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FULL-LENGTH RESEARCH ARTICLE

Farmers' Perception on Climate Variability and its Effects in Ambassel District, Northern Ethiopia

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Abstract Ethiopia currently faces many critical climate-related challenges that affect the lives and livelihoods of smallholder farmers. It is important to understand how differently situated communities perceive climate variability. This study investigates farmers' perception of historical changes in climate and associated effects on agriculture in Ambassel District, Northern Ethiopia. The study was based on multi-stage sampling techniques to select the study area and 147 sample household respondents. Both primary and secondary data were used for data analysis. Primary data were collected through a household survey, focus group discussion and key informant interviews. The collected data were analyzed using descriptive statistics. We used regression model to determine the relationship between historical climate data and yield for food crops. Chi-square tests were also employed to compare the difference among agro-ecological zones. The results revealed that majority of the farmer's perceived changes in the level of local climate and experienced its effects over two decades. As a result, both crop and livestock production by smallholder farmers have already been adversely affected. The regression analysis revealed significant relationship between rainfall and crop yields, *teff (Eragrostis tef*) and sorghum, which was consistent with perceived impacts of climate variability on crop production. Significant relationship was also observed between maximum temperature and sorghum yield. Therefore, there is a need to introduce water-related interventions such as small-scale irrigation and water harvesting as a drought adaptation strategy.

Keywords Climate Crop · Drought · Effects · Livestock · Perception

Introduction

Climate change and variability are a global concern and the defining challenge of our time. Most of the debates and researches for the last decades have been focused on regional and national assessments of the potential effects of climate changes and variability [20]. Human influences on the Earth's climate are clear, and recent anthropogenic emissions of greenhouse gases are the highest in the history of human civilization with widespread impacts on life and life support systems [21]. The consequence of the long-term changes in precipitation patterns, rainfall variability and the temperature has increased the frequency of droughts and floods in different parts of the world [17, 38]. Climate variability and change impact all economic sectors directly or indirectly to some degree, but agriculture is among the sectors which are most sensitive and inherently vulnerable [28, 35]. Climate-related hazards also exacerbate other stresses, often with negative outcomes for livelihoods, especially for people living in poverty [20].

Africa has been identified as one of the continent's which is most vulnerable to the effects of climate change largely due to their geographic exposure, low income,

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greater reliance on climate-sensitive sectors such as agriculture, and weak capacity to adapt to the changing climate [10, 15, 30]. In developing countries, 26% of the total agricultural damage and loss was due to climate-induced impacts between 2005 and 2015 [17].

Ethiopia can be cited as a good example of a developing country whose economy is highly influenced by climate change, and frequently faces climate-related hazards, commonly drought and floods [11, 27]. The nature-dependent agricultural sector of the economy, mingled with the country's geographical location, topography and low adaptive capacity have made the country highly vulnerable to adverse effects of climate change [27]. Previous studies have shown that climate change in Ethiopia will pose palpable risks to agricultural productivity [2, 8], cropland suitable for cultivation [2, 16], net farm income per hectare [14], agricultural GDP which is likely to reduce Ethiopia's GDP by 10% from its benchmark level food aid and drought expenses [38]. Similarly, increasing temperature and rainfall variability in a different part of Ethiopia were adversely affected agricultural production of rural households [14].

Frequent and severe droughts, floods, increase in temperature, erratic and uneven rainfall, shifts in the onset and cessation of the seasonal rainfalls, and shorter rainy days, water stress and scarcity, increased health risks (malaria, diarrhea, and malnutrition), hailstorm and frost in some areas, increased landslides and soil erosion are the common climate-related shocks which are observed in Ethiopia [3, 29].

Climate change and variability have further worsened the situation of crop yield reduction by increasing moisture stress in the growing seasons of most cereal crops [2, 3]. It has also far-reaching consequences on livestock production mainly arising from its impact on grassland and rangeland productivity. The indirect impact of climate change will be on the water, feed and fodder which are the most important inputs for livestock production [3].

In different parts of Ethiopia, majority of the farmers have perceived changes in rainfall pattern and experienced the effects over two decades [9, 13, 18, 19]. Besides, the majority of farmers in Ethiopia are also aware of climate variability patterns and their adverse effect on income, food security, diversity, forest resources, food prices and crop and livestock diseases [32]. Understanding the local perceptions and adaptive measure provides better insights and information relevant to a policy that helps to address the challenge of sustainable agricultural development in the face of variable and uncertain environments [31].

Many studies have shown that climate variability and change have adverse impacts on the livelihoods of Ethiopians in general, and Amhara region in particular [39]. In South Wollo zone of Ethiopia, climate change and variability are manifested through frequent droughts, floods, erratic rainfall and fluctuating of mean temperature. However, farmers' perception of climate variability and its effect on crop and livestock production is not studied in Ambassel District. Therefore, this study is designed to assess the smallholder farmers' perception of climate change and its effects in their locality.

Methodology

Description of the Study Area

The study was carried out in Ambassel District, South Wollo Zone of Amhara regional state, Ethiopia, from January 2018 to November 2019. Geographically, the study area is located at 11° 44′ 59.99″ N latitude and 39° 14′ 60.00″ E longitude (Fig. 1). The topography of the area is characterized by mountainous, undulating, valley and plain lands. The altitude varies from 1200 to 3627 m above sea level which supports the presence of all agro-ecological zones. The area receives an annual rainfall amount ranging from 500 to 1500 mm. The district has bimodal rainfall patterns, *i.e.*, short rains (Belg) from mid-February to the end of April and long rains (Kiremt) from the end of June and lasts until mid-September. The average yearly minimum and maximum temperatures are 12.5 °C and 22.5 °C, respectively (Ambassel District Office of Early Warning, 2016).

Sampling Techniques

The study follows multi-stage sampling procedures. In the first stage, Ambassel District was selected purposively from the districts of South Wollo Zone due to the occurrence of recurrent drought in the area. In the second stage, the district kebeles, the smallest administrative units, were stratified into strata based on agro-ecological characteristics, i.e., Dega (Highland), Woyina Dega (Mid-land) and Kola (Lowland), and then, three kebeles including Abet, Kollet and Walkit were randomly selected from the three agroecology. The purpose of analysis to agro-ecological differentiation is to investigate how farmers living in different agro-ecologies perceive climate change and variability. Finally, sample households were selected from each kebele randomly. A household list of each selected kebeles was obtained from the administrative records of each kebele. The sample size was determined using the formula proposed by Yemane [34], and a total of 147 households were selected.

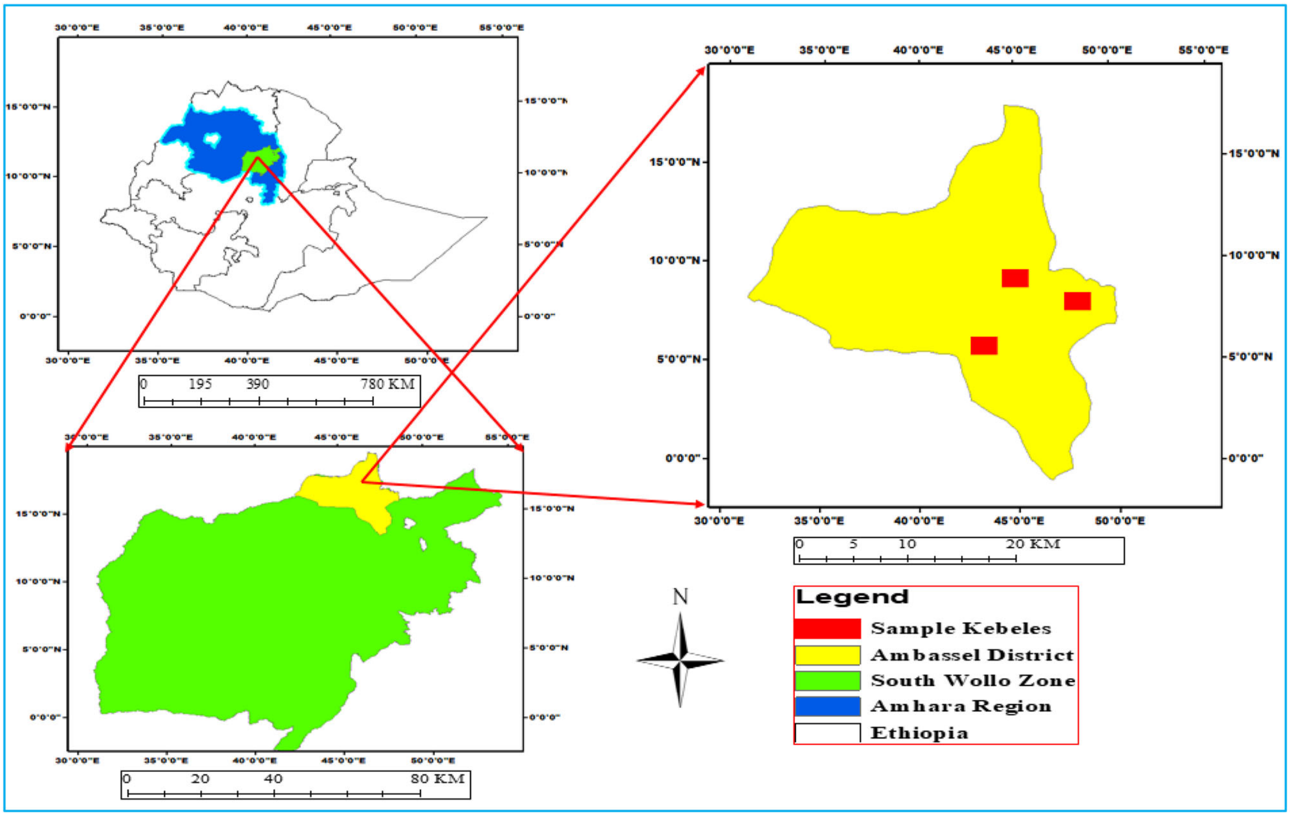

Fig. 1 Map of the study area

Sources and Method of Data Collection

Both primary and secondary sources of data were used. Primary data were collected through a household survey, key informants' interview, focus group discussions and field observations, whereas relevant secondary data were collected from different sources such as published and unpublished books, journals and district and/or kebele reports. Long-term climate data for the periods 1986–2018 from National Meteorological Agency (NMA), Ethiopia and 10 years *teff (Eragrostis tef)*, sorghum, wheat and barley yield data from the district's agricultural office were collected. The purpose of collecting these data was to investigate the effects of climate variability on food crops in the study area and justify the perceived impact of climate change with quantifiable data.

Data Analysis

Data collected from the household survey were analyzed using Statistical Package for Social Sciences (SPSS) version-20, STATA version-14.2 and Microsoft excel v-2010 software's. Also, Chi-square tests were used to compare the difference among agro-ecologies for different socio-economic and demographic variables. This test is mainly employed to know whether the difference is statistically significant or not. In the present study, the effects of climate variability on major food crops were analyzed using multivariate regression model. The dependent variables were crops yield, and independent variables were rainfall, maximum temperature and minimum temperature. We used the anomalies of rainfall and temperature and crop yields to test the relationship between crop yield and climate variability. The relationships were described using the following equation:

$$\Delta Y = \text{Constant} + (\alpha X \Delta RF) + (\beta X \Delta T\text{max}) + (\gamma X \Delta T\,\text{min})$$

where ΔY is the observed change in the crop yield because of rainfall and temperature in the same season as crop growth, and α, $\beta and \gamma$ are the coefficients of rainfall, maximum and minimum temperature in that season, respectively. Similarly,ΔRF, ΔTmax and $\Delta Tmin$ are the observed changes in rainfall and maximum and minimum temperatures of the season, respectively, during the study period.

Results and Discussions

Characteristics of Respondents

From a total of 147 respondents included in the survey, 86.4% (25.2% from lowland, 23.1% from midland and 38.1% from highland) were males and the rest 13.6% (3.4% from lowland, 4.8% from midland and 5.4% from highland) were females. The age of household head ranged from 27 to 81 years old. The findings revealed that the average farm experience of farmers was 27.49 years old with a standard deviation of 11.66 (Table 1). Aged and experienced farmers were able to perceive the local climate condition and had a higher probability to adapt to the changing climate than younger farmers.

The results indicated that about 60.5% of the respondents attended formal education and 39.5% of respondents didn't attend formal education. The levels of literacy across the altitudinal zones revealed that about 17.21% of households in the lowland, 20.76% of households in the midland and 60.02% in the highlands were illiterates (Table 2).

Farmers' Perceptions to Climate Change and Variability

Understanding local people's perception of climatic variation is a crucial for designing appropriate adaptation strategies to climate variability for many poor countries that are highly vulnerable to the effects of climate variability and change [6, 25, 36].

The results indicated that about 95.9% of respondents perceived the change in local climate while 1.4% of households perceived the local climate was not changed in the last two decades. We found that a small portion of respondents (2.7%) didn't have any perception of whether the local climate was changed or not (Table 3). The result was true across each kebeles/agro-ecological zones that revealed a non-statistically significant difference. The result is supported by Nega Debela in Borena, Southern Ethiopia [13]; Fikeremaryam Birara in Southern and Central Tigray [18]; and Mohammed Gedefaw in Quara District, Northern Ethiopia [19].

Indicators of Climate Variability and Change in Ambassel District

Indicators of climate change and variability can be assessed mainly in terms of variations in temperature and precipitation [20]. Accordingly, 32.7% of the respondents perceived unpredictable rainfall as an indicator, followed by (27.9%) who responded increase in temperature as the major indicator of change in local climate. The rest (39.6%) complained recurrent droughts, a decrease in water availability, disease and flooding as indicators of climate change and variability in the study area (Fig. 2). This result confirms the findings of previous studies conducted in Eastern Ethiopia, Northwest Ethiopia, Western Oromia and North-west Ethiopia [7, 12, 32, 37]. Moreover, the same types of indicators were mentioned in both agro-ecological zones to perceive the changes in the local climate.

Farmers' Perception of Temperature and Rainfall Changes

A clear understanding of local people's perception of temperature and rainfall pattern is an important element to guide appropriate actions on climate adaptation endeavors. To perceive the change in climate, farmers focus on extreme events relative to the experienced effect on crop and livestock production [21]. The majority of farmers perceived the increasing trend of temperature, many hot days and warm nights from time to time in their localities. Among those who perceived a change, about 94.9% of respondents had perceived that the temperature is increased over the past two decades. On the contrary, only 5.1% of respondents perceived as a decrease in temperature trend and none of the respondents perceived "no change" in temperature at all. Besides, farmers perceived an increase in hot days and warm nights in the study area (Table 4). This is in consistent with scientific claims in Northwest highlands of Ethiopia, Southern and Central Tigray, Eastern Ethiopia, Northwest Ethiopia, Omo-gibe Basin, Western Oromia and Lay Gayint district, Northwestern Ethiopia [7, 12, 18, 32, 33, 37].

According to the information obtained from the focus group discussions (FGDs) and key informant

Table 1 Descriptive statistics showing age, family size and farm experience of farmers in the study area. *Source*: Author's own data collected using household survey

Variables	Min	Max	Mean	Standard deviation
Age	27	81	49.14	11.27
Family size	1	12	4.71	1.50
Farming experience	6	60	27.49	11.66

Table 2 Educational level of sampled households with respect to agro-ecology. *Source*: Author's own data collected using household survey

Educational status	Agro-ecology			Total	%
	Lowland	Midland	Highland		
Illiterates	10	12	36	58	39.5
Read and write	21	7	16	44	29.9
Primary	4	9	8	21	14.3
Elementary	6	11	2	19	12.9
Secondary	0	2	2	4	2.7
College/University	1	0	0	1	0.7
Total	42	41	64	147	100

Table 3 Perceptions of respondents on local climate. *Source*: Authors own survey

Agro-ecology	Local climate		
	Changed (%)	Not changed (%)	I don't know (%)
Lowland	27.9	–	1
Midland	26.5	1	1
Highland	41.5	1	2
Frequency	141	2	4
Percentage (%)	95.9	1.4	2.7

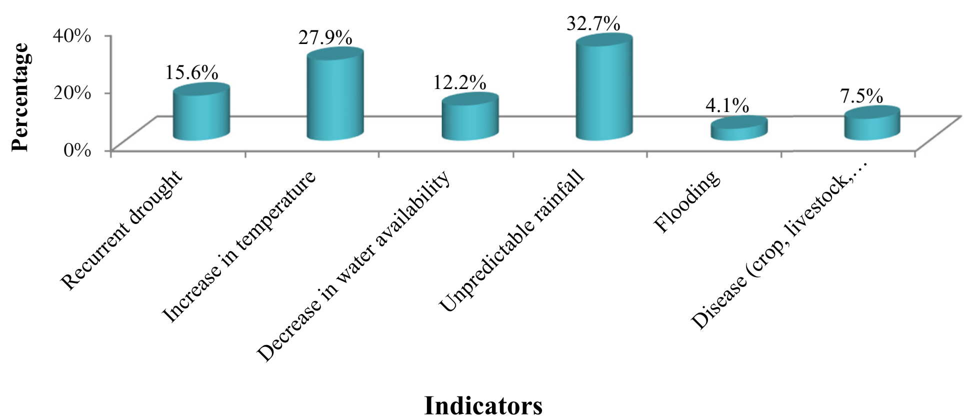

Fig. 2 Perceived indicators by different households to climate change and variability

interviews (KII), participants had observed an increase in temperature and irregular distribution of rainfall during the rainy season. They observed the shortening of the rainy seasons, delayed in rainfall events than they used to do in the past. Also, they observed that the rainfall amount, frequency and distributions had changed. The problem has become more severe since the last decades. Moreover, some of the participants from highland and midland AE claimed an increase in temperature had a positive effect to increase agro-biodiversity and productivity. For instance, maize has been introduced to those areas in recent years, which is favored by the increasing temperature.

Similarly, the majority of the respondents (83.3%) complained that the annual rainfall amount has decreased and this was due to irregular distributions of rainfall, while a few respondents (5.8%) perceived increased in rainfall and other farmers (10.9%) felt that annual rainfall amount was the same as the previous one (Table 4). Similar findings on perception by farmers about rainfall have been reported in different studies conducted in Ethiopia such as in Doba district, Western Ethiopia, Borena, Southern

Table 4 Farmers' perceptions on temperature and rainfall trends in Ambassel District. *Source*: Author's own data collected using household survey

Variables	Increased (%)	Decreased (%)	No change (%)
Temperature trend	94.9	5.1	–
Number of hot days	93.5	2.4	4.1
Number of warm nights	58.8	27.5	13.6
Annual rainfall	5.8	83.3	10.9
Kiremt rainfall	–	95.3	1.7
Belg rainfall	–	98.3	–
	Comes early	Comes late	Comes early or late
Onset of rainfall	–	36.2	63.8
Cessation of rainfall	–	17.1	82.9
Cropping period	1.2	8.3	90.5
N = 147			

Ethiopia, Southern and Central Tigray, Eastern Ethiopia, Western Oromia and Borena, Southern Ethiopia [12, 13, 18, 23, 32]. Moreover, majority of farmers had the opinion to the change in timing of rainfall onset and cessation as becoming more unreliable in their localities. About 36.2% and 17.1% of the farmers perceived the late start and early end of the rainy season, respectively. Also, 90.5% of households perceived the late start of cropping period than normal. This means that they observed a decrease in the length of growing season over the study area.

Perceived Effects of Climate Variability and Change on Smallholder Farmers'

In addition to variability and change in climate parameters, its effects have been perceived by smallholder farmers in Ambassel District. The farmers complained that climate change and variability had caused a prolonged drought that had negative effects on livestock and crop production. This was emphasized by results from key informant interviews, focus group discussions and the household survey. The result showed that 98% of households responded that they were worried about the effects of climate change and variability. Only 2% of the respondents were not concerned about climate change-related risks.

Effects on Crop Production

Climate variability and change are likely to affect crop productivity directly or indirectly through the change in temperature and rainfall patterns. Reduced and irregular distribution of rainfall caused poor survival of seedlings, the prevalence of the disease, and shift in crop sowing and harvesting times, and reduced availability of water [10]. These effects of climate change can directly influence the performance of the agricultural economy on which the local farmers depend to sustain their life. The dominant crops for the communities of Ambassel District are teff, wheat, barley, lentil, sorghum, beans, small millet, chickpea, vetch, maize and peas. However, crop yields in the study area have been declining due to climate change and land degradation. Notably, 98.6% of the respondents indicated that climate change and variability brought a reduction in crop yields. Respondents complained that *sorghum and teff* (*Eragrostis tef*) were the most affected crops in the study area. However, only 1.4% of the households had not observed any change in crop yield reduction. The result is the same across all agro-ecological zones (Table 5). In the middle and lowland kebeles, the farmers complained that a reduction in annual crop production was highly associated with drought and delay in the onset of rainfall. This result corroborates with a study conducted in Kenya which indicated that the effect of climate change on crop production was due to the change in the season of crop planting dates and length of the growing season [26]. Moreover, the result was in line with a study conducted in Ethiopia which indicated a decline in crop productivity due to rainfall reduction in Eastern Ethiopia, Central Rift Valley Ethiopia and Western Oromia [1, 12, 32].

> FGDs and KII from lowland also confirmed 'a progressive decline in productivity of major crops such as sorghum and teff (*Eragrostis tef*) over the last two decades. The change in patterns of rainfall forced them to change the cropping date. The growing season became shorter than before. Even, nowadays the late onset of Kiremt rainfall becomes more frequent. Besides, they faced less rainfall at the growing period, which caused a decline in crop productivity.

Table 5 Farmer's responses on the effects of climate variability on crop production

Agro-ecology	Crop production		
	Decreased (%)	Increased (%)	No change (%)
Lowland	27.9	–	0.7
Midland	27.9	–	–
Highland	42.8	–	0.7
Frequency	145	–	2
Percentage (%)	98.6	–	1.4

Most of the time, they faced a strong and excess rainfalls during harvesting which resulted in damaging of crops commonly teff.

In addition, 36.7% of farmers perceived drought as the main cause of the decreasing in crop production. Besides, soil erosion (29.5%), continuous cultivation (23.4%) and not using crop rotation systems (10.4%) were also the causes for crop yield reduction. This result was in line with a study carried out in the Nile Basin of Ethiopia which indicated that crop yield declined as a result of climate shocks such as drought [14]. A similar study was also done by carried out by Kim et al. [22], who reported that drought and soil erosion were the major challenges for crop production in the central rift valley of Ethiopia.

Major Crops Yield in Ambassel District

In this study, major crops yield data were gathered from District Office of Agriculture for the period 2011–2020 to support the perceived impacts of climate change on crop production with quantifiable data. It was observed that teff has the lowest mean yield of 17.18 quintals per hectare while wheat has the highest mean yield of 25.48 quintals per hectare for the district (Table 6). The maximum yields (in quintal per hectare) for teff (22.59), sorghum (20.65), barley (24.91) and wheat (32.45) were recorded in different years while the minimum values for teff (12.24), sorghum (11.97), barley (11.74) and wheat (20.38) were recorded in the period 2011 to 2020.

Crops Yield Changes Due to Climate Variability Trends

The multi-linear regression analysis findings are presented in Table 7 for teff and sorghum crops. The model describes that the variations in the crop yields due to changes in climate ranged from 45% (0.45) in the case of teff to 52% (0.52) in the case of sorghum. The regression results reveal strong significant relationship between climate variables (rainfall and temperatures) and crop yields. The coefficients sign shows the direction of rainfall and temperatures changes versus the changes in the crops yield. Around 45% of the variation in teff yield was explained by changes in climate variables, whereas in the case of sorghum yield, changes in rainfall and temperatures account for 52% of the yield changes. In the present study, significant relationships were not observed between climate variables trend and barley and wheat crops yield.

The findings revealed that a unit decrease in rainfall during the summer season decreases teff yield by 2.481quintal (*q*) per hectare (ha) holding other variables constant (Table 7). Similarly, significant relationship was observed between sorghum yield and rainfall during the summer and spring season. A decrease in rainfall by 1 mm during the summer and spring season decreases sorghum yield by 2.082q/ha and 2.526q/ha, respectively. The coefficient for maximum temperature during the summer season (− 1.07) implies maximum temperature has negative and significant relationship with sorghum yield. The results signify that an increase in maximum temperature by 1 °C in the summer season decreases sorghum yield by 1.07q/ha.

Effects on Livestock

The availability of pasture and water for livestock is determined by seasonal availability of rainfall [4, 5]. The change in climatic factors such as increasing temperature and recurrent droughts directly affected livestock production. In both agro-ecological zones, about 96.6% of respondents indicated that the number of animals per household was decreased where as 0.7% and 2.7% of respondent's perceived increase and no change in livestock production, respectively (Table 8). All the households in the lowland agro-ecology perceived a decline of livestock

Table 6 Descriptive statistics of major crop yield for Ambassel District from 2011 to 2020

Crop type	Minimum	Maximum	Mean	Std. Deviation
Teff	12.24	22.59	17.18	2.73
Sorghum	11.97	20.65	18.18	8.78
Barely	11.74	24.91	22.25	3.35
Wheat	20.38	32.45	25.48	3.78

Table 7 Regression analysis for summer and spring season's climate variables with teff and sorghum yield

Crop		RF_S	Tmax_S	Tmin_S	RF_SP	Tmax_SP	Tmin_SP	R2
Teff	Coeff	− 2.481	− 0.018	− 0.148	− 3.010	− 2.78	− 1.46	0.45
	p-value	0.002*	0.86	0.16	0.001*	0.23	0.35	
Sorghum	Coeff	− 2.082	− 1.07	− 0.27	− 2.52	− 2.12	− 0.35	0.52
	p-value	0.011*	0.003*	0.094	0.006*	0.94	0.09	

Coeff. coefficient, *RF* rainfall, *Tmax* maximum temperature, *Tmin* minimum temperature, *S* summer, *SP* Spring,
*Significant at 5% level

production and productivity due to recurrent drought and shortage of feed. Climate variability and change affected the productive and reproductive performances of livestock and consequently their population growth through its effects on the quantity and quality of pastures and water availability in addition to increasing heat stresses. The households complained that cattle were the most affected species due to degradation of grasslands. Recently, grasslands have been degraded and replaced by bushes due to prolonged and recurrent droughts and mismanagement by the communities as reported by local respondents. Goats and sheep have been relatively surviving on browsing trees and bushes. This is consistent with [4, 37] who showed a decline in livestock assets due to climate extreme events. Besides, the result is in harmony with [5, 13, 32] who found a decrease in the number of livestock due to climate variability and change in Arba Minch District, Southern and Eastern Ethiopia.

Furthermore, 44.2% of the respondents perceived a shortage of pasture/feed as the primary constraints for livestock production followed by a shortage of water (27.9%) and livestock disease (24.5%). Reduction in feed and water in quantity and quality, and animal disease outbreaks were major challenges of livestock production in the study area. The result agrees with a study conducted in pastoral area of Borana, Ethiopia [24, 40].

> Results obtained from FGDs revealed that feed and water scarcity associated with frequent droughts were the main critical challenges for livestock productions and forced the local people to sell their livestock at unreasonable price. In addition, milk production has been declined as compared with the previous two decades due to the occurrence of frequent drought. Informants complained that cattle were more affected by climate change and variability.

Effects on Water Availability

The survey results revealed that the majority of respondents (82.3%) perceived a decrease in water availability and the remaining (17.7%) perceived no change. This implied that most of the households in the study area were suffering from a shortage of water. Besides, the majority of the respondents get pipe line water access in the last five years. However, the amount discharged has been decreasing.

In line to survey data, participants of KII and FGDs in the each agro-ecological zone unanimously agreed that "even if they get water from pipe lines for drinking, the amount of water in the rivers is decreasing from year to year and some springs are drying up. Household members, mainly women and children, travel long distances (> 10 km) to fetch water for livestock and household consumption. In addition to this, members of FGD from lowland AE clarified that previously, the months of April, May and June were the periods when the local people suffered from water shortage. However, recently, the problem of water scarcity had been expanded to December,

Table 8 Farmers' response on the effects of climate variability on livestock production. *Source*: Authors own survey, 2019

Agro-ecology	Livestock production		
	Increased (%)	Decreased (%)	No change (%)
Lowland	–	28.6	–
Midland	–	27.2	0.7
Highland	0.7	40.8	2
Frequency	1	142	4
Percentage (%)	0.7	96.6	2.7

January and February and become more severe in the last five years."

Conclusion and Recommendation

In this study, the results showed that the majority of farmers perceived the change in climate for two decades. The respondents were aware of the decline in seasonal and annual rainfall amounts, the change in rainfall onset and cessation and an increase in temperature across agro-ecological zones. Moreover, farmers were also encountered the effects of climate change and variability on agricultural productivity over decades. As a result, both livestock and crop production by smallholder farmers have already been adversely affected due to recurrent drought, decrease in rainfall amount, the change in growing period and occurrence of flooding which were considered as the major indicators to the change in local climate.

The study implied that rainfall patterns had become highly variable and frequency of drought has been increased that adversely affected livelihood of farmers. Therefore, local decision makers should develop adaptation strategies to the local people to adapt climate change and variability. There should be an effort to introduce water-related interventions such as small-scale irrigation and water harvesting during a good rainy season as a drought adaptation strategy. Farmers should be provided with drought and disease-tolerant crop varieties, livestock breeds and early maturing crops to enhance climate resilience of farmers. Enhance farmers understanding of climate change for taking advantages of any opportunities it offers. It is also important to enhance farmer's participation in soil and water conservation practices. However, further research is needed to understand, irrigation potential of the area and costs associated with irrigation practices. In addition, enhancing farmers understanding of climate change and variability is crucial for taking advantages of any opportunities it offers.

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Author contributions FD designed the data collection tools, undertook fieldwork and most of the analysis, and developed the manuscript. MM reviewed and advised the research proposal development and writing-up of findings and made editorial comments on the draft manuscript.

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Declarations

Conflict of interest The authors declare that they have no competing interests.

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