For example, access to training influenced IRAFAIN (Strategy 2), AFAIN (Strategy 4), and AFAIN (Strategy 5), but it influenced AFAINAP (Strategy 3) negatively (Table 6). Furthermore, variables that were relevant for one technique were not relevant for others. Nonfarm income, for example, is determined to be important for IRAFAIN (Strategy 2) but not for AP (Strategy 6) (Table 6). This clearly illustrates that the relevance of a particular factor influencing the choice of adaptation strategies is influenced not just by the socioeconomic features of the household but also by ecological elements in the area. This type of adaptation strategy concept is in line with research finding of Smit and Pilifosova [63] that show trends from adaptation to adaptive capacity and vulnerability reduction. The summary of the six important tactics in the study is listed in Table 6.

3.3. Forest-Dependent Community's Climate Change Mitigation Activities. According to the farmers' adaptation strategies, they engage in various mitigation activities such as

Table 5: Categorized adaptation strategy used by farmers.

Adaptation category	No. of respondents	Percentage
Irrigation, agroforestry practices, agricultural inputs, and agronomic practices (IRAFAIAP or Strategy 1)	9	6
Irrigation, agroforestry practices, and agricultural inputs (IRAFAI or Strategy 2)	14	9.3
Irrigation and agroforestry practices (IRAF or Strategy 3)	7	4.7
AF, A. inputs, and A. practices (AFAIAP or Strategy 4)	31	20.7
AF and agricultural inputs (AFAI or Strategy 5)	26	17.3
Agronomic practices (AP or Strategy 6)	27	18
Agricultural inputs (AI or Strategy 7)	3	2
No adaptation (NOAD)	33	22
Total number of observation	150	100

Source: results of the study (2021).

Table 6: Summaries of the explanatory variables with adaptation strategies.

Explanatory	Strategy 1		Strategy 2		Strategy 3		Strategy 4		Strategy 5		Strategy 6	
Variables	+ve	−ve	+ve	−ve	+ve	−ve	+ve	−ve	+ve	−ve	+ve	−ve
Sex of HHH											√	
Family size								√		√		
Farm experience			√				√					
Extension	√		√		√		√		√			
Access to credit								√				
Weather information	√		√				√			√		√
Distance from NF		√	√				√			√	√	
Training			√			√	√		√			
Size of farmland						√						
Livestock holding		√		√				√		√		√
Nonfarm income			√									√

Source: results of the study (2021).

preserving natural forests, adhering to land-use policies and regulations, particularly those incorporated into PFM by-laws established in the study area, planting trees, fodders, and grass species, participating in natural forest protection, and receiving training on natural resource management and the use of energy-saving stoves for their energy sources to reduce greenhouse gas emissions [64]. The research conducted in Tanzania concluded that the forest-based climate adaptation strategy implication for climate change mitigation potential is promising [65]. However, climate change mitigation strategy needs to be more innovative to optimize carbon storage and local livelihoods' potentials in forest-dependent communities [66].

3.3.1. Conservation of Natural Forest. Deforestation emissions can be kept out of the atmosphere by conserving existing forests. This technique has the potential to make a significant contribution to climate change mitigation. Forest protection, forest conservation, training, and involvement in NRM are all activities that conserve carbon stocks. It goes on to show the results of the mitigation actions, which help carry out adaptation and mitigation activities. Some mitigation options, such as income diversification, revenue from mitigation services, agriculture intensification, and agroforestry practices, have the potential to reduce vulnerable people's vulnerability [67]. In addition, it is believed that the ecosystem-based adaptation approach has proved to be an effective strategy to address the impact of climate change on the world [68, 69]. In the study area, the BERSMP, OFWE-BB, and CBOs jointly carried out a series of activities that can, directly and indirectly, protect forest cover and reduce pressure on forest resources for the last five years.

According to the household survey, farmers' participation in forest protection and enforcing forest regulations varies by the village. The discrepancy could be attributed to proximity to natural forests or the extent of community-based organization committee participation. As shown in Table 7, forest protection (46%) was less common in the study area than enforcing forest regulations (68%). Oborso Village has a higher level of forest protection engagement than Kerkero Danisa and Gura Werika villages, which may be due to a larger portion of Oborso Village's boundaries than other kebeles. These findings suggest that illegal settlement, farmland expansion, and other activities in Oborso were regulated not just by community-based organizations but also by state organizations working to safeguard natural forests [70]. In general, the community was claiming illegal settlements and farm expansions in the forest region, as the researcher observed from questioners and group conversations. This shares the study finding concept in other parts of Ethiopia that local farmers had conventional ordinances that they utilized to prevent people and/or livestock from illegally destroying tree seedlings planted on their landholdings and monetary punishment was the most common traditional bylaw utilized for this reason [71]. As a result, participation is crucial in natural resource management. Furthermore,

Table 7: Participation in protecting natural forest.

Study kebeles	Respondents' participation in the prevention and mitigation of threats to natural forest				Respondents' participation in abiding by forest regulation			
	Yes	%	No	%	Yes	%	No	%
Oborso	46	58.23	33	41.77	52	65.82	27	34.18
Kerkero Danisa	12	26.67	33	73.33	32	71.11	13	28.89
Gura werika	11	42.31	15	57.69	18	69.23	8	30.77
Total	69	46	81	54	102	68	48	32

Source: results of the study (2021).

Table 8: Seedlings planted in the natural forest for the last five years.

Activities	2009	2010	2011	2012	2013
Seedling planted	55,000	70805	112,100	140,729	170432
Land covered by seedlings	7.1	8.872	8.2	15	29.5

Source: OFWE-BB.

Table 9: Respondents planted seedlings on farmland.

Kebele	Planting trees, fodder, and fruit trees on farmland			
	Yes	%	No	%
Oborso	31	20.67	48	32
Kerkero Danisa	19	12.67	26	17.33
Gura Werika	14	9.33	12	8
Total	64	42.67	86	57.33

Source: results of the study (2021).

community participation is accountable for forest management and conservation efforts.

3.3.2. Restore Natural Forest. The amount of carbon that forests can collect from the atmosphere and store in their biomass can be increased by restoring forests by planting trees or promoting natural regeneration [72]. The study area is part of the OFWE-BB district and collaborated with community-based organizations to plant seedlings of native and exotic tree species in and around natural forest and planting in natural forest and on their farmland (Tables 8 and 9). This is in line with the truth determined earlier that forests and woodlands are sinks and reservoirs, which naturally absorb carbon dioxide (CO_2) Stern, 2006, [66].

Rather than growing trees on their farmland, communities in the study area rely heavily on natural forests. More than 57% of respondents said they had not planted trees on their property. Only 42.67% of the trees, fodder, and fruit trees were planted. This is because the population in the research region had access to the natural forest for firewood, construction materials, medicinal herbs, farm equipment, and other items. Planting tree seedlings in near-natural forests may aid in the improvement of the area's vegetation cover. Aside from OFWE-BB, communities require education about the value of trees in terms of climate change and additional income. As a result, considerable government support for the establishment of plantations on farmers' plots in the research region may be required.

4. Summary of the Finding

Over the previous 27 years, the district has endured numerous droughts, which have been followed by deforestation, land-use changes, livestock, and agricultural disease problems, exposing the people to severe food shortages as a result of crop loss and product degradation. According to the farmers' perspective, the temperature in the research region had risen substantially, and the recorded metrological data at the station support their claim. For temperature data collected at Madda Walabu Station for the years 1986 to 2010, standard deviations for the "Belg (spring)," "Meher (summer)" seasons, and yearly temperature were 0.851, 0.421, and 0.453, respectively. Total rainfall of "Belg (spring)," and "Meher (summer)," standard deviations were 146.19, 139.99, and 292.61, respectively, and had a significant variability. In response to the risks to agricultural productivity from the increasing temperature and unpredicted rainfall, farmers in the study area have adopted various adaptation strategies, such as increasing irrigation, increasing the use of agricultural inputs primarily chemical fertilizers and improved seeds, using crop diversification (cereals, oil crops, vegetables, and root crops), and making a shift to organic farming. In addition, this assessment showed that agroforestry methods, agricultural inputs, and agronomic practices were used in combination. Furthermore, the farmers engaged in various adaptation and mitigation activities such as preserving natural forests, adhering to land-use policies and regulations, planting trees, fodders, and grass species, and participating in natural forest protection and the use of energy-saving stoves to reduce greenhouse gas emissions.

5. Conclusion and Recommendation

5.1. Conclusion. This study reveals that the different local actors mentioned are necessary for the establishment of adaptation and mitigation of climate change strategy. However, in the context of synergy, if the activities are carried out by local actors independently they may not achieve better results. Thus, it is required to coordinate the efforts of different actors at different levels that should be in real collaboration, communication and information sharing, etc. The goal of this study was to define and analyse several climate change adaptation techniques, such as increasing irrigation, applying agroforestry practices, using various agricultural inputs, performing various agronomic activities, and combining strategies. According to this study's findings, climate change adaptation and mitigation activities are not separate. Mitigation without adaptation is unfeasible, whereas adaptation without mitigation is costly. As a result, integrating adaptation and mitigation could be a viable alternative for policymakers, academics, and others seeking to enhance social, economic, and environmental development. Furthermore, in this study result, there were deviations of some statistical results from the expected level of synergies of climate change adaptation and mitigation that should be addressed by other supplementary investigations. The study area is a pastoralist area with large livestock numbers and under a challenge from climate change stressors where local adaptation and mitigation should be critically investigated.

5.2. Recommendation. Based on the outcome of this assessment, the following recommendation is forwarded.

(1) Setting up of information channels and databases that enable the analyses of climate change and adaptation and mitigation strategies at local levels is required.

(2) Promotion and development of climate change adaptation strategies should consider important household characteristics and extension service provisions as they affect the adoption of the strategies significantly.

(3) Governmental and nongovernmental organizations should work closely to enhance the adaptive capacity of the local communities to climate variability and change.

(4) Further studies should be conducted in the area of climate change and mitigation strategies as there were deviations in some statistical results from the expected level of synergies of adaptation and mitigation. In addition, the households of the study were largely pastoralist and their climate change adaptation and mitigation strategy to the livestock sector were the area that should be addressed critically.

Data Availability

The Data for this research is available with resercher and will be shared up on request.

Disclosure

The research was performed as part of the employment of the authors at Madda Walabu University. In the university, the role of lecturers is 75% to teach and 25% to participate in research and community service activities and this research was conducted in this way. In addition, the employer was not involved in the manuscript writing editing approval or decisions to publish.

Conflicts of Interest

The authors declare that there are no conflicts of interest for funding and other contribution to the manuscript.

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