



Perception of Smallholder Coffee Farmers on Trends of Climate Change and Its Impacts: A Case of Yeki Woreda, South West Ethiopia

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Abstract

This study analyzed the perception of climate change among smallholder coffee farmers in Yeki woreda, southwest Ethiopia. The study used cross-sectional data collected from a randomly selected sample of 307 with a three-stage sampling technique in 2023. Both qualitative and quantitative data from the primary and secondary sources was collected through face-to-face interviews, FGDs, KIIs, and reviewing written and unwritten materials. Descriptive statistics were used to examine the gathered data, producing tables, graphs, means, and percentages. The results indicate that the farmers perceived a considerable change in temperature and precipitation parameters, which has been characterized by rising temperatures and an uneven distribution of rainfall. The rise in pests and diseases, the decline in yield, the falling of flowers and fruits, and the failure of coffee trees were the major climate change impacts on stallholder coffee production.

Keywords: Climate change, Perception, Coffee, *Brassicaceae*, *Fabaceae*

INTRODUCTION

Climate change and associated impacts have been reported to be capable of posing imperative short-term and long-term impacts on crop production and food security (Amare et al., 2017). The impacts of climate change are evident on livelihood of many, especially the rural farmers in Africa who depend on rainfall for crop cultivation with low adaptive capacity (Mcsweeney et al., 2010). Ethiopia's agriculture industry is very susceptible to the impacts of climate change, and even with its substantial economic contribution, it is inherently vulnerable to climate-related disasters like drought and flood (Whitmarsh et al., 2018). This is due to the sectors strong reliance on traditional, rain-fed farming methods with limited capacity of adaptation (Daba A et al., 2023). These make smallholder farmers more susceptible to climatic variability, which in turn impacts the

productivity of agriculture (Woyesa et al., 2021). Smallholder farmers are particularly affected by climate change and variability since they are primarily dependent on rain-fed farming practices and have limited capacity for adaptation (Tadesse et al., 2021).

An understanding of local perceptions and adaptive behavior improves insights and information pertinent to policy that addresses the problem of sustainable agricultural development in the face of unpredictable and changing environments (Albore et al., 2019). Climate change perception is a complex process that encompasses a range of psychological constructs such as knowledge, beliefs, attitudes and concerns about if and how the climate is changing (Denu et al., 2016).

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It is important to know farmers’ views about climate change parameters (including precipitation patterns, droughts, temperature, floods, cyclones, and rainfall), which help to design appropriate adaptation and mitigation strategies (Gebre et al., 2021). A farmer's decision to adapt depends in large part on their capacity to recognize the effects of climate change. Perception is influenced and shaped, among other things, by the individuals’ characteristics, their experience, the information that they receive, and the cultural and geographic context in which they live (Gebremichael et al., 2019). Assessing farmers’ perceptions of climate change and its impacts is imperative to provide guidance to decision-makers in the development of efficient climate change adaptation plans (Geberewold et al., 2023).

Thus, the objectives of the study are to: 1) Assess coffee farmers’ perception of changes in temperature, precipitation, and dry spells and compare their perception with the observed metrological data, 2) Examine the perceived impacts of climate change on coffee. Farmers’ perceptions about hydroclimatic trends and impacts of climate change were gathered through the face to face interview, Focus Group Discussions (FGDs) and Key Informant Discussion (KIIs) (Chanie et al., 2021). The insights gained from this study contribute to advancing our fundamental understanding of the impacts of climate change on coffee production in the study area, which, in turn, could help inform the design of adaptation and mitigation strategies (Mulatu et al., 2019).

MATERIALS AND METHODS

Description of study area

The study was conducted in Yeki woreda, Sheka Zone. It shares borders with the Andracha woreda to the north, the Benchi-Sheko zone to the south, the Kaffa zone to the east, and the Gambella Region to the west. The study area is located between 7°10’0’’ N and 7°20’0’’ N and between 35°20’0’’ E and 35°40’0’’ E in coordinates. It also covers an area of 590.035 km². With a height of 1200 meters above sea level, and has temperatures that range from 36 °C to 15

°C at its lowest point (Difabachew et al., 2022).

Livelihood activities

The majority of residents in the study areas rely on agriculture as their primary source of income. The main income crops are coffee, spices (ginger, turmeric, and black pepper), and maize and sorghum, which are also the area's main yearly staple crops. The potential for fruits, primarily bananas, avocados, and mangos, is well known in the research area.

Data acquisition and analysis

This study employs both qualitative and quantitative data collected from primary and secondary sources through face-to-face interviews, Key Informant Interviews (KII), and Focus Group Discussions (FGD) administered to farmers. For this study, a total of 307 copies of a questionnaire, 10 key informant interviews, and 4 focus group discussions were used. Demographic and socioeconomic data and the perceptions of farmers about climate change and its impacts were collected directly from respondents. Climatic data for 20 years (2000–2020), including rainfall and minimum and maximum temperatures, were sourced from the archive of the Ethiopian Meteorological Institute (EMI). Descriptive statistics were used to examine the gathered data, producing tables, graphs, means, and percentages.

RESULT AND DISCUSSION

Characteristics of the respondents

The survey results for the demographic and socioeconomic characteristics of the respondents are shown in **Table 1**. The results found that the majority of the respondents, 79.80%, were male; the mean age of respondents in the study area was 45.67 years; and the mean year of schooling was 2.73. The mean family size of respondents in adult equivalent was 5.02; the respondents also stated that they had a mean farming experience of 14.98 years.

Table 1. Socioeconomic characteristics of respondents.

Variable	Total sample (N=307)						t-test
	Mean				SD		
Age HH in year	45.67				4.46		4.04***
Education level (year)	2.73				2.06		-7.69***
Family size in AE	5.02				0.87		-8.39***
Farm experience (year)	14.98				3.02		-7.68***
Land holding (ha)	1.58				0.56		-3.16***
	Freq.	%	Freq.	%	Freq.	%	
Sex of household head	Female	39	25.32	23	15.03	62	20.2
	Male	115	74.68	130	84.97	245	79.8

Perception of respondents on trends of climate change in the study area

The smallholder coffee farmers were asked to report the changes in local climate patterns they had observed over the past 20 years (2000–2020) and how these changes influenced their coffee production. Farmers' perception of climate change is considered as an aggregated awareness about the trend of the following three climatic parameters (rainfall, temperature, dry spells) generated from the historical climate records of the research area. During the surveys, farmers were asked whether they had observed any long term changes in temperature and rainfall over the

last 20 years.

Perceptions of respondents on CC and its impacts

Data collected through questionnaire surveys and FGDs indicate that the farmers perceived a considerable change in temperature and precipitation parameters. As per the survey results presented in **Figure 1**, 99.35% of the respondents stated that throughout the past 20 years, there has been climatic change in the research area. Conversely, just 0.65% reported that they have not noticed any change in the environment.

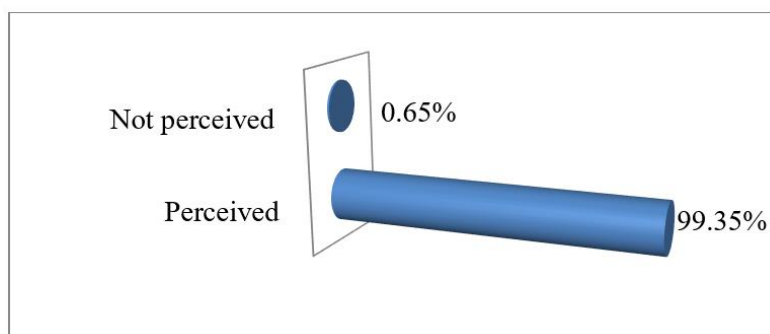


Figure 1. Perception of respondents on occurrence of CC in the last 5-20 years.

Perceptions of respondents on temperature

When the sample HHs were questioned about the perception of changes in temperature in the study area over the last 20 years, the majority, constituting 94% of the total respondents, perceived an increase in temperature, while 4% indicated decrease in temperature and 2%

perceive no change (**Figure 2**). In comparing this perception with the actual trends of the maximum and the minimum temperature recorded during the last 20 years (**Figure 3**), a clear increase was noted, suggesting that farmers' perception in terms of long term changes in temperature was supported by the climatological evidence (**Figure 2**).

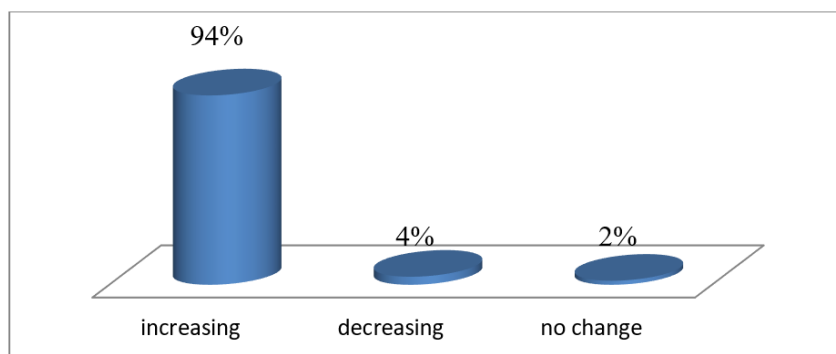


Figure 2. Perception of respondents on temperature in the last 5-20 years.

Perceptions of respondents on rainfall patterns

About 51% of the respondents claimed that the distribution of rainfall in the research area over the last 20 years has been "erratic, while 22%, 15% and 12% of respondents reported that rainfall pattern was increasing, decreasing and no change, respectively (**Figure 3**). The perception

report indicates that there is an uneven distribution of rainfall, a periodic increase in temperature during the dry season, and other factors that are making agricultural activities in general and coffee producers in particular in the study area more difficult.

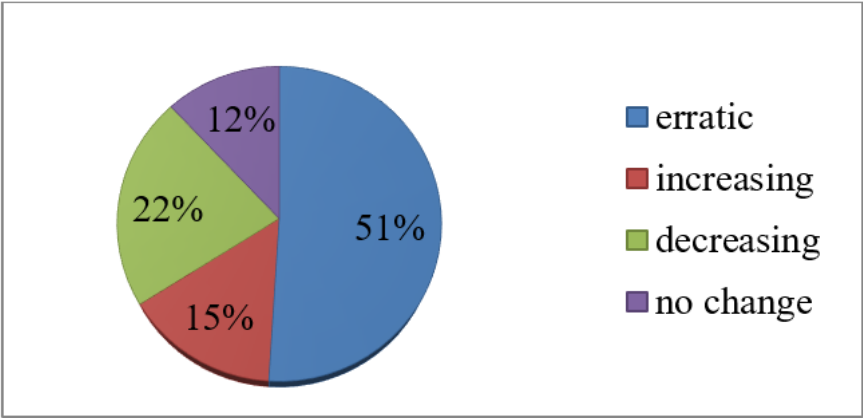


Figure 3. Perception of respondents on rainfall in the last 5-20 years.

Perceptions of respondents on dry spells

About 59% of the respondents indicated that there had been an increase in dry season patterns during the previous

20 years, while roughly 6% and 24% of respondents reported that there was a decrease and no change, respectively, in relation to the study area's (Figure 4).

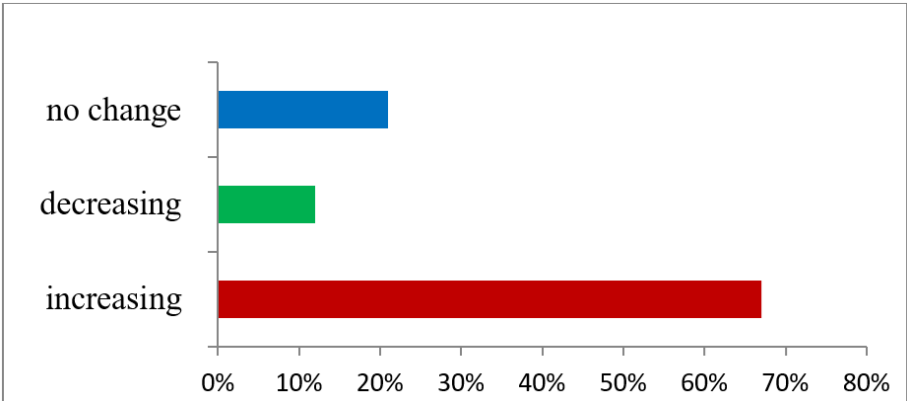


Figure 4. Perception of respondents on dry spells in the last 5-20 years.

Views of participants focus group discussions and key informants

Participants in the Focus Group Discussions (FGDs) in the study area highlighted the occurrence of climate change during the past two decades, which has been characterized by rising temperatures and an uneven distribution of rainfall. According to certain participants in FGDs, the irregular distribution pattern makes it challenging to forecast trends in rainfall. The participants of FGDs that “Rainfall can arrive early and disappear early, arrive late and disappear late, cause flooding, and then dry out for a period”. In general, they claimed that the seasons are erratic and that it is today hard to distinguish between the Kiremit and Belg seasons.

Furthermore, throughout the last 20 years, CC incidents have been reported in the research area by key informants as well. This was demonstrated by altered rainfall patterns, an increase in the highest temperature, extended dry spells from the customary January to April, a reduction in the length of the previous April–August rainfall season, an alteration in humidity levels, and the appearance of new diseases and pests over a two-decade period. In the

research area, there have been observations of rising temperatures, erratic rainfall patterns, and prolonged dry seasons that stretch from December through May.

Metrological data based trend analysis of climate change (2000-2020)

The past 20 years of climate data on trends and variability of precipitation and temperatures in the study area recorded by the Ethiopian Meteorological Institute (EMI) were evaluated in comparison with how farmers perceived these changes. The study area's total annual and seasonal rainfall, as well as the annual and seasonal means of temperature, was tested for linear trends.

Trends of temperature

The statistical record of temperature data of the study area from the Ethiopian Institute of Meteorology between 2000 and 2020 shows an increasing trend. The research area's temperature distribution was typified by yearly variations as well as general patterns of higher temperature. The research area's maximum and minimum yearly

temperatures for the previous 20 years have varied between 26.1°C and 35°C and 9.4°C and 17.9°C, respectively, according to data retrieved from EMI. The study area's yearly average minimum temperatures for the previous 20 years varied from 13.51°C to 16.43°C, while its average maximum temperature varied from 29.36°C to 30.53°C, indicating a high degree of temperature variability. The highest temperature (35°C) and lowest temperature (9.4°C) for the past 20 years (2000–2020) were recorded in 2017, and 2005, respectively. The maximum and minimum

temperatures in the study area increased steadily over the 20 years between 2000 and 2020, as shown in **Figure 3**. In the studied area, the average annual minimum and maximum temperatures in 2000 were 14.75 and 30.55, respectively, whereas in 2019 they were 15.05 and 31.05, respectively. The mean annual maximum and minimum temperatures in the study area have increased by roughly 0.1°C and 0.3°C over the previous 20 years, as shown in **Figure 5**.

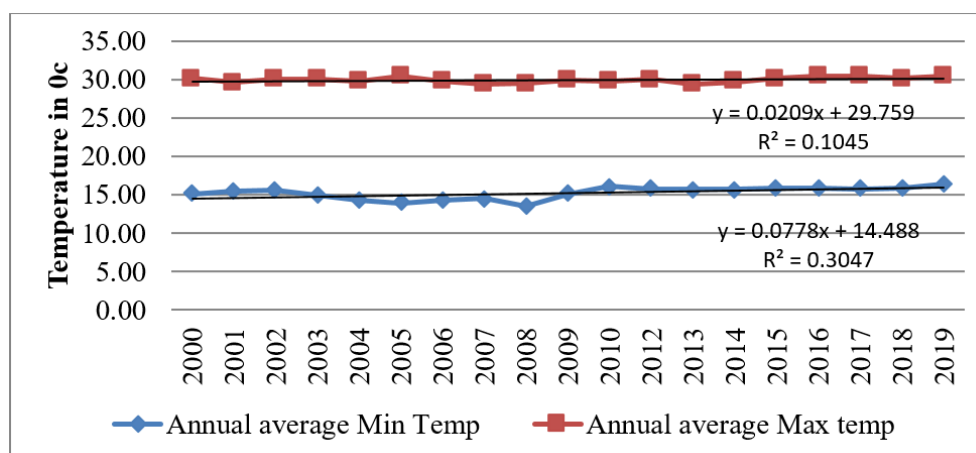


Figure 5. Annual average min and max temperature of the study area (2000–2020).

Trends of rainfall in the study area

The study area saw an annual rainfall of 1127.3 to 2386.7 mm, with a mean of 1488.05 mm, a standard deviation of 270.67 mm, and coefficient of variation 18% (**Table 2**). This suggests that although rainfall varies somewhat, it is not far from high variability. The years with the least and most annual precipitation totals in the region were 2012 and

2008, respectively. The analysis confirms the findings of McSweeney et al., who found that Ethiopia has significant seasonal and yearly rainfall variability. The distribution of yearly rainfall in the research area has shown an irregular trend over the last 20 years, as shown in **Table 2**, and the seasonal and annual rainfall distribution patterns are still unpredictable.

Table 2. Seasonal and annual rainfall distribution of the study area (2000–20200).

Year	Spring	Summer	Autumn	Winter	Annual total
2000	484.3	429.5	473.5	90.6	1477.9
2001	452.3	594.4	353.1	131	1530.8
2002	398.8	459.4	319.2	109.8	1287.2
2003	292.3	521.8	434	107.1	1355.2
2004	438.2	403.3	348.9	156.6	1347
2005	337.1	506.9	318.6	43.3	1205.9
2006	484.1	607.7	481.6	141.1	1714.5
2007	445.4	553.6	357.6	121.3	1477.9
2008	511.9	1170.9	545	158.9	2386.7
2009	549.1	356.7	330	126.7	1362.5
2010	463	512.9	444.1	234.6	1654.6
2012	452.7	105.9	452.9	115.8	1127.3
2013	464.2	546	471.1	116.5	1597.8
2014	318.8	496.8	401.8	70	1287.4

2015	503.4	418.1	505.3	34.2	1461
2016	570.5	489.7	291.5	107.8	1459.5
2017	520.8	502.2	545.5	61.2	1629.7
2018	409.4	352.8	321.4	103.4	1187
2019	320.9	418.4	680.2	248.6	1668.1
2020	403.06	500.97	484.48	123.91	1512.42
Min	292.3	105.9	291.5	34.2	1127.3
Max	570.5	1170.9	680.2	248.6	2386.7
Mean	457.5	498.33	427.99	120.28	1488.05
SD	70.64	192.43	99.7	53.29	270.67
CV %	15	39	23	44	18

Based on the results displayed in the **Table 2**, the average amount of rain that fell during the spring was 457.5 mm, with the highest total amount recorded in 2016 at 570.5 mm and the lowest in 2003 at 292.3 mm. With a standard deviation of 70.64 mm and a coefficient of variation of 15%, it suggests that springtime rainfall varies moderately. The average summer rainfall was 498.33 mm, with the highest total rainfall of 1170.9 mm in 2008 and the lowest of 105.90 mm in 2012. The summer rainfall had a high degree of variability (CV of 39%) and little consistency (SD of 192.43 mm). accordingly, it is challenging to forecast the patterns of rainfall distribution in the research area. Because rain-fed agricultural production systems are the only ones used in the research area, this could have a major negative impact on the cropping systems there.

Perception on the observed impacts of CC on coffee farming

The effects of climate change that have been observed on coffee cultivation over the previous 20 years in the research region were assessed through the use of a survey containing appropriate questions. The survey results displayed in **Table 3** demonstrated the different impacts of CC that have been observed on coffee production in the

study area throughout the course of the preceding 20 years. The main effects that the respondents in the study area noted were the rise in pests and diseases, the decline in yield, the falling of flowers and fruits, and the failure of coffee trees. In response to questions about the occurrence of pests and diseases in coffee farming, 47.23%, 43%, and 9.77% respondents said they were "strongly agreeing," "agreeing," and "ambivalent," respectively. The sample respondents, comprising 49.19%, 43.32%, and 7.49%, expressed strong agreement, agreement, and ambivalence on the decrease in smallholder coffee producing yield. The falling of fruits and flowers was one of the CC-influenced concerns that smallholder coffee growers in the research area had to deal with; 48.86% and 43.97% respondents said they "strongly agreed" and "agreed," respectively. 14.03%, 28.99%, and 57.98% of the respondents said that they "strongly agree," "agree," and "ambivalently" felt about the failure of coffee trees, respectively.

The participants of FGDs talked about their experiences with harvesting and post-harvest losses due to unexpected rain, fruit falling, and difficulty in drying and storing all of which degrade coffee quality. This clearly showed how farmers in the research area are starting to recognize the threat that climate change poses.

Table 3. Perception on adverse impacts CC on coffee farm in the last 5-20 years.

Occurred impacts	Level of perception					
	Strongly agree		Agree		Ambivalent	
	Freq.	%	Freq.	%	Freq.	%
Occurrence of pests and disease	145	47.23	132	43	30	9.77
Decreasing of yield	151	49.19	133	43.32	23	7.49
Falling of flowers and fruits	150	48.86	135	43.97	22	7.17
Failure of coffee trees	40	13.03	89	28.99	178	57.98

Perception on extent of impact of CC on coffee production

An appropriate inquiry was given to the respondents in order to find out if the research area's coffee production was being impacted by CC. According to the survey results

shown in **Table 4**, 50%, 37%, and 13% of respondents reported that the effect of climate change on coffee has been high, medium, and low throughout the previous 20 years.

Table 4. Perception of impacts of CC on coffee in the last 5-20 years.

Perception	Level of perception	Freq.	%	X ²
Extent of impacts on coffee farm	High	154	50	20.97***
	Medium	113	37	
	Low	40	13	

Perception of respondents on sources of information

Regarding the availability of information on CC and CSAPs, the survey report showed that all respondents had access to information from various sources. Table 5 provides a

summary on the sources of information that smallholder farmers used to learn about climate variability and CSAPs. Extension agents were the major source of information for smallholder farmers in the study area, followed by neighbor farmers, radio and television, respectively.

Table 5. Information sources about CC and CSAPs.

Sources information	'Yes' responses on each sources of information (N=307)		Rank
	Freq.	%	
Extension services	290	94.46	1 st
Radio and television	240	78.18	3 rd
Neighbor farmer	263	85.67	2 nd
Local administrations	45	14.66	4 th

CONCLUSIONS

This study analyzed the historical trends of observed temperature and precipitation in Yeki woreda, Southwest Ethiopia. The study compares the farmers' perceptions with the observed temperature and precipitation trends recorded by the Ethiopian Metrological Institute over the past 20 years. Face-to-face surveys, focus group discussions, and key informant interviews were conducted to assess farmers' perceptions about climate change and its impacts on smallholder coffee production. The results indicate that the farmers perceived a considerable change in temperature and precipitation parameters. The results suggest that farmers' perceptions of temperature and precipitation trends approximately coincided with observed trends. The changes in climate parameters (temperature, rainfall, and dry spells) substantially and negatively affected smallholder coffee production.

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