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Adaptation Response of Farmer to Climate Change and Variability in Gibe District of Hadiya Zone, SNNPR of Ethiopia

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Abstract: Climate change and variability across human borders and borders pose the greatest environmental, social, and economic concerns in many countries. Different mechanisms exist to react to the impacts of climate change and variability, including the adaptation. This study aim was to evaluate adaptation responses of farmers' to climate change and variability. Using an interview of household, key informant interviews, and focus group discussions, the study has collected qualitative and quantitative data using a stratified random sampling technique and a multiple stage sampling procedure. As a result, 299 household respondents were selected from three kebeles to provide primary data. National meteorological agency provided secondary data of rainfall and temperature. With the help of SPSS software version 20 and Microsoft Excel, the data were analyzed using descriptive statistical and multinomial logistic methods. The result reveals that seasonal and yearly rainfalls in the area are unpredictable with a declining tendency, while temperature is dramatically rising. Crop yield is also reducing and becoming highly unstable, according to the survey result, due to the effects of climate variability and change. Furthermore, the findings revealed that the majority of farmers are aware of climate change and its effects on crop production. Changes in crop type/or and variety, as well as proper soil and water conservation, are the most important climate change adaptation responses in the area. Similarly, findings revealed that raising agricultural community awareness and knowledge, providing to implement appropriate adaptation responses, are critical requirements for reducing the negative effects of climate change and variability. To improve crop production in the study area, it is critical to create way of adaptation responses and facilities to the climate variability and change adaptation responses to the smallholder farmers.

Keywords: Climate Variability, Climate Change, Crop Production and Adaptation Response

1. Introduction

Current climate variability is already posing a significant challenge to the global community by affecting food security, water and energy supply and sustainable development efforts [6]. Climate change is likely to have a negative impact on the lives of poor and rural African farmers, potentially undermining food security and socioeconomic development if appropriate measures are not implemented [14]. Adaptation response to the effects of climate change on agriculture has thus become a major concern for various stakeholders in Sub-Saharan Africa (SSA), with a focus on how to assist farmers in improving their adaptive capacity [5]. Climate change is generally detrimental to the agriculture sector if adaptation is not implemented. However, the debate over small-scale farmers' adaptation to climate change in Africa has occurred in the absence of knowledge about existing and potential adaptation practices. Because a current study about adaptation response is conducts focused research on potential adaptation practices and articulate appropriate advice for implementing new practices.

Several studies have identified specific variables that may influence the selection of specific adaptation methods in either a positive or negative way [1]. Furthermore, rather than a mechanical adjustment to a current state, adaptation is an iterative, dynamic, multi-scale, and multi-actor process, and the dynamic nature of adaptation makes it difficult to determine when, for example, a farmer's decision to grow one crop variety rather than another is a coping response to climate variability [15]. Adaptation to climate change is one of the approaches thought to be effective in mitigating the effects of long-term changes in climate variables. Adaptation is the process of improving, developing, and implementing strategies to mitigate and cope with the effects of climate change; including climate variability [8].

African leaders emphasized during the Copenhagen Climate Conference in December 2009 that adapting to the effects of climate change variability is Africa's top priority [13]. According to farmers are known to practice different adaptive strategies to minimize the effect of climate variability and to enhance and maintain the quality of their land [2]. However, without sufficient adaptation strategies, rising temperatures are projected to have a negative impact on the majority of the region. This causes increased evaporation and transpiration rates, changes in the timing and regularity of showers, and, in many places, a rise in the intensity of rainfall events as well as an increase in the frequency and duration of droughts [12]. Some of these changes are already being felt throughout the region, while others are expected in the near future.

According to predictions of future climates for the countries of Eastern Africa vary, with high altitude areas of Ethiopia potentially benefiting from warming temperatures [10]. Climate change is a major rising threat to the lives and livelihoods of Ethiopia's rural poor. Since dominate livelihood in agriculture the country has historically been affected by climate variability and related drought and social, economic and environmental costs of extreme climate incident have always been immense. Climate variability, human and livestock diseases, pests, flooding, unfavorable market trends, institutional deficiencies, etc. can present risks and inhibit livelihood endeavors [6]. This data clearly indicates Ethiopia's high vulnerability to climatic difficulties as well as its limited adaptive potential to respond to damage. A few degrees of warming and an increase in the frequency of extreme weather events will have a considerable influence on agricultural production, causing society to suffer as a result of the occurrences and reducing future adaptive capacities [11].

Climate change and variability are emerging as key concerns to Sub-Saharan Africa's development. Despite significant local variability, regional trends show declining precipitation and rising temperatures, especially among Africa's fragile farming populations [17]. Climate variability and change have serious environmental, economic, and social consequences for livelihoods in Ethiopia. Regardless, a number of encouraging changes have been documented, including the construction of various soil water conservation, water recharging, and water harvesting structures in Hadiya zone [3]. Yet, adaptation response of farmers to climate change and variability limited scientific information in zone particularly in my study area.

Furthermore, weather-related information, such as seasonal forecasts is scarce. Farmers in this area are expected to be more vulnerable because they rely solely on traditional/indigenous knowledge and skills to forecast the onset of seasonal rainfall, when to plant, and which crop to cultivate. The study's all-embracing goal was to assess farmers' adaptation responses to climate change/variability based on rural livelihoods. This can be used as a reference in setting priorities to bridge the community's knowledge gap and designing effective farmer's adaptation responses in climate variability and change in the study area.

2. Materials and Methods

2.1. Description of the Study Area

This study was conducted in the Gibe district which is located at Hadiya zone of Southern Nation Nationalities and regional state /SNNRS/, southern part of the country. It situated at 260 Km south of Addis Ababa and 30 Km South West Hossana towns. Geographically it lies at 7° 37'53" -7° 42'43"N Latitude and 37°37'07"-37° 44'25" E Longitudes. The total area of Gibe district is 44783 ha. Gibe district has a Kola, Woynedega and Dega climatic characteristics with the mean annual rainfall range from 600 to 1200mm. The rainfall in the district is bimodal, which is locally called belg and meher. The mean annual temperature ranges from 17.6°C to 25°C. The area coverage of the land use system indicates that 69.8% is cultivated lands, 14.5% is forest lands, 8.4% is grazing lands and 7.3% is others. The main annual crops grown in the area under the rain fed system are wheat (Triticum aestivum), barley, maze (*Zea mays* L.), Teff (Eragrostis teff) and sorghum.

2.2. Sampling Techniques/Procedures

This study employed stratified random sampling technique and multiple stage sampling procedure to collect data for the study site. In the first stage; Gibe district was selected purposively because it is one of the most climate variable and change affected area in the southern regional state, Ethiopia. In the second stage, 3 kebeles were stratified into three agro-climatic zones (highland, midland and lowland). Then in the third stage, out of three kebeles; Megacho from highland, Hadaye from midland and Olawamo from the lowland agro-ecological zones were selected purposively based on their climate variability and change impacts and agricultural crop adaptation response. In the fourth stage, a list of 299 farm household heads was obtained randomly selected from the three kebeles by the district's agricultural office. For instance 110, 103 and 83 households were proportionally sampled from Megacho, Olawamo and Hadaye respectively.

2.3. Sample Size

Out of the total households of sampled kebeles (1179 households) the researcher was used (299) households as a sample by using the formula provided by Yamane (1967) used to determine the required sample size at 95% confidence level and 5% level of precision.

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

$$\text{n} = \frac{1179}{1+1179(0.05)2} = 299$$

Where: n = Sample size N = Size of population e = Level of precision.

2.4. Methods of Data Collection

The data were gathered from both primary and secondary sources of data would be used. The primary data included; climate trend and its impact on rained crop production; and agronomic adaptation strategies by using semi-structured interview, Key informants were selected both from households and agricultural experts for interviews. Secondary data such as temperature and rainfall were collected from 1992-2021 from Ethiopia National Meteorology Agency (NMA) records.

2.5. Methods of Data Analysis

Quantitative and qualitative data obtained from survey were analyzed using descriptive statistical methods such as frequencies, percentages, tables and graph with the help of Statistical Package for Social Science (SPSS) software version 20 and Microsoft Excel. Descriptive statistics such as mean, frequency of occurrences and percentage were computed to summarize rainfall and temperature change and crop production trends; and also adaptation responses used by farmers. Regression analysis was employed to evaluate long term rainfall and temperature trends/ changes. The regression equation that describes a simple linear type regression relationship in a population is expressed as:

$$\text{Yi} = \alpha + \beta Xi + \varepsilon\text{i} \quad (2)$$

Where: 'Yi' dependent variable (rainfall and temperature),'α' Population Y-Intercept, 'β' Population Slope, 'Xi' independent variable (time series), 'εi' random error.

Coefficient of determination (R^2) value which shows the degree of relationship between dependent (Y) variable (rainfall and temperature) and the independent time series (X), using the following equation:

$$R^2 = \frac{(\Sigma XY - \Sigma X^n \Sigma Y)^2}{(\Sigma X^2 - \frac{\Sigma X^2}{n}(\Sigma Y^2 - \frac{\Sigma X^2}{n})} \quad (3)$$

To understand the current relationships of rainfall and crop production, the Pearson product moment correlation Coefficient of variability (CV) was used calculated to estimate the extent of variability especially in annual and seasonal rainfall.

$$CV = \frac{\sigma}{\mu} * 100 \quad (4)$$

Where: 'CV' is the coefficient of variation; μ is the average long-term rainfall over the given decade; 'σ' is the standard deviation of the decadal rainfall.

Multinomial *logi*t model was used to identify determinant factors that influence the selection and implementation of adaptation responses by the famers as follows:

$$P\left(y = \frac{i}{x}\right) = \frac{\exp(x\beta j)}{[1+\Sigma jh-1 \exp(x\beta j), j=1..,J} \quad (5)$$

Where: 'P' stands for probability, 'J' stands for adaptation responses, 'X' for explanatory variables and βj = K x 1 is coefficients j = 1, 2.., J.

3. Results and Discussion

3.1. Climate Variability and Change of Gibe District (1992-2021)

3.1.1. Annual and Seasonal Rainfall Variability and Trend

To assess the pattern and variability, long-term annual, seasonal, and monthly rainfall data from the NMA of study area station were retrieved over the period 1991-2021. The three 10-year data sets, known as Climate Assessment Decades (CAD), were categorized to allow comparison of changes in rainfall distribution in the study area. They ranged from 1992 to 2001, 2002 to 2011, and 2012 to 2021. According to the findings, the seasonal rainfall in Gibe district's Hadiya zone follows a bimodal pattern, with CAD for each data set divided into summer (major) rainy season, which runs from June to September, and winter (minor) rainy season, which runs from March to May. The purpose of this grouping was to look at the comparative foundation for the degree of variability. The major season for the first decade (1992-2001) had an average rainfall of 616.12 mm, the second decade (2002-2011) had an average rainfall of 628.02 mm, and the third decade (2012-2021) had an average rainfall of 600.08 mm, which was lower than the second and first decade. Similarly, during 1992 - 2001, 2002 - 2011, and 2012 - 2021, the minor season for each CAD recorded 370.27 mm, 232.47 mm, and 226.38 mm, respectively, with the highest incidence of variability and decreased rainfall of the period under review. In general, the results reveal a declining trend and variability in the distribution of annual and seasonal (major and minor) rainfall amounts in the studied area over the last 30 years (Table 1).

The statistical analysis also found that the seasonal coefficient of variation for the study area was larger than the yearly coefficient of variation (Table 1). The coefficient of variation (47.90 percent) of the *Belg* rainfall suggests that there was a lot of inter fluctuation, making it unreliable for agricultural crop production. In contrast, annual rainfall variability (14.76 percent) implies that there are seasonal swings in rainfall, with the unexpected and less productive winter showers stabilizing the annual rainfall inconsistency.

Table 1. *Coefficient of values of total annual, summer and belg RF in Gibe district (1992-2021).*

Rainfall	Min	Max	Mean	Std	CV (%)	R-value	Slope	R^2 -value
Annual	608.0	1205.0	906.50	128.54	14.76	-0.292**	-8.163	0.263
Summer	520.0	916.0	718.0	119.52	28.29	-0.059	-1.185	0.007
Belg	112.0	618.0	365	96.17	46.90	-0.290**	-5.246	0.190

A rainfall amount with a CV percent less than 20 is less variable, a CV percent between 20 and 30 is moderately variable, and a CV percent greater than 30 is very variable, according to Ethiopia's National Meteorological Agency (NMA, 2007). Furthermore, when the negative anomaly from the mean seasonal rainfall is 19 percent or more, the likelihood of drought is substantially higher. Summer rainfall, on the other hand, had a 28.29 percent CV value, indicating that it was less erratic than *belg* rainfall and hence agricultural production is conceivable, though the consistency is still low. Summer and especially *belg* rainfalls are generally erratic, which could have a negative impact on crop production in the study area unless supplemented by additional irrigation.

3.1.2. Temperature Variability and Trend

Using data collected in Meteorological stations over the last thirty years, the mean monthly temperature was examined across the Hadiya zone of Gibe districts. In the study area, mean minimum and maximum temperatures of 13.0°C and 24.90°C were reported in December and June, respectively (Table 2). The highest temperature in June indicates a later start to the rainy season, which influences crop planting timing. Furthermore, December (8.54 percent) and February (8.28 percent) were the months with the most significant monthly temperature fluctuations. The month with the highest temperature standard deviation was February (1.17°C), while the month with the low temperature standard deviation was March (0.61°C) (Table 2).

Table 2. *Values of temperature trend analysis of Gibe district (1992-2021).*

Month	Minimum	Maximum	Mean	Std. Deviation	CV (%)	R-value	Slope	R^2-Value
Jan	15.10	21.00	18.47	0.68	5.04	0.191	0.015	0.036
Feb	16.40	21.40	19.40	1.17	8.28	0.453^{*}	0.06	0.205
Mar	16.60	21.30	18.95	0.61	3.87	0.479^{**}	0.035	0.247
Apr	16.80	21.90	18.14	0.80	4.79	0.534^{**}	0.049	0.286
May	15.20	22.40	18.10	0.90	4.87	0.502^{**}	0.051	0.252
Jun	17.20	24.90	20.05	1.03	5.41	0.579^{**}	0.051	0.335
Jul	16.20	23.00	19.90	1.07	5.76	0.505^{**}	0.062	0.255
Aug	15.90	23.60	19.25	0.82	4.65	0.477^{**}	0.044	0.228
Sep	15.50	24.50	20.00	0.69	3.45	0.427^{*}	0.029	0.183
Oct	15.40	24.10	19.65	0.86	5.86	0.579^{**}	0.057	0.335
Nov	16.30	24.20	19.20	1.11	8.02	0.540^{**}	0.068	0.292
Dec	13.00	23.73	18.36	1.03	8.54	0.380^{*}	0.044	0.144

As indicated in Figure 1 below there was a general increasing annual maximum and minimum temperatures change from 1992 to 2021 years. Although the increasing rate of all minimum, maximum and the mean are all above the national (0.01°C) rate of annual increase. UNDP's (2008) report also revealed an increasing trend of mean annual temperature of Ethiopia. In addition, National Meteorology Agency of Ethiopia (NMA, 2001), reported that, the average annual maximum temperature in the country has increased by 0.1°C per decade, whereas, the average annual minimum increased by 0.37°C per decade (NMA, 2007).

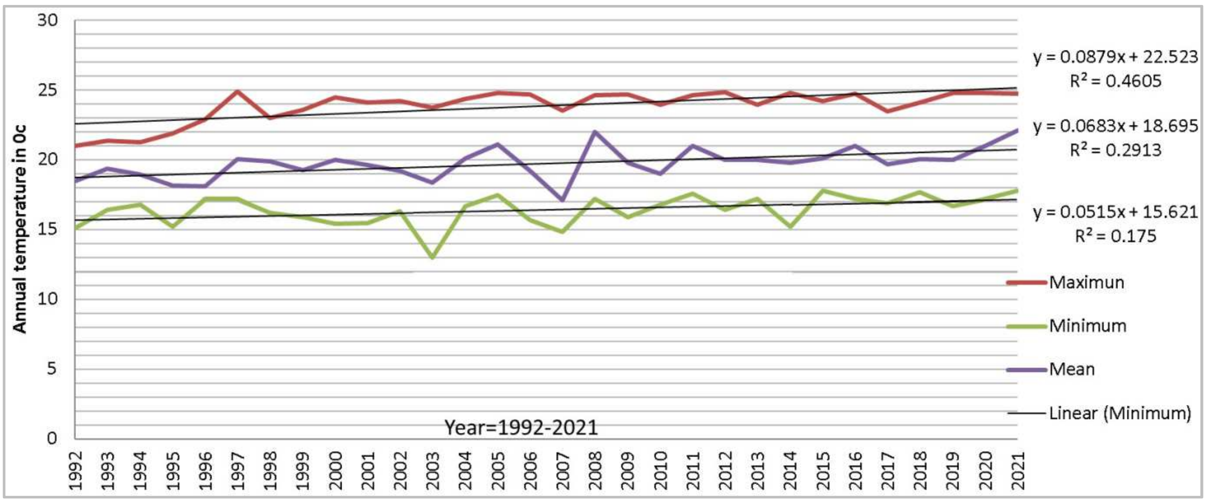

Figure 1. *Trends of Annual maximum, minimum average and temperature (1992-2021).*

Farmers' perceptions on climate variability and change

The process of addressing climate change challenges requires a thorough grasp of socioeconomic settings in the context of climate change trends and how farmers interpret climate change patterns. As a result, assessing farmers' perceptions of climate change trends and comparing them to scientific evidence from long-term climate data will reveal how perceptions of climate change influence farmers' willingness to adaptation responses to climate change. In Gibe district, a household study on smallholder farmers' responses and experiences of climatic variability and change impacts by agro-ecological zones, gender, and age of family heads yielded significant results.

Furthermore, focus group discussions and key informant interviews revealed that rainfall in the study area is unpredictable, with shorter durations due to late onset and early cessation in both small and main rainy seasons, which has damaged crop productivity during the last thirty years. According to the household survey, approximately 95% of respondents perceived long-term climate variability and change, whereas just 5% of respondents did not perceive any change in climate in the study area. In terms of temperature, around 66.65% of respondents indicated a rising trend in temperature, particularly in the study area's highlands, where the temperature had been increasing, whereas 7.14% thought the temperature had been decreasing. However, 5.57 percent of families had no concept, and 20.64 percent of respondents thought the temperature stayed the same.

Table 3. *Farmers' perceptions on climate change and variability on Gibe district (n=299).*

S/N	Recent climate variability and change		Percent (%) of perceptions at kebele level			
			Hadaye (High land)	Olawamo (Midland)	Megacho (Lowland)	Total
1	Temperature level	Increasing	72.38	63.38	64.64	66.65
		Decreasing	6.83	10.56	4.04	7.14
		Stayed the same	17.94	18.30	24.24	20.64
		No concept	4.83	7.74	7.07	5.57
	Total		100	100	100	100
2	Total RF amount	Increasing	8.06	8.45	4.04	5.83
		Decreasing	77.42	81.69	88.89	83.66
		Stayed the same	12.90	7.74	5.05	1.41
		Do not aware	1.62	2.11	2.02	9.19
	Total		100	100	100	100

Similarly, 83.66 percent of households believe the amount of rainfall is decreasing, while 5.83 percent believe it is increasing. However, 9.19 percent of families were unaware of it, and 1.14 percent of respondents thought the amount of rain remained steady. In general, smallholder farmers in the study region reported an increase in temperature but a decrease in rainfall as the most significant climate-related changes.

Household farmers also mentioned their varied sources of climate knowledge, in addition to their perceptions. Besides, more than 67 percent of respondents cited proper communication with government focal agents as a source of information, but the importance of non-governmental groups and the media was also emphasized. Farmers' improper communication is often cited as a valuable source of information on climate change and its consequences (Table 4).

Table 4. *Sources of information for climate change and its impacts Gibe district (299).*

S/N	Source of Information	Frequency	Percentage (%)
1	Government focal agents	195	65.00
2	Local elders	16	5.50
3	Radio/TV	39	13.00
4	NGO	14	4.70
5	Own understanding	19	6.40
6	From other farmers	16	5.40
Total		299	100

3.1.3. Climate Variability and Change on Crop Production

When respondents to the current study were asked about the negative effects of climate variability and change on crop production, 54.6 percent thought crop yield had decreased, 20.0 percent supposed crop productivity had fluctuated, and 12.5 percent supposed pests and diseases had increased as a result of changes in temperature and rainfall over the previous 12 years (Table 5). Climate variability and change, on the other hand, were blamed by 3.4 percent of respondents for crop quality loss and 1.9 percent for overall crop loss in the study area.

Climate change has caused dry spells, late commencement and early cessation of rainfall, high prevalence of pests and illnesses, and seasonal flooding, according to the findings of this study's expert and focus groups. Climate variation and change have had a substantial impact on cereal crops, which represent the principal stable food in the study area. In general, decreasing rainfall and unpredictability, as well as rising temperatures, are among the key factors affecting crop yield and productivity in the area. According to Anand (2011) reported that rising temperatures cause agricultural failure by reducing crop water availability, producing heat stress, and increasing crop plant pollen sterility.

Table 5. *Impact of climate variability and change on crop production (n=299).*

Agro ecological zones								
Impacts of climate events	Highland		Midland		Lowland		Total	
	N	%	N	%	N	%	N	%
Total crop loss	2	2.4	4	2.1	1	1.0	7	1.9
Reduces crop yield	45	49.2	85	51.4	34	53.5	144	54.6
Reduce production land	18	21.1	45	26.8	9	15.2	72	20.0
Increases pest and disease	15	16.9	15	9.2	12	19.2	42	12.5
Delayed crop maturity	3	3.2	8	4.9	1	2.0	12	3.8
Loss of indigenous crop varieties	4	4.0	5	2.8	3	5.1	12	3.8
Loss of crop quality	3	3.2	5	2.8	2	4.0	10	3.4
Total	90	100	167	100	62	100	299	100

In contrast, according to this study's household survey, wheat is the most damaged crop for 52.10 percent of respondents, while barley is the most impacted crop for 22.40 percent (Table 6). Sorghum was also shown to be a better adapted crop to the detrimental effects of late start and early stop rain, as well as a high frequency of pests and illnesses in the area, than extended season crop varieties like barley, according to the study.

Table 6. *Impacted crop types by climate variability and change in districts.*

Major crops	Frequency	Percentage (%)
Barley	67	22.40
Wheat	156	52.10
Tef	45	15.20
Sorghum	31	10.30
Total	299	100.0

Table 7. *Trends in study area of major crops in district.*

Crop varieties	Area (ha)			
	Std. Deviation	R-value	Slope	R^2-Value
Wheat	1.649	-0.342	-0.240	0.035
Barely	1.342	0.575^{**}	0.192	0.490
Teff	0.418	-0.658^{**}	-0.213	0.658
Sorghum	0.748	-0.146	-0.028	0.019

Among the major crops, wheat is the predominant crop followed by barley. Although, sorghum and teff, important according to the observed cultivated area in the production seasons. The production land of wheat, tef and sorghum in the area shows a decreasing trend and highly fluctuation time to time, while the cultivated area of wheat and barley showed increment over past twelve years in the study area (Table 7). Wheat and Barely were the crop type of higher standard deviation in area of production land.

3.2. Adaptation Response of Climate Change in District

According to the results of a household survey, 35.90% of respondents utilize drought-resistant or early-maturing crop types, while 22.5% use soil and water conservation as adaptation responses to combat the effects of climate variability and change on crop production (Figure 2). To response the negative effects of climate variability and change in the study area, the remaining respondents use crop diversity, crop rotation, additional irrigation, and modifying planting time. According to the findings, communities have implemented a variety of adaptation techniques in response to the negative effects of climate variability and change on crop production (Figure 2). According to implementing adaptation tactics is not an option for most African poor countries, including Ethiopia; rather, it is a need to exist in a changing environment [9]. As a result, rural communities that have recognized climate variability and change are using intensification of agricultural crop inputs and technologies as adaptation strategies, such as changing crop types or/and varieties, soil and water conservation practices, crop diversification, crop rotation, increasing irrigation farming, and adjusting planting time.

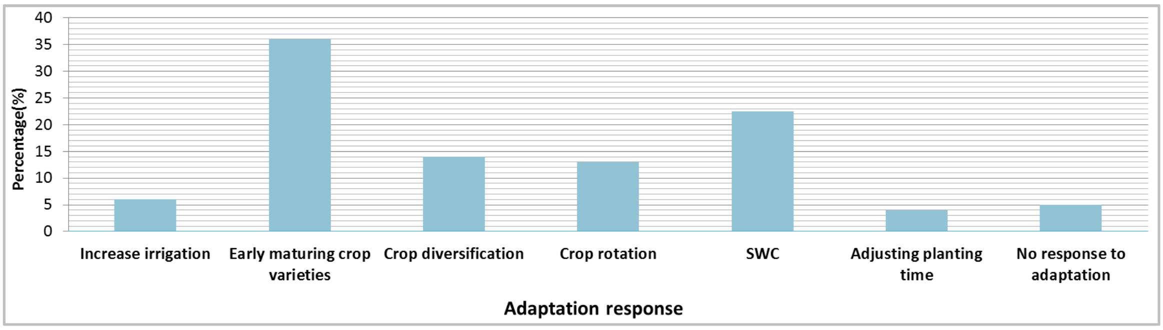

Figure 2. *Adaptation response of respondent to climate change.*

Smallholder farmers in the study area use a variety of adaptation response to decrease the impact of climatic variability and change, according to FGD participants and key informants. The use of early maturing crop varieties (drought-resistant) and moisture conservation methods were the most effective adaptation responses they used to decline the effects of climate variability and change in study area.

3.3. Determinants of Adaptation Responses of Farmers' to Climate Variability and Change

The MNL model's likelihood ratio statistics revealed that the Chi-square test (218) was highly significant (P<0001), implying that the model has substantial explanatory power (Table 8). The findings revealed that the explanatory variables influenced whether farmers used one or a combination of climate change adaptation responses.

Farmers in different agro-ecological zones employ a variety of climate change adaptation responses to climate variability and changes. In comparison to farming in the lowland, the MNL found that farming in the midland reduces the probability of employing irrigation and soil and water conservation as compared to farming in the lowland (p <0.05). Furthermore, farming in the midland increases the likelihood of shifting crop kinds when compared to farmers in the lowland (p<0.01). This difference could be attributable to differences in soil fertility, climate, and other relevant issues, as well as climate-related stress experience. Male-headed households are more likely to modify crop varieties, crop diversification, soil and water conservation, and irrigation methods as climate change adaptation responses, according to the gender of respondents' analyses (Table 8). As other variables are held constant, however, being the head of a male-headed household reduces the probability of employing altering planting time when compared to female household heads (p<0.05). Male-headed households favor these climate change adaptation techniques that necessitate labor, finance, and information more than female-headed households. This supports the claim that male-headed households are more likely than female-headed households to get knowledge about new technology [16].

The age of the household head was found to significantly increase the probability of adapting to changes in crop type/variety, crop diversification, soil and water conservation, and irrigation practices. This could be due to the fact that older farmers have more experience, knowledge, and technical expertise in terms of adaption possibilities, allowing them to make more informed adoption decisions [4].

The usage of irrigation practices as climate change adaptation responses increases dramatically when the household head is educated. Farmers with a higher education are more likely to be informed about climate change, which may increase the probability of using climate change adaptation responses. Crop diversity, soil and water conservation, and irrigation practices all increased, when access to meteorological advice was available (Table 8). This finding suggests that improved institutional support is critical in encouraging the use of adaptation strategies to mitigate the negative effects of climate change. This result supports [7] finding that increased access to climate information enhances farmers' willingness to choose crop diversification and planting date changes as climate change adaptation alternatives.

Table 8. *Determinants of Adaptation responses of farmers' to climate variability and change.*

Explanatory variables	drought-resistant (early mature crop			Crop Diversification			Soil and water conservation			increase irrigation			Adjusting planting time		
	Coef	P Value	ME	Coef	P value	ME	Coef	P value	ME	Coef	P value	ME	Coef	P value	ME
Sex of HH	1.016	0.300	0.0004	0.341	0.520	0.214	1.060	0.281	0.374	3.041	0.173	0.132	-3.35^{**}	0.027	-0.72
Age of HH	0.308^{**}	0.030	7.9e5	0.276^{**}	0.010	0.003	0.313^{***}	0.008	0.024	0.324^{***}	0.007	0.002	0.070	0.365	-0.023
Agro-ecology	19.45^{***}	0.000	0.563	-0.216	0.628	0.243	-2.95^{***}	0.005	-0.529	-5.48^{***}	0.002	-0.343	1.203	0.263	0.135
Wealth status	0.0006^{*}	0.041	1.76e-6	0.002	0.356	0.000	0.0004	0.250	0.000	0.008	0.147	9.4e0	0.005	0.122	0.000
Education level	0.4701	0.327	0.0000	0.562	0.203	0.023	0.563	0.266	-0.032	0.626^{*}	0.060	0.021	0.536	0.276	-0.006
Farming size	0.765	0.721	0.0002	-0.229	0.712	-0.254	0.587	0.676	0.233	0.771	0.612	0.051	0.274	0.846	-0.022
Const	-26.9^{***}	0.000		-16.7^{***}	0.000		-17.8^{***}	0.001		-30.00^{***}	0.000		-8.10^{*}	0.048	
Base category						No adaptation response									
						299									
Number of observations L chi-square						218.15									
Log likelihood Pseudo R^2						-118.78									
						0.405									

4. Conclusion and Recommendation

4.1. Conclusion

Farmers' perceptions of climate change trends and comparing them to scientific evidence from long-term climate data will reveal how perceptions of climate change influence farmers' willingness to adaptation responses to climate change. In Gibe district, a household study on smallholder farmers' responses and experiences of climatic variability and change impacts by agro-ecological zones, gender, and age of family heads yielded significant results. The impacts of climate change and variability on crop production showed reduction in crop yield and fluctuated crop land coverage. The yield of major crops is declining due to climate change especially rainfall variability and decline. Moreover, the results showed that, the most of the farmers have perceived changes in climate and experienced the effects of a changing climate on crop production in the district.

The findings also revealed that changes in crop type or/and variety along with proper soil and water conservation are the most important climate change adaptation responses that practiced in the area. The level of education and age of household heads, wealth status and meteorological information positively influenced the use of one or combination of climate change adaptation responses identified by farmers. Gender of household head was also found to influence the choice of adaptation responses by the farmers.

4.2. Recommendation

Based on the finding of the current study the following recommendation was forwarded:

1) Makes timely recording meteorological stations and generates meteorological advisory services provision was important to enhance crop production in the study area.
2) Different concerned body like agricultural extension experts, development agents, local government etc... should participate for disseminating early metrological output information about climatic conditions. And also the farmers should integrated this early warring information with their local indicators to resist the coming seasonal and daily variation of weather futures.
3) The farmers should diversified livelihood system to minimize the impacts of climatic shocks.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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