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Original Research

Climate Variability, Farmers' Perceptions, and Adaptation Strategies in Begi District, Western Ethiopia

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Abstract

The aim of this study was to assess the trends of climatic variability, farmers' perspectives, and adaptation strategies to climate variability. The study involved 127 household respondents and group discussions with rural farmers from Begi district. It utilized both qualitative and quantitative data collection and analysis techniques of primary and secondary data. The result revealed that mean annual temperature was a slightly increasing while the annual rainfall, total rainfall and seasonal rainfall showed high variability and slightly declining. Moreover, age, educational background, access to extension services, and farming experience have a positive impact on farmers' views on climate variability. Additionally, farmers residing in lowland regions demonstrated higher levels of awareness compared to those in mid-highland areas. Afforestation, terracing, planting early maturing crops and diversifying sources of income were among the commonly used adaptation strategies to climate change. Enhancing resilient agricultural practices to combat climate variability and change increases agricultural productivity, local community wellbeing and their environment.

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INTRODUCTION

Climate variability is the term used to describe the variation from the average of a climate feature, such as temperature or precipitation (UCAR, 2024). The entire climatic distribution is moving toward warmer temperatures due to global increases in climate variability and extremes, indicating a shift in the average climate state (IPCC, 2012). The lives of smallholders and the communities who depend on biological systems are already being significantly impacted by climate variability. The growing trends in climatic variability and extreme events pose serious challenges for agriculture (Malik *et al*., 2022). Climate change directly affects agricultural production because this sector is among the most vulnerable to the risks and consequences of global climate change due to its inherent sensitivity to weather (Raghuvanshi and Ansari, 2016). This is because substantial fluctuations in agricultural yields and output levels are caused by variations in temperature and precipitation. The overall trend of yearly rainfall was consistent throughout time, despite an increase in the annual temperature. Raising the temperature had no appreciable effect on rice yield, but it had a favorable effect on maize and a negative effect on longan output. The trend of rainfall had no effect on crop output (Kyaw *et al*., 2023). The relationship between climatic variability and crop yields reveals that while increases in precipitation boost maize yields and decrease variability, temperature and precipitation changes typically have an opposing effect on crop yield variances and the mean. However, the agricultural industry suffers financially as a result of an increase in the severity and frequency of a specific type of extreme event (Adams *et al*., 2001).

In addition, research done in Kenya revealed that although climate variability and change affect agricultural productivity, the effects differ according on the crop. Rainfall negatively affects tea, although warmth positively affects tea and negatively affects crop and corn income. Temperature has a greater impact on crop productivity than rainfall (Ochieng *et al.,* 2016). A literature study showed that Ethiopia has

encountered both climate change and fluctuation, as seen by the country's average annual temperature increase of 1.3 ^{O}C since 1960 and a rise of 0.28 C every ten years. Precipitation differences in both space and time have increased, emphasizing how vulnerable the nation is to changes in the climate (Kobe, 2024). This indicates climate variability significantly affects agricultural production resulting food insecurity. Rainfall negatively affects tea, although warmth positively affects tea and negatively affects crop and corn income. Temperature has a greater impact on crop productivity than rainfall (Walker *et al*., 2004).

To modify farming operations, one must have a thorough understanding of climate change. In order to adjust to the changing weather, farmers must have a thorough understanding of climate change, including its origins and impacts (Raghuvanshi and Ansari, 2016). Farmers' perceptions have a significant impact on the adaptation strategies they take in response to climate change, according to Ansari *et al*. (2018). Ethiopia is susceptible to the effects of climate change, which could harm the country's cow herds, food and water security, productivity in agriculture, and human health (Asrat and Simane 2017; Yirga, 2007). Furthermore, as far as agricultural practices are concerned, farmers' perceptions are crucial to the effective use of adaptation measures to lessen the effects of climate change (Bisrat *et al*., 2017). Furthermore, as far as agricultural practices are concerned, farmers' perceptions are crucial to the effective use of adaptation measures to lessen the effects of climate change (Guoyong *et al*., 2015).

Stallholder farmers in Begi district, West Wallaga are mainly dependent on small-scale agriculture which is sensitive to the effect of climate variability (Asrat and Simane, 2017). Additionally, the district is located in low land area where the influence of temperature could be higher on agricultural production including coffee, but there is no information available with respect to the effect of climate variability, farmers' perception and adaptation mechanism in Begi area. Therefore, this research is to gather preliminary information which would be useful for future studies and design policies and strategies to address the effect of climate variability and change. Therefore, the purpose of this research was to assess farmers' perspectives, climate variability adaptation, and climatic changes.

MATERIALS AND METHODS

Study area: Begi district is found in West Wallaga Zone of Oromia Regional State, Ethiopia with an average altitude of 1673ma.s.l. Geographically the district is located between 9º 26N′ latitude and 34º 32'E longitude with an average elevation of 1650-2000 masl. The average temperature of the area is 17.8°C per annum, with mean annual rainfall of 1278mm (Sinore *et al*., 2017). Based on the recent population projection by Ethiopia Statistical Service (2023), Begi district is projected to have a total population of 176,166 of whom 89,216 were males and 86,950 females. The fundamental characteristic of this agricultural system is that the majority of people live in mixed crop-livestock subsistence farming systems. Chickpeas, wheat, maize, and teff are commonly farmed crops in the area. Sheep and cattle are the two most prevalent livestock species, while coffee is a substantial revenue crop. Locals are worried about the quantity and duration of rainfall because the farming system is dependent on rainwater (Begi District Agricultural Office, 2019 unpublished).

Data sources: Relevant quantitative and qualitative data were collected from primary and secondary data sources to support each strategy (Creswell, 2009). Thus, the study covered four kebeles in the district (Shash Dembi Guda Teki, Ego Girmos, Kongilo Gara Kelo and Shigigo Fermikisi). Key informants, focus group discussions, and household surveys were the sources of primary data. Additional secondary data came from several district government department, Central Statistical Agency (CSA) data (CSA, 2008), Ethiopian Meteorological Institute (EMI, 2020) data and published and unpublished written sources. Trends for different seasons and annual averages from 1983 to 2019 were computed with the aid of secondary data on climate variables.

Methods of data collection

Key informant interviews with eight respondents and focus group conversations with eight discussants (eight focus group discussions were held in all kebeles or two for each) were the methods used to gather qualitative data. To better understand how farmers perceive climate change, variability, and the adoption of adaptation strategies by the respondents, data from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were used to supplement the information obtained from a household survey of 127 respondents.

A household questionnaire was used to gather quantitative data. The dataset included perceptions of changes in climate variables and extreme events (such as variations in rainfall and temperature); options for adaptation or response strategies; farm attributes (such as landholding, livestock ownership, agricultural practices, land tenure, land use, and income sources); and institutional attributes (such as access to credit services, extension services, and weather forecast and climate information). The survey also included information on biophysical aspects, as well as demographic and socioeconomic characteristics of homes. A variety of activities were gathered as adaptation measures, along with farmers' opinions of how the climate has changed over the previous 30 years. The Ethiopian Meteorological Institute (EMI) meteorological station provided the monthly precipitation, monthly mean minimum temperatures (derived from the daily minimum temperatures observed), and monthly mean maximum temperatures (derived from the daily maximum temperatures observed) for the observation station closest to the study area (EMI, 2020).

Sampling Methods: Purposive and simple random sampling, which are non-probability and probability sampling methods, were utilized in the study's sample approach to choose the kebeles and households, respectively. For primary data collection, firstly, Begi district was purposively selected. This was based on lack of study in the area; it has different topographic features and frequent susceptibility to climate-related problems. Second, four kebeles were randomly selected from the total of 45 kebeles based on their coverage by productive potential and climate change/variability adaptation practices. Since the area is vast and is difficult to undertake a survey in all kebeles, about four kebeles were randomly selected. In the third phase, a total of 29, 35, 31, and 32 participants from households in Shash Dembi Guda Teki, Ego Girmos, Kongilo Gara Kelo, and Shigigo Fermikisi were selected, with a combined age of over 45 years. The team conducting the survey used a basic random sampling method that took into account the probability proportional to size for selection. A team of trained data collectors was assigned a day in each kebele to finish the household listing. Upon completion of the household listing, each listed household was assigned a unique identification number. Then households were randomly selected using a systematic random sampling technique.

To calculate the necessary sample size at a 95% confidence level, 5% degree of variability, and 8% level of precision, the simplified formula from Yamane (1967) was utilized. This value is acceptable since it is less than 10%. $n = N/1 + N (e)^2$ Where **n** is the sample size, **N** the population

(total household) size and **e** is the level of precision. n = 668/1+ 668*0.0064 = 668/5.2752 = 127

Method of data analysis

The data analysis method used was a combination of qualitative analysis and descriptive statistics. Descriptive statistics, which include frequency, percentage, graphs, and tables for quantitative data presentation, were used to examine the demographic and socioeconomic features of the homes. The data gathered was inputted into Microsoft Excel using the 2010 software program and then analyzed with SPSS Version 20. The information was presented using descriptive statistics for different variables. On the other hand, qualitative data obtained from key informant interviews, focus group discussions, and observational notes was transcribed, categorized, and interpreted. Ultimately, connections were formed based on groupings and causal relationships.

RESULTS AND DISCUSSION

Respondents' socioeconomic and demographic details

Out of the household heads included in the sample, 3 (2.4%) were led by females and 124 (97.6%) were led by males (Table 1). The participants in the research ranged in age from 45 to 78, with an average age of 57 (Table 1). However, 69% of the respondents were younger than the average age. Santrock (2011) identifies three age group categories: young for individuals aged 20-40, adults for those aged 41-60, and elders for those over 60. In terms of religious composition, 52 (41%), 65 (51.1%) and 10 (7.9%) of survey households are believer of (Orthodox, Muslim and Protestant), respectively (data not shown).

Table 1: Distribution of Sample Households by Kebele and Gender and age group in four kebeles of Begi district, 2020.

Gender	Kebele				Total	%	Age			
	Shash Dembi Guda Teki	Ego Girmos	Kongilo Gara Kelo	Shigogo Fermikisi			45-60	%	>60	%
Male HHs	28	34	31	31	124	97.6	82	65	42	33
Female HHs	1	1	0	1	3	2. 4	3	2	0	0
Total	29	35	31	32	127	100	85	67	42	33

Moreover, about 59% of the respondents had 0.51 to 2ha of farmland, while about 18% have had 0.5ha of farm land and 23% of the respondents have >2.1ha. In general, 47.4% of the respondents have less than 1ha of farmland. The average household size of the participants is 7, with families ranging in size from 4 to 17 members (Table 2). More than 39% of the respondents could read and write, while 21% have completed primary school while 40% of the household heads were illiterate with no formal education. In general, 60% and 40% of the respondents were literate and illiterate, respectively (Figure 1).

Table 2. Distribution of sample households by land holding size in four kebeles of Begi district, 2020.

Kebele	Sex	Size of Farmland (ha)			
		0.5	0.51-2	>2.1	Total
Shash Dembi Guda Teki	Male	4	15	9	28
	Female	1	0	0	1
Ego Girmos	Male	10	16	8	34
	Female	0	1	0	1
Konglo Gara Kelo	Male	5	19	7	31
	Female	0	0	0	0
Shigogo Fermikisi	Male	3	23	5	31
	Female	0	1	0	1
Sum		23	75	29	127

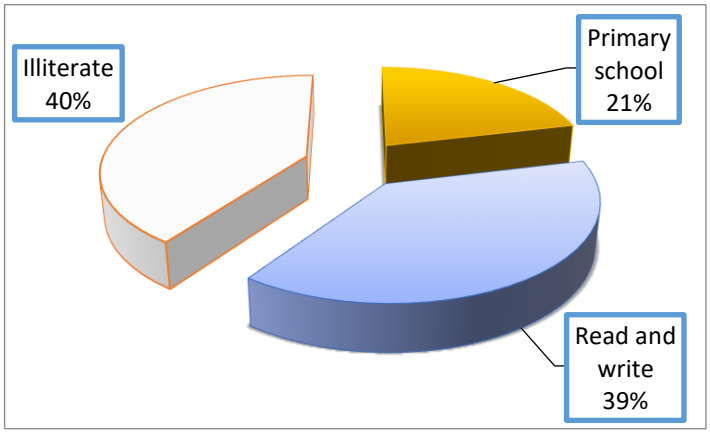
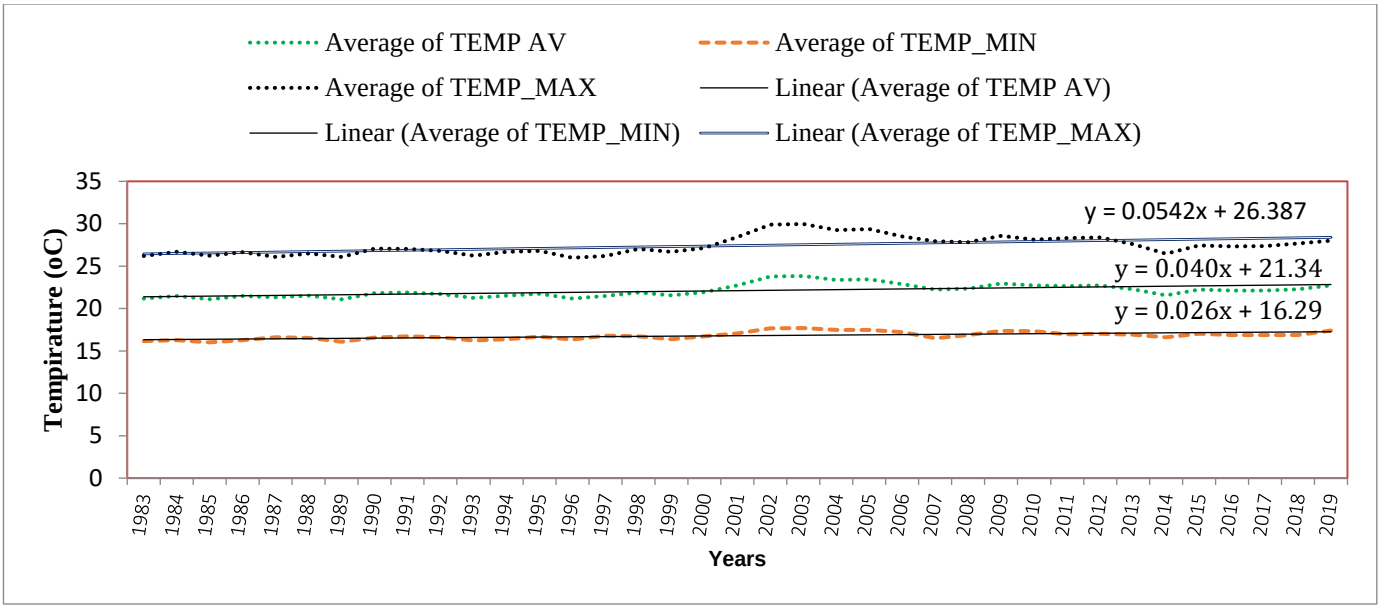


Figure 1. Distribution of sample households by educational status

Climate data analysis

Temperature: The annual maximum, minimum, and average temperatures of the area from 1983 to 2019 is displayed in Figure 2. Thus, the result showed that year 1990 was in the maximum range of average temperature, while the year of minimum average temperature was 2005. It appears that the temperature was very slightly in an increasing trend. Accordingly, the data points to an annual temperature increase of 0.040 ^{O}C on average, with annual temperature increases at the maximum point of 0.054 ^{O}C and the lowest point of 0.026 ^{O}C (Figure 2). According to data collected from EMI (2020), the average temperature in the research area ranges from 21.08 ^{O}C to 23.83 ^{O}C

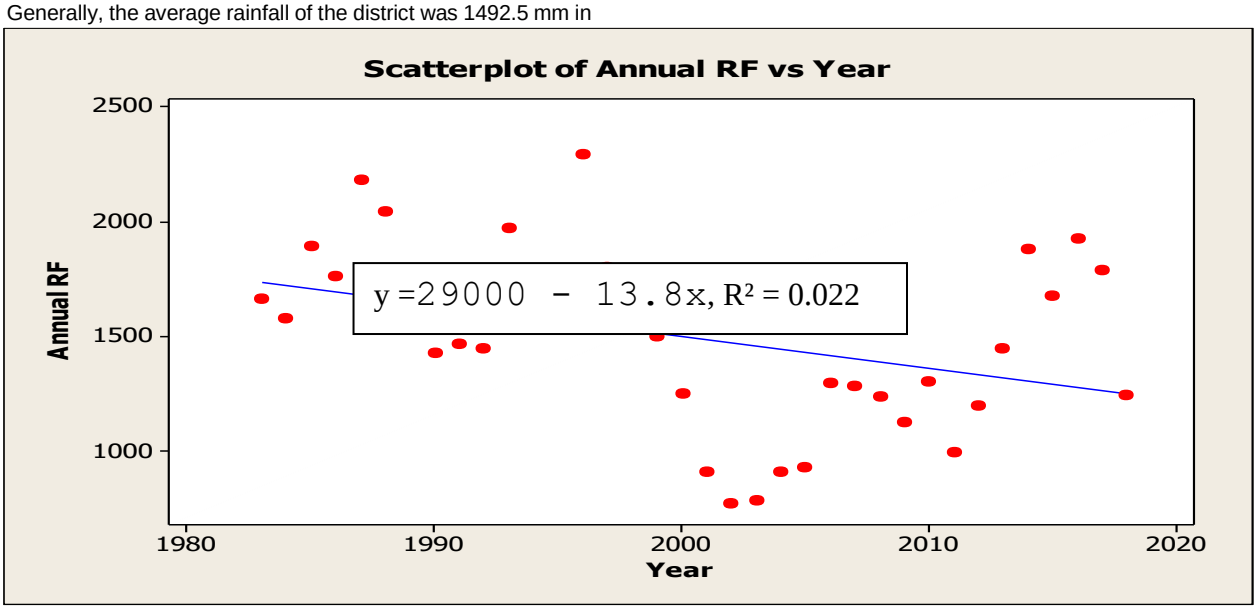


Source: Ethiopian meteorology Institute (EMI, 2020)
Figure 2. Temperature trend of study Area, four kebeles of Begi district (1983-2019).

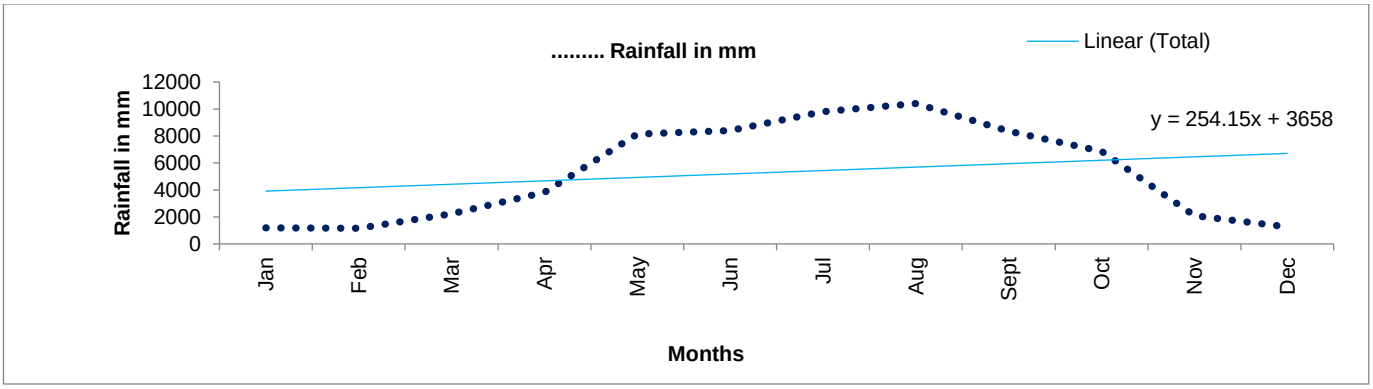
The average maximum temperature fluctuates between 25.99 ^{O}C and 29.96 ^{O}C. The yearly minimum temperature in the district has been between 16.01 ^{O}C and 17.69 ^{O}C for over thirty years (Figure 2). Similarly, an increase in temperature was reported by Nasir *et al.* (2021) and Dejene (2011).

Trend and distribution of rainfall of Begi District

For the previous 36 years, the annual rainfall in the Begi district has ranged from a minimum of 771 mm in 2002 to a maximum of 2294.57 mm (Figure 3). Data analysis result shows annual rainfall has a decreasing trend at the rate of 13.8mm/year in the past 36 years and maximum in 1996. The amount of rainfall showed annual fluctuation between 1983 and 2018. Generally, the average rainfall of the district was 1492.5 mm in the past thirty six years. The inter-annual patterns of rainfall distribution showed that annual rainfall amounts were above the average in most years except in 1990, 1991, 1992, 2000-2013 (Figure 3; Figure 4). In Begi district, similar to numerous other regions in western Ethiopia, the rainy season usually takes place from June to September, while November, December, and January are considered the driest months. Thus, the monthly distribution and variability shows the wettest month is August, while the driest month is February with an average rainfall of 29.90 mm. On the other hand, the wettest season is summer, while the driest season is winter. Relatively, spring is the second rainy season in the district (Figure 4).



Source: Ethiopian meteorology Institute (EMI, 2020)
Figure 3. Annual rainfall trend of Begi District area (from 1983-2018).



Source: EMI (2020) data

Figure 4 Overall average monthly rainfall distribution of Begi district, western Ethiopia (1983 to 2018).

Table 3: Descriptive statistics for continuous variables

Characteristics	Adopters		Non-adopters		t-test value	P value
	Mean	SD	Mean	SD		
Age	41.9	10.4	45.6	10.0	0.0005***	0.0003
Farm size	6.5	0.17	0.16	2.3	0.80**	0.059
Livestock ownership	6.2	2.1	7.3	2.5	0.0000***	0.0000
Family size	7.1	2.4	7.0	2.4	0.81NS	0.59
Market distance	6.9	2.0	7.4	1.9	0.009***	0.004

Source: Computed from own survey data (2021). ***, **, * 1, 5 and 10% significance levels. NS

Descriptive Statistics for Categorical Variables

Table 4 presents various household parameters, including gender, educational level, off-farm participation, extension services, credit availability, farmer assessment of wheat yield, and farmer perception of input cost. The data indicates that males predominantly head households that have adopted improved bread wheat varieties, with a statistically significant gender difference. The chi-square test shows a significant association between education level and adoption, with 25.8% of non-adopters being uneducated. Off-farm participation also differs significantly, with 32.3% of adopters and 28% of non-adopters engaged in such activities. Access to extension services is significantly higher among adopters (33.6%) compared to non-adopters (17.2%). Additionally, 60% of adopters are involved in local cooperatives, whereas 40% of non-adopters are not. Credit participation is significantly higher among adopters (70%) compared to non-adopters (30%) (Table 3). Training participation also shows a significant difference, highlighting the link between perception and variety adoption.

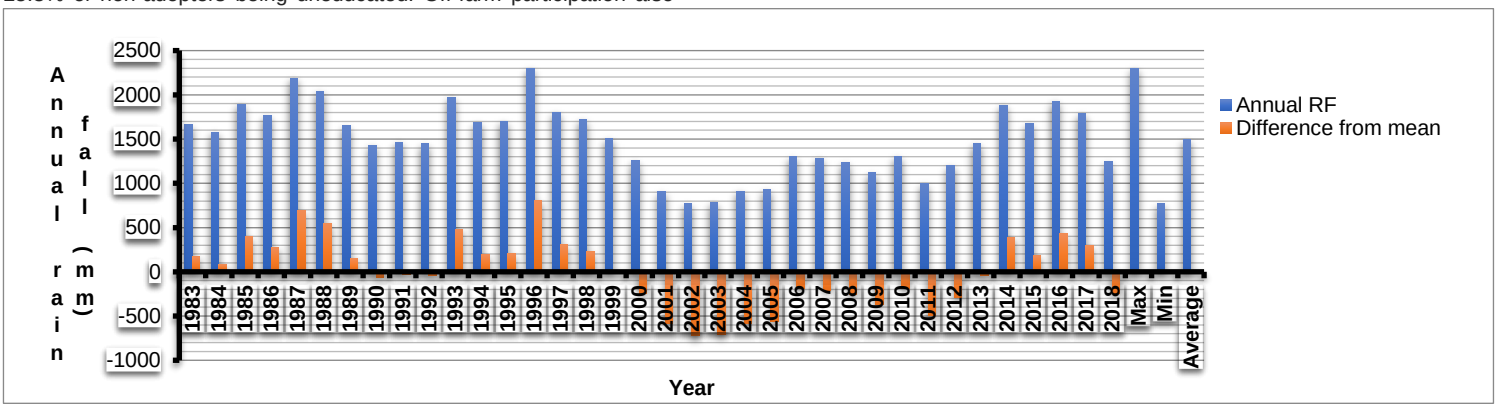


Figure 5. Annual rainfall distribution and its deviation from the mean (from 1983 to 2018). Source: EMI (2020)

Trends of seasonal rainfall variability

Analysis of autumn rain has shown decline trend from 1983 to 2018. The average rainfall of autumn in the past three decades was 173.5 mm with standard deviation of 81.8 and coefficient of variation of 47.1% showing high deviation from the mean. Similarly, the mean rainfall of winter and summer was 46.3 and 785.4mm with the coefficient of variance was 71.4% of winter and 15% of summer, respectively (Figure 4). The rainfall data for over thirty years demonstrated significant annual variation in the amount of rainfall (Figure 5). With a coefficient of variation of 70.6% and an average annual rainfall of 1492.5 mm over the previous three decades, the rainfall was very variable and trended downward over time (Figure 3; Figure 5). A decline in annual rainfall, total rainfall and seasonal rainfall trend was also reported by Nasir *et al*. (2021) in Pakistan. According to Wagesho (2016), all of the stations in southern Ethiopia have extremely varying yearly precipitation concentration indexes due to non-uniform rainfall concentration over the stations from year to year. This fluctuation is most noticeable during the Bega season.

Farmers' perception on rainfall variability in Begi district

Awareness of the potential risks linked to climate change can enhance the development of adaptation plans and the execution of techniques to counteract climate change in farming regions. Assessing farmers' views on climate change is essential to developing successful policies for climate adaptation (Nasir *et al*., 2021). The amount, timing, and distribution of rainfall in the research area have fluctuated over the previous three decades, according to over 91% of participants in the farmers' group discussions and key informant interviews. According to farmers' perceptions of variations in rainfall, 72% of respondents in midland areas and 94% of respondents in lowland areas observed changes in rainfall amounts (data not shown). This demonstrates that farmers' perceptions of rainfall changes differed across agro-ecologies. The decrease in yearly and seasonal rainfall totals supports the agreement between farmers' observations and meteorological patterns. This research coincides with the findings of Nasir *et al*. (2021). Another study on farmers' perceptions of rainfall variability in southern Ethiopia found that, on average, 80% of respondents believed there was variability in the amount and frequency of rainfall, whereas 1% thought there had been no change in rainfall pattern and 4% said they were unsure if it existed or not over the previous 20 years (Wagesho 2016).

Farmers' perception determinants of Begi district on rainfall variability

In the survey, t he people responses revealed that the farmers' used some indicators to detect the occurrence of climate variability were loss of livestock and plant species (72%), an increased frequency of occurrence of temperature and respondents said a decreasing in rain fall (78%) and spread of human population and animal disease (97%), shortening of growing period (83%), rainfall comes lately and goes early (100%), decline of agricultural yield (97%) and decreased available water (100%) were reported as indicators of variability in rainfall in the area over the past three decades (Figure 6).

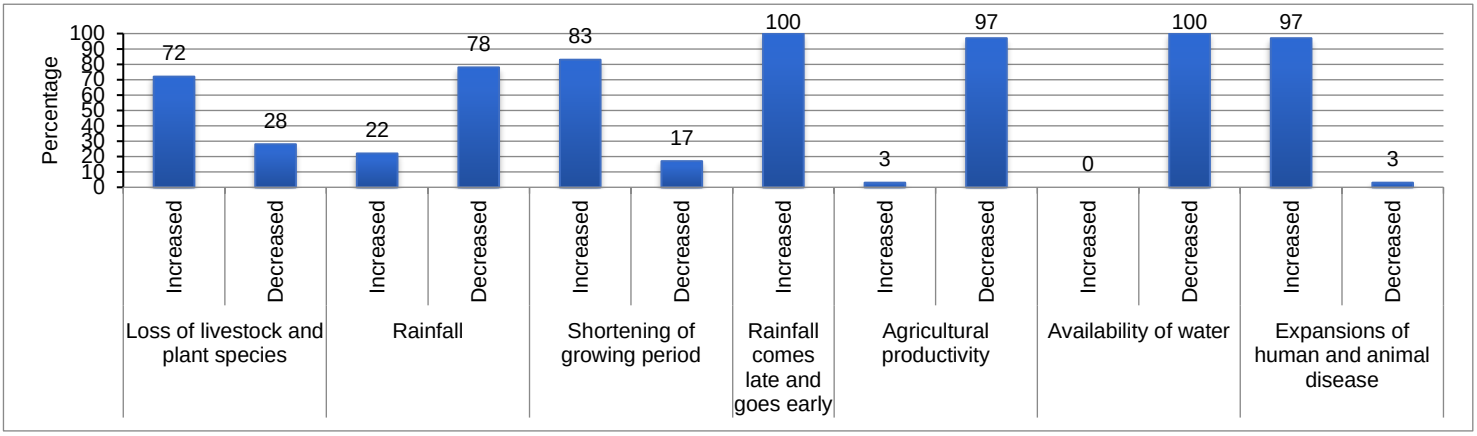


Figure 6. Farmers' perspectives on changing rainfall patterns

Farmers' view point on temperature fluctuation and its indicators in Begi district

All household leaders acknowledged a consistent rise in temperature over the last 30 years based on survey results. All of the participants reported an increase in the annual temperature in both the lowland and midland zones. In the lowland area, 100% of people observed the increase, while in the midland area, 97.7% noticed the same. Only 2.3% of residents in the midland kebele mentioned no change in temperature (Figure 7).

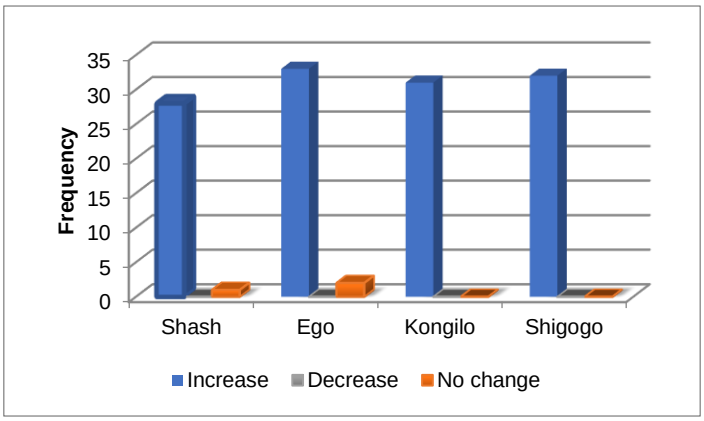


Figure 7. Farmers' perception on temperature variability in Begi district

Respondents were also asked to identify some of variability's in temperature they have observed in the surroundings resulting over the past decades. Accordingly, they responded that some indicators in the environment reported by the respondents as a result of temperature variability and rainfall disturbance over time included the occurrence of newly introduced human and animal disease (58%), drying up of rivers and streams (94%), and damage of crops caused by pests (75%). Participants in focus group discussions and key informant interviews also mentioned declining water availability, biodiversity loss, and land degradation as signs of rising temperatures in the region (Data not shown). The rise in temperature recorded in the meteorological data in this research confirms the alignment between farmers' beliefs and temperature patterns, as stated by Nasir *et al.* (2021). Another research found that small-scale farmers observed a steady decline in annual rainfall and a rise in local mean temperatures. The farmers witnessed significant shifts in both rainfall trends and average temperatures, consistent with the findings gathered from scientific studies (Obert *et al*., 2017). Report indicated that low land area farmers perceived climate change more as lowlands are already hotter in temperature which can be perceived more easily (Deressa *et al.,* 2008).

Farmers' perception by sex on climate change in Begi district, Ethiopia

With regard to farmers' perception, FGD participants, key informants and respondents were asked their understanding of climate change and source of information. 96% of male and 55% of female respondents confirm that there is a climate change in their locality. More than 70% of male and 60% of female respondents have had information on climate change. Approximately 54% of the participants primarily receive information about climate change from the radio. On the other hand, 41% of respondents obtain information from development agents, while 5% receive information from NGOs (Table 4).

Table 4. Farmers' attitude on climate in Begi district.

Questions		Frequency			Percentage (%)		
		Male	Female	Total	Male	Female	Total
Do you think that there is climate change?	Yes	164	23	187	96	55	88
Change in your local area?	No	6	19	25	4	45	12
Are you familiar with the term climate variability before?	Yes	120	25	145	70	60	68
	No	52	17	69	30	40	32
Climate variability before?							
Information source about climate variability?	Radio	92	24	116	50	75	54
	DAs	83	5	88	46	16	41
	NGO	7	3	10	4	9	5

Perception by age group and educational status

In this study, 88% and 93% participants found under age 45-60 (adult) and >60 (aged) understand the existence of climate variability, respectively (Table 5). Amadou *et al.* (2015) claim that seasoned farmers are more aware of climate change. Because adults have more access to knowledge and resources, they should be able to recognize climate change (Deressa *et al.,* 2008). Elders were seen more favorably because of their experience than their education, nevertheless, as the majority of the adults in this investigation were illiterate.

Table 5. Participant's perception of climate change by age and educational status.

No	Was there CC in your locality?	Age category (N=127)				Educational status (N=127)					
		45-60		>60		Illiterate		Read and write		Primary school	
		No	%	No	%	No	%	No	%	No	%
1	Yes, there was	75	88	39	93	35	27	38	30	26	20
2	No,	10	12	3	7	16	13	11	9	1	1
Total		85	100	42	100	51	40	49	39	27	21

CC=climate change

Of the 51 participants who were illiterate, 70% acknowledged the presence of climatic fluctuation. The proportion of individuals who can read and write and who have completed primary school who believed that there is climate fluctuation was 78% and 96%, respectively (Table 5). The findings indicate that the majority of respondents (30%) who did not believe that climate variability exists are illiterate, while the following groups (23%) and (4%), respectively, are capable of reading and writing and having completed basic school. The educational level of farmers has a direct link with the perception to climate variability. Farmers with relatively higher education levels have opportunities to get information from schools, environmental clubs and other sources of information. The level of awareness of farmers in this study was higher than the result reported in Nigeria but similar in that younger farmers with higher education background had better understanding on climate change (Nkwusi *et al*., *2015*). According to a study done in eastern Ethiopia by Tesfaye & Seifu (2016), the majority of farmers there are aware of how climate change affects a variety of factors, including income, food security, biodiversity, forest resources, food prices, and diseases that affect crops and livestock.

Farmers' opinions on the impacts of climate change

Climate variability in rain fall and temperature has influenced livestock, crop production and human health in Begi district and hence livelihood of the people was affected by climate variability due to shortage of water, diseases occurrence, shortage of animal feed, loss of livestock and famine (due to reduced production) (Figure 8). As a result, some portions of the households were exposed to reduction of food crops and widespread of disease. Shortage of forage affected their livestock. A report by Dejene (2011) indicated in Tigray, both male and female respondents identified drought as the main climate-related threat. It is happening frequently and has a significant impact on their means of living. The absence of advanced early warning systems, a rigid agricultural calendar, and limited crop options have further increased the farmers' susceptibility. The authors further suggested that it is important to improve weather predictions and share climate data, develop crops that can withstand drought, and promote on-farm adaptation methods like using irrigation technology and adjusting planting schedules to increase community adaptability to climate change. According to Shrestha *et al*. (2022) study conducted in Nepal, farmers' perceptions of

temperature and rainfall features are at odds with the trends in winter temperature, yearly precipitation, and winter precipitation that have been recorded. Furthermore, farmers are experiencing an increasing number of extreme weather occurrences, such as floods, landslides, droughts, and heavy rains. Thus, it may be helpful to combine observations with farmer perspectives when developing mitigation and adaptation strategies for climate change.

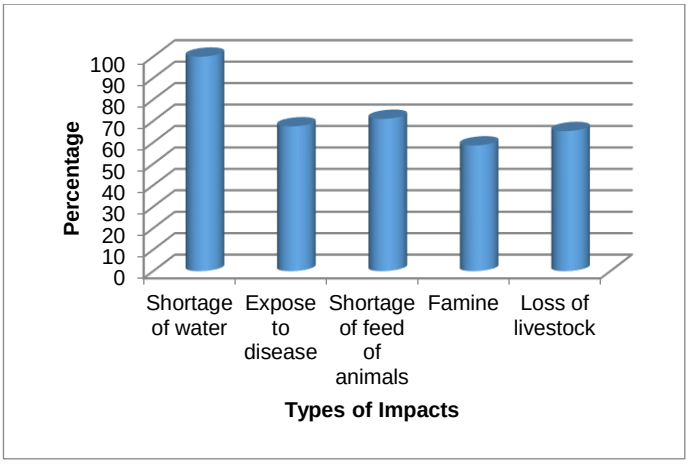


Figure 8. Most commonly mentioned impacts of climate change

Impacts of climate change on natural resources and the environment

The household assessment on the state of environmental resources in the area showed that about 96% and 100% of the respondent households in the study area indicated that the forest cover and water availability have decreased over time, respectively (Table 6). About 92% of the respondents observed increment of problems of soil erosion in Begi district. Generally, 84% of the respondents showed that land degradation is a serious problem of the society now a day (Table 6). FGDs and KII participants also confirmed that some plant species like *Acacia, Ficus* and *Cordia Africana* are highly decreased in number and some wild animal populations decreased from the study area. Based on research carried out by Tesfaye & Seifu (2016) in eastern Ethiopia, it was discovered that the majority of farmers in the area have a good understanding of how climate change affects different areas including income, food security, biodiversity, forest resources, food prices, and diseases in crops and livestock.

Table 6: Household's assessment of the state of environmental resources

Natural resources		Frequency	Percentage
Change in forest cover	Risen in amount	5	4
	Reduced	122	96
	No change	0	0
Soil erosion over time	Risen in amount	117	92
	Reduced	10	8
	No change	0	0
Water availability	Risen in amount	0	0
	Reduced	127	100
	No change	0	0
Land degradation	Risen in amount	107	84
	Reduced	16	13
	No change	4	3

Farmers' adaptation strategies to the effects of climate change

The effects of climate change are now widely acknowledged, with a range of strategies for adaptation and coping being accessible. The study indicated that people in the surveyed region have implemented various measures to lessen the effects of significant climate change. The results indicated that 73.8% of participants engaged in reforestation activities, 64.5% participated in terracing, 79.3% were involved in growing short maturing crops, and 74% diversified their household income (Figure 9). The majority (56.9%) of the respondents preferred borrowing money from relatives and credit institutions for adaptation, while 4% chose migration as an option. Furthermore, when experiencing food shortages, farmers also decreased the size and frequency of their meals, in addition to selling firewood and charcoal. The findings of this study align with the conclusions drawn by Sahu *et al*. (2013), which suggest that the adaptation choices of farmers in Odisha, India are impacted by various factors such as age, education level, family size, farming experience, number of family members involved in agriculture, and annual income. Moreover, farmers in the Odisha region are employing various adaptation strategies in light of climate change, including planting specific crops multiple times, adjusting crop selection, altering planting timelines, and improving irrigation techniques.

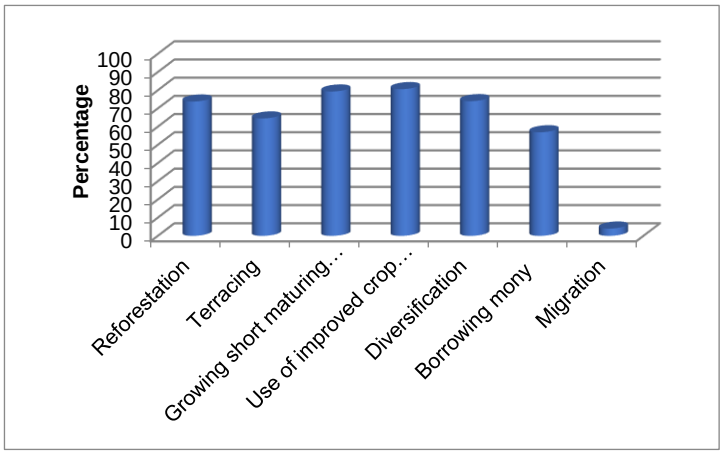


Figure 9. Farmers coping mechanisms to climate change in Begi district, Ethiopia.

In a study conducted by Hermine *et al*. (2019), four categories of farmers were discovered to have varying ways of developing intentions for adaptation and avoidance in relation to climate change. These categories include climate change adaptors, integrative adaptors, cost-benefit calculators, and climate change fatalists. An additional report in the same area of east Ethiopia revealed that various strategies were employed to mitigate the negative impacts of climate change. These strategies included shifting planting dates, cultivating different crops, planting different varieties, conserving water and soil, implementing conservation agriculture practices, and participating in non-farm income generating activities. The number of agricultural plots, the size of the farm, the distance from the market, and the gender of the family head all affect the adaptation tactics that are chosen (Tesfaye & Seifu, 2016). Planning and executing adaptations successfully depend on having a thorough awareness of the risks associated with climate change at different stages of adaptation, as stated by Mahmood *et al*. (2021). Raghuvanshi and Ansari (2016) have demonstrated how important it is to consider farmers' perspectives while attempting to mitigate the adverse effects of climate change on agriculture. They recommended that focused interventions be put into place to improve farmers' and other stakeholders' readiness to deal with the problems brought on by climate change.

CONCLUSION

The study's findings showed that Begi district has experienced variations in rainfall and temperature throughout the previous thirty years. Maximum and minimum temperatures showed small rise, while inter-annual rainfall, total, and seasonal rainfall indicated fluctuations and small decline. The majority of farmers in the research region are aware of how climate change is affecting agricultural productivity and livelihoods. The study also showed that years of farming experience, education level, age, and access to agricultural extension services all had a substantial impact on farmers' opinions about climate change and how to solve it. Afforestation, tracing, growing quick-growing crops, diversifying income sources were the main adaptation tactics used in the area. It has been demonstrated that in order to support farmers' livelihoods, enhance their well-being, and advance sustainable agriculture, better strategies and policies for adapting to climate change are required.

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Data Availability

All data generated are included within the article. Furthermore, datasets are available from the corresponding author upon request.

Conflict of interest

There is no conflict of interest, according to the authors.

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