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Perceptions of Pastoralists about Climate Change in Ethiopia: A Case Study of Saba Boru District

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***Abstract*:** This study was conducted in the Saba Boru district of the Guji zone in Ethiopia's Oromia regional state. A long-term alteration in a nation's or region's climatic tendencies is referred to as climate change. Agriculture accounts for roughly 47 percent of Ethiopia's GDP, and more than 85 million people rely on agriculture for a living, either directly or indirectly. This study examined local pastoralists' perceptions of climate change and related problems and is based on primary data collected from 821 households of 12 kebeles of the Saba Boru district. The collected data have been analyzed via descriptive and inferential statistics evaluate the results. There is increased annual temperature from 20.6 °C to 21.28 °C, large variance in annual rainfall from 758.23 to 2.32 mm, and higher change in annual solar radiation from -99 °C to 18.33 °C during 1981 to 2019 are the evidence of climate change. More than 81 percent of respondents agreed that higher rainfall and changes in rainfall patterns were the shreds of evidence of climate change, while 78.1 percent agreed that greater drought was a sign of climate change. Although 79.3 percent of respondents agreed to an increase in temperature and high sunlight intensity as observed evidence of climate change, 15.2 percent disagreed. Similarly, 41.3 percent of respondents disagreed on the low fertility of most soils as observed signals of climate change, while 53.4 percent agreed. The study demonstrates that respondents in the communities examined are aware of climate change, but with variable levels of agreement.

Keywords: Climate Change, Perception, Pastoralists, Variance, and Saba Boru district

Climate change is one of the world's most critical environmental challenges. The Intergovernmental Panel on Climate Change projects a global mean temperature increase of 1.1°C to 6.4°C of 2100, which is likely to cause storms and floods, and as the oceans expand thermally and ice sheets and glaciers melt, sea levels rise (Lemmen et al 2008). Climate change is predicted to have a significant influence on dry and semi-arid rangelands, which comprise approximately two-thirds of the African continent (Galvin et al 2001). Many of the impacts of climate change in these areas are characterized by variability in rainfall patterns and extreme weather events such as recurring droughts, floods and windstorms (IPCC 2013). These places, such as Sub-Saharan Africa, are home to an estimated 386 million people, including pastorals who rely on natural resources for a living (Conway 2009, IPCC 2015, Thornton et al 2007 and Adhikari et al 2015). Agricultural production activities in Africa, on the other hand, are more vulnerable to climate change than any other social-economic activities (Bonatti 2016, Elum et al 2017). It is predicted that agricultural production in African will be decreased by 8 to 22% by 2050 (Schlenkerand and Lobell 2010). The repeated dry seasons have been seen over the last thirty years, as well as the continued consequences of El Nio in East African nations in general, and Ethiopia in particular, has resulted in a huge number of people being food insecure as a result of climate change. Ethiopia's agricultural industry is vulnerable to the effects of climate change because the country's livelihood is mostly built on rain-fed agriculture (Burnett 2013, ISET 2013).

Ethiopia is experiencing an increase in the warming trend of annual temperatures as well as the severity of droughts. The country's annual temperature has risen by 0.37 degrees Celsius every ten years over the last 55 years (Tadege 2007, Mcsweeney et al 2010). Ethiopia is one of Africa's most vulnerable nations to climate change and unpredictability, and it is regularly confronted with climate-related hazards that threaten people's lives and livelihoods (World Bank 2010, Burnett 2013, ISET 2013). Climate change elements such as drought, flood, and soil degradation are among the key contributors to Ethiopia's low agricultural production (Asrat and Simane 2017c, Yirga 2007). These factors, combined with a heavy reliance on traditional farming techniques and improper complementary services (such as extension, credit, marketing, etc.), reduce smallholder pastorals' adaptive capacity or increase their vulnerability to climate change, affecting the already poor agricultural performance (Asrat and Simane 2017d).

The region's ecosystem is fragile, with a growing trend of

natural resource degradation, and rainfall patterns and distribution have changed and become unpredictable (Nega et al 2015). One of Ethiopia's pastoral areas is the Saba Boru district, Guji zone, and the Oromia region. The federal and regional governments, as well as humanitarian groups, are concerned about the study area's recurring drought and severe food insecurity. The area's pastoral livelihood system is sensitive to the negative effects of climate change (Fratkin 2014) since their livelihood is reliant on fundamental natural resources such as water and pastures. Pastoralists have continued to struggle for generations to adapt to climate change. However, due to the growing tendencies of recurring droughts and high rainfall variability, as well as the existing weak socioeconomic conditions, pastoralists have become low adaptable to climate change and variability (Ayal and Leal 2017).

Pastoral communities, on the other hand, have indigenous knowledge of their environment and have implemented a variety of adaptation strategies to deal with climate-related risks and environmental stresses (Egeru 2012). Such adaptation strategies have significant cultural and religious dimensions and implications, but their applicability and effectiveness may be limited due to societal values, processes, and power dynamics (Lorenzoni et al 2009). According to studies, understanding local climatic knowledge can be very valuable for major decision-making processes (Beatrice et al 2009). Traditional knowledge may offer new insights for strengthening current scientific understanding as well as a foundation for developing suitable research and development policies. Furthermore, the potential value of local practices, increasing socio-ecological resilience has been underappreciated, notably in Ethiopia's pastoral production system, including the Guji pastoral and agro-pastoral areas. However, in recent years, significant climatic occurrences (e.g., recurring drought and fluctuation in rainfall) have contributed to food insecurity, poverty, and exacerbated the area's existing susceptibility (Abate 2016).

Ethiopia is among the most underprivileged African countries to climate change. Whether directly or indirectly, pastoralists reliant on natural resources face threats from climate change impacts such as water scarcity, changing rainfall and drought patterns, increased desertification and bush encroachment in rangelands, expansions of human and livestock diseases, and exacerbated conflicts due to competition for resources, primarily water. Even though pastoral communities are preserving and surviving their lives through knowledge-based adaptation strategies, most academics do not consider pastoralists' Indigenous Knowledge to be a foundation of scientific knowledge in every aspect. Similarly, in Ethiopia, the government's pastoral area policies are insufficient in light of the regular occurrence of droughts and the broader effects of climate change (Global Assessment Report 2015). As a result, the policies suggested in various countries were mainly ineffective in resolving pastoral communities' challenges, particularly reducing their vulnerability to climate change consequences (Mengistu and Haji 2015).

Southern Ethiopia, where the Guji Zone is located, and other portions of Ethiopia's Somali area depend on IK aimed at mitigating climate change losses or accelerating recovery (Abarufa 2011). The Guji pastoralists, in particular, who dwell in the Sabba Boru district of the Guji zone, bear the brunt of climate change and face a slew of issues as a result. Even so, they had already adapted to the effects of climate change and reduced their vulnerability through IK-based weather forecasting, pond and well construction and management (water-related practices), hay collection and storage for the dry season, seasonal livestock mobility, crop cultivation participation, livestock species diversification and livestock traditional health care systems and are surviving in these extremely difficult environmental conditions in the area. As a result, examining the impact of climate change and pastoral communities' adaptation techniques is critical, and this study is intended to fill some of these gaps and expand its vital role in autonomous adaptation in the local region. The major aim of this study is to assess the perception of local pastoralists' on climate change. The specific objectives are to examine pastoralists' knowledge of climate change and the actions they may take. Investigate the sources of climate change information used by pastoralists and scrutinize pastoralists' perceptions of climate change's effects. Explore the coping strategies used by pastoralists and evaluate the government's efforts to alleviate the effects of climate change.

MATERIAL AND METHODS

Study area: The study was conducted in the Saba Boru district, Guji zone of Ethiopia's Oromia region, which is located between 5°2'47"N-5°46'43"N latitudes and 38°50'2"E-39°15'42"E longitudes, and is 563 kilometers far from the country capital Addis Ababa in the southern part of the Oromia regional state (Fig. 1). The major topography of the Sabba Boru district is rugged and broken, with various hills and ridges varying in elevation from 800 to 1500 meters. The district is divided into two agro-climatic zones: desert (81 Per cent) and semi-arid (19 Per cent). The district's annual temperature ranges from 12.71 °C to 29.6 °C, with an average rainfall of 600 - 1400mm. The rainy season is divided into two parts: March-May (Ganna), which is the long rainy season, and September-October (Hageyya), which is the

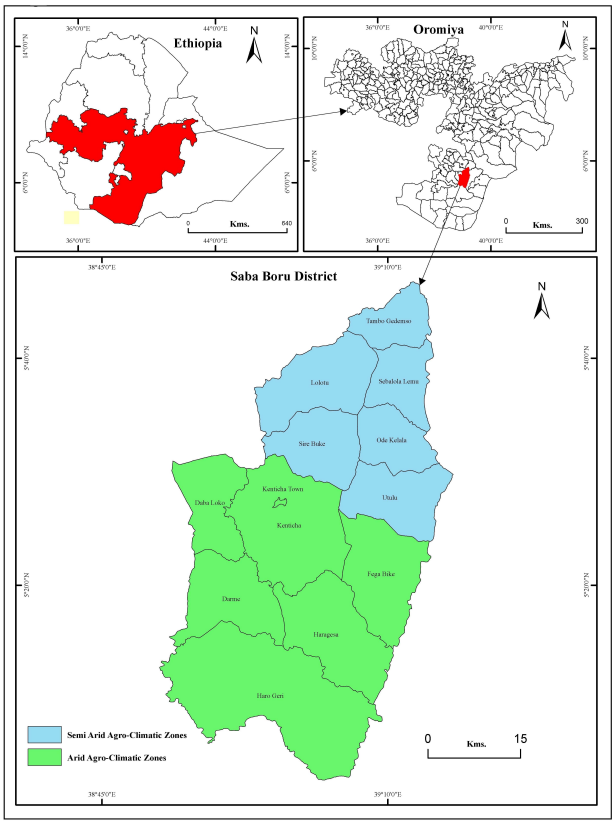

Fig. 1. Study area

short rainy season. The regular tendency of the rainfall pattern was changing. The area contains two soil types, 70 percent sandy soil and 30 percent fertile soil, with a mean annual temperature of 20.61°C. Livestock farming employs 75 percent of the district's population, while sedentary farming and non-farm activities employ the other 25 percent. It is distinguished by subsistence livestock and crop cultivation practices. There are 214,456 cattle, 255,899 goats, 16,733 sheep, 14,621 camels, 46,442 donkeys, 8,056 mules, 284 horses, and 360,581 chickens. The most common crop kinds grown in the study area are maize, teff, haricot bean, and wheat. The area was sparsely inhabited and characterized by a moisture deficit, which resulted in water problems, reducing the area's livestock and crop production potential.

Research Methodology

Design: The district of Saba Boru was selected for this study based on the following criteria (i) pastoral communities' homeland, where livestock is their biggest source of income (ADF 2003) and (ii) comprised primarily of arid/semi-arid lands that have experienced serious climate change variabilities, such as rising drought periods and unpredictable rainfall (Theodory and Malipula 2014). In the Sabba Boru district, there are 12 Kebeles; 6 are categorized as arid agro-climatic zones, while the remaining 6 are categorized as semi-arid agro-climatic zones. Therefore, the major attention was to give equal status to both climatic zones of the district. The district administrators were consulted initially to choose the best representative kebeles based on vulnerability to drought, water scarcity, and representativeness of the livelihood activities. A simple random sampling method was used, as a result, 6 Kebeles were chosen from arid agro-climatic zones and 6 semi-arid agro-climatic zones, and 821 (26.3 percent) households from these kebeles were selected for as a sample size respectively by considering its representativeness in reflecting the realities of pastoralism and agro-pastoralism in the study area. In this study, a mixed research approach was used, with both qualitative and quantitative methods used for primary and secondary data collection. Household surveys, structured questionnaires, Key Informant Interviews (KII), and Focus Group Discussions (FGD) were employed to collect primary data and secondary sources of data were obtained from published and unpublished documents. Preliminary surveys were performed with local enumerators and key informants before the start of the main survey, and the final questionnaire was revised and updated when required. The survey questionnaire was open-ended, dichotomous, and multiple-response in nature, and it was translated into the home's native language. Data on various viewpoints were acquired through household interviews conducted by local field assistants. The collected data were analyzed with descriptive and inferential statistics, and the hypothesis was tested.

Analytical techniques: For analyzing the data, a combination of descriptive statistics (sum, averages, percentages, livelihood component framework, and recommendation matrix), mathematical techniques (percentage perception index and agreement index), and statistical techniques (logistic regression model & Logit model) were used to achieve the goal, objectives and produces the meaningful results. To input the primary data, Microsoft Office Excel 2010® was used, and IBM SPSS Statistics Version 27 was used to analyze the primary data and to develop the map of the study area, ArcGIS version 10.8 software was used.

Livelihood component framework: The livelihood component framework was constructed to measure the impact of production practices on pastoralists' asset possession, activities and strategies, wellbeing, and external policies and institutions (Ashley and Hussein 2000).

Percentage perception index: To quantify pastoralists' perceptions of experiencing climate change, the percentage perception index was used (Dhar and Uddin 2017). Each pastoralist of the research areas was asked to indicate

his/her option regarding each level of change on selected opinions. During the pre-testing of the questionnaire, pastoralists identified a large number of statements but for the simplicity of calculation, the first ten of them were selected based on the highest frequencies. Pastoralists had the option to indicate each statement as 'increase', 'decrease', and 'no change'. To see the percentage of each statement, the following simple percentage formula was used:

Percentage perception index = No. of respondents' opinion about statements (increase, decrease or constant) × 100] ÷Total no. of respondents

Agreement index: The agreement index was used to quantify pastoralists' perceptions about the impacts of natural calamities on their day-to-day life (adopted from Bernhart et al 2007). The index was composed of two divisions: (1) positive impacts of natural calamities; and (2) negative impacts of natural calamities. Each division of the index included 10 statements based on questionnaire pre-testing and secondary literature (Nyuor et al. 2016; Alam et al. 2017; Zoundji et al. 2017). The authors found plenty of statements in this case also but kept the first ten statements for each division based the on highest frequencies. Each division of the index included 10 statements.

Logit model: To identify the factors influencing changing climate change decisions by the pastoralists, the logistic regression model (i.e., Logit model) was used (Gujarati 2003). The model was constructed individually for each study area to get specific and meaningful estimates. The independent variables included in the analysis were not the same in all the models as major determining factors varied in each study area based on pastoralists' socioeconomic characteristics, geographical state, and agricultural systems (Daskalakis et al 2002). The major determining factors in each study area were identified through personal interviews, FGDs and KIIs.

Assessment of pastoralists' livelihood: To analyze the livelihood outcome of the pastoralists after changing climate change decisions, a sustainable livelihood framework was approached (DFID 1999). The approach identified and measured five types of livelihood assets or capitals which were: human capital, social capital, financial capital, natural capital, and physical capital.

Recommendation matrix: Suggestions and policy recommendations were presented by the researchers in the form of a recommendation matrix (Dhar et al 2018b) for improving pastoralists living standards through adopting the best decision.

Statistical analysis: One-way analysis of variance is commonly used to determine the significance of differences between and within variables and, on the other hand, is used to test the statistical significance of the variables.

F=MSTMSE (2)

MST = Σki = 1(ti/nu)-G2/nk-1 (3)

MSE= Σki = 1 Σkj = 1Y2ij- Σki = 1(ti/ni)k-1 (4)

There F is the variance ratio for the overall test, MST is the mean square due to treatments/groups (between groups), MSE is the mean square due to error (within groups, residual mean square), Yij is an observation, Ti is a group total, G is the grand total of all observations, ni is the number in group i and n is the total number of observations. In this research study, One way ANOVA analysis was performed.

RESULTS AND DISCUSSION

Climate variations from 1981 to 2019: Increased annual temperature 20.6°C to 21.28°C, large variance in annual rainfall 758.23 to 2.32 mm, little change in annual relative humidity 60.95 to 60.19 percent, and higher change in annual solar radiation -99°C to 18.33°C are evidence of climate change from 1981 to 2019 (Table 1). P-value is 0.00000 at p≤0.05. As a result of this, the climate change variability hypothesis has acquired significant scientific acceptance.

Pastoralists' knowledge of climate change: The 81.2 percent of respondents agreed that higher rainfall and changes in rainfall patterns were evidence of climate change, while 78.1 percent agreed that greater drought was a sign of climate change. Although 79.3 percent of respondents agreed on an increase in temperature and high sunlight intensity as observed evidence of climate change, 41.3 percent disagreed on the low fertility of most soils as observed signals of climate change, while 53.4 percent agreed. It demonstrates that respondents in the communities examined are aware of climate change, but with variable levels of agreement. The P-value is 0.00003 at p≤0.05. As a result, the hypothesis that Pastoralists' awareness of climate change varies significantly in the study area is accepted. The findings demonstrate that individual Pastoralists have various degrees of understanding regarding climate change.

Source of information about climate change: Pastoralists in the study area have five major sources of information on climate change as 87.1% of the respondents obtain information through radio, 74.8% through natural experience, and 58.2% through television. However, 33.6% of the respondents were undecided about obtaining information from extension personnel compared to 41.3% who agreed while 51.5% of the respondents were also undecided about obtaining information on climate change from the newspaper as against 15.6% who agreed. It reveals that the major sources of information on climate change available to pastoralists are radio, natural experience, and

Table 1. Study area's average annual temperature, precipitation, relative humidity, and solar radiation (1981 to 2019)

Year	Annual temperature (°c)	Annual perception (mm)	Annual relative humidity (%)	Annual solar radiation (°c)	Variance
1981	20.06	758.23	60.95	-99	0.17°c annual temperature
1982	19.94	824.73	63.07	-99	
1983	20.33	690.42	59.83	19.34	
1984	20.66	391.39	51.37	21.61	42031.59 mm annual precipitation
1985	19.87	645.44	59.51	20.65	
1986	19.92	774.84	59.52	20.59	
1987	20.41	737.18	59.64	21.05	
1988	20.27	855.61	60.77	19.98	9.72 (%) annual relative humidity
1989	19.82	795.66	62.29	19.79	
1990	20.3	695.86	61.01	20.01	
1991	20.79	559.31	56.48	20.54	
1992	20.6	553.14	57.58	20.44	706.04°c annual solar radiation
1993	20.24	594.02	58.13	20.74	
1994	20.67	613.84	56.39	21.15	
1995	20.42	702.33	60.65	20.07	
1996	20.21	733.86	61.09	19.77	
1997	20.25	997.68	64.12	20.43	
1998	20.58	649.58	61.39	19.14	
1999	20.65	469.7	54.67	20.11	
2000	20.96	379.19	51.65	20.64	
2001	20.88	523.86	56.71	20.21	
2002	21.07	555.76	57.71	19.53	
2003	21.13	485.41	56.21	20.26	
2004	21.29	401.64	55.39	20.06	
2005	20.96	538.92	55.79	20.15	
2006	20.57	805.12	62.23	19.49	
2007	20.71	681.23	59.03	20.22	
2008	20.66	586.78	55.68	19.58	
2009	21.21	517.86	56.44	19.62	
2010	20.74	675.69	60.07	18.7	
2011	21.17	525.74	55.63	19.74	
2012	20.53	729.14	59.64	19.75	
2013	20.13	927.36	64.7	18.58	
2014	20.77	690.22	60.21	18.88	
2015	20.95	833.83	59.65	20.22	
2016	20.84	721.99	59.92	19.36	
2017	20.84	759.16	57.27	18.31	
2018	20.21	2.54	64.04	17.52	
2019	21.28	2.32	60.19	18.33	

Source: https://power.larc.nasa.gov/data-access-viewer/

television. On the other hand, very few respondents obtain information through newspaper and extension personnel which indicates the dearth of training sessions on climate change in the study area. The P-value is 0.03720 at p≤0.05. Therefore, the hypothesis which states that there is a significant variation in pastoralists' sources of information on climate change is accepted. It, therefore, means that pastoralists in the study area do not get information on climate change from a singular source. This is true given that there are various sources of information on a particular issue and most importantly where there are various media and other sources where information can be obtained.

Pastoralists perception of effects of climate change: The 75.6 % of the respondents perceived the effects of climate change as an increase in rainfall, 69.6 % as a decrease in agricultural output, 65.1% as an increase in the cost of food crops, 45.5% as a decrease in rainfall. However, 47.6% disagreed with to decline in the availability of forest resources as an effect due to climate change while 32.6% agreed while 19.8 % of the respondents are undecided about the increase in daily temperature as an effect of climate change. 69.6 % of the respondents perceived that climate change has led to a decrease in agricultural output and is a very significant factor that increases the cost of food crops generally as agreed by 65.1% of the respondents. Furthermore, 41.8 and 38.6% of the respondents also agreed that there had been an increase in drought and flood respectively which are serious contributing problems associated with climate change that threatened the livelihood of pastoralists in the study area. P-value is 0.00007 at p≤0.05. Thus, the hypothesis which states that pastoralists' perception of climate change varies significantly in the study area is accepted. The result confirms the fact that individual pastoralists feel the effect of climate change differently hence, the variation in their perception of effects.

Pastoralists' coping strategies of climate change: The 78.9% of the respondents used supplementary irrigation, 75.4% adopted planting of different varieties of crops probably because the different varieties of crops have different levels of tolerance for adverse effects of climate change and so would not result in a complete loss on the part of the pastoralists. 73.9% of the respondents adopted the application of fertilizers to improve and enhance crop yield, 71.1% of the respondents engaged in changing cropping patterns because changing crop patterns guides against crop infestation and disease attack. 65.5% of the respondents adopted new farming techniques while 28.2% disagreed with the shading of young plants as a coping

Table 3. Pastoralists source of information on climate change

Source of information	Agree (%)	Disagree (%)	Undecided (%)	P-value p≤0.05
Radio	87.1	7.4	5.5	0.03720
Newspaper	15.6	32.9	51.5	
Television	58.2	26.2	15.6	
Extension personnel	41.3	25.1	33.6	
Through natural experience	74.8	14.1	11.1	

Table 2. Pastoralists' knowledge about climate change

Knowledge of climate change	Agree (%)	Disagree (%)	Undecided (%)	P-value p≤0.05
Increase in temperature and high sunshine intensity	79.3	15.2	5.5	0.00003
Increased rainfall and change in rainfall pattern	81.2	11.7	7.1	
Increased drought	78.1	14.4	7.5	
Poor fertility of most soils	53.4	41.3	5.3	

Table 4. Pastoralists perception of effects of climate change

Perception of effects	Agree (%)	Disagree (%)	Undecided (%)
Increase in rainfall	75.6	8.9	15.5
Decrease in rainfall	45.4	33.2	21.4
Due to climate change, there is increased spread in agricultural pests, diseases, and weeds on farmland	37.5	36.2	26.3
Climate change has led to a decline in the availability of forest resources	32.6	47.6	19.8
Decrease in agricultural output due to climate change	69.6	24.8	5.6
Increase in the cost of food crops due to climate change	65.1	26.4	8.5
Climate change has led to an increased rate of erosion and flooding in many places	38.6	39.9	21.5
Increased incidences of drought during the dry season due to climate change	41.8	32.4	25.8
Increase in daily temperature	41.2	30.5	28.3

Table 5. Pastoralists' coping strategies of climate change

Coping strategies	Agree (%)	Disagree (%)	Undecided (%)
Planting of different varieties of crops	75.4	9.9	14.7
Changing cropping pattern	71.1	13.4	15.5
Using supplementary irrigation	78.9	17.6	3.5
Application of fertilizers to improve and enhance crop yield	73.9	17.6	8.5
Mulching of crop plants	57.7	14.8	27.5
Shading of young plants	43	28.2	28.8
Adoption of new farming techniques	65.5	21.1	13.4

Table 6. Governmental actions on climate change

Actions are taken by government	Agree (%)	Disagree (%)	Undecided (%)
Provision of weather alert (Radio and television for daily weather forecast and relevance to agricultural activities) to help for effective adaptation	65.1	23.5	11.4
Provision of extension agents to educate more on agriculture and better land management techniques	39.3	43.2	17.5
Adequate access to new technologies	24.8	63.7	11.5
Provision of sufficient current knowledge to adapting measures	33.8	44.4	21.8
Provision of irrigation facilities and investments	31.7	48.6	19.7

Table 7. Things that should be done to mitigate climate change

Things that should be done to mitigate climate change	Frequency	Percentage
Early notification	28	15.9
Insurance	36	25.8
Better Awareness	24	18.5
Teaching new techniques	29	17.2
Provision of technology	24	14.4
Extension agents	18	8.3
Total	159	100.0

strategy and 28.8% of the respondents were undecided about the shading of young plants as a coping strategy. P-value is 0.00000 at p≤0.05. Thus, the hypothesis which states that climate change coping strategies adopted by pastoralists have a significant variation in the study area is accepted.

Governmental actions on climate change: Weather alerts (radio and television for daily weather forecast and relevance to agricultural activities) to help for effective adaptation accounted for 65.1%. Provision of extension agents to educate more on agriculture and better land management techniques accounted for 39.3%, provision of sufficient current knowledge to adapting measures accounted for 33.8% while 63.7% of the respondents disagreed that adequate access to new technologies an action so far taken by the government while 24.8% are agreed. Also, 48.6% of the respondents disagreed on the provision of irrigation facilities and investments as actions taken by the government respectively. 31.7% of the respondents were undecided about the provision of agricultural insurance as governmental action. This indicates that the pastoralists need adequate agricultural insurance and adequate access to new technologies from the government. P-value is 0.00908 at p≤0.05. Thus, the hypothesis which states that governmental Actions on climate change for pastoralists have a significant variation in the study area is accepted.

Things that should be done to mitigate climate change: Insurance accounted for 25.8%, better awareness 18.5%, teaching new techniques accounted for 17.2%, early notification accounted for 15.9%, provision of technology 14.4%, and 8.3% provision of extension agents. This indicates that Government should provide adequate insurance schemes for pastoralists, better awareness and teaching new farming techniques should be adopted by these pastoralists by providing extension agents by the Government. P-value is 0.01612 at p≤0.05. As a result, the hypothesis that things that should be done to mitigate climate change vary significantly, and government need to deliver palatable assurances plans for pastoralists, predominant mindfulness, and educating present-day developing procedures in the study area is accepted.

CONCLUSION

There is a significant statistical variation in respondents' knowledge and sources of information about climate change. The study also through its findings concludes that there is a significant statistical variation in pastoralists' perception of the effects of climate change while there was no statistically

significant variation in the coping strategies adopted by pastoralists. There has been not enough action taken in the study area to help pastoralists mitigate the effects of climate change. Pastoralists in the study area need to adjust to the changing climate trend to save their means of livelihood, as addressing the climate change issues observed in the study will significantly help Pastoralists remain in business. Supporting pastoralists to increase their adaptation capacities through the provision of necessary resources such as credit facilities, information and training can significantly help them increase and sustain high levels of productivity even under changing climatic conditions. Government policies need to support the research and development of appropriate technologies to help pastoralists adapt to changes in climatic conditions. Government responsibilities include putting in place policy measures to mitigate the adverse effects of climate change on pastoralists. Examples of these policy measures include the introduction of drought-resistant crop varieties, improving climate information forecasting and dissemination, or promoting farm-level adaptation measures, such as the use of irrigation technologies. Accessibility to key agricultural production information like water and soil conservation techniques as well as the other adaptation options identified will help to boost pastoralists' coping strategies.

REFERENCES

Abate T 2016. Contribution of indigenous knowledge to climate change and adaptation response in southern Ethiopia. *Journal of Earth Science and Climatic Change* **7**(11): 1-9.

Abarufa J 2011. *Climate Change and Variability and its Impact on the Livelihood of Pastoralists: Case Study in Dire Woreda of Borana Zone, Oromia Region.* M.Sc. Thesis. Addis Ababa University School of Graduate Studies Rural Livelihood and Development, Addis Ababa, Ethiopia: 118.

Adger W Neil, Suraj Dessai, Marisa Goulden, Mike Hulme, Irene Lorenzoni, Donald R Nelson, Lars Otto Naess, Johanna Wolf and Anita Wreford. 2009. Are there social limits to adaptation to climate change? *Climatic Change* **93**(3): 335-354.

Adhikari U, Nejadhashemi PA and Woznicki SA 2015. Climate change and eastern Africa: A review of the impact on major crops. *Food and Energy Security* **4**(2): 110-132.

Agwu EA, Egbule CL, Amadu FO, Morlai TA Wollor ET and Cegbe LW 2011. *What policy options can promote agricultural innovations for climate change adaptation and food security in the West African Sub-Region African Technology Policy Studies Network.* Technology Brief No.29. www.atp~net.org. accessed on November 29, 2021.

Asrat P and Simne B 2017. Characterizing the vulnerability of crop-based rural systems to climate change and variability: agro-eco-specific empirical evidence from the Dubus watershed, northwest, Ethiopia. *American Journal of Climate Change* **6**: 643-667.

Asrat P and Simane B 2017. Household and plot-level impacts of sustainable land management practices in the face of climate variability and change: empirical evidence from Dabus Sub-basin, Blue Nile River, Ethiopia. *Agriculture and Food Security* **6**(61): 1-12.

Anselm AE and Taofeeq A 2010. Challenges of agricultural adaptations to climate change in Nigeria: A Synthesis from the Literature. *Field Actions Science Reports,* 4:1-11. http://journals.openedition.org/factsreports/678. accessed on November 29, 2021.

Ayal Y and Leal W 2017. Farmers' perceptions of climate variability and its adverse impacts on crop and livestock production in Ethiopia. *Journal of Arid Environments* **140**: 20-28

Beatrice R, Hachileka E, Awuor C and Hammill A 2010. Climate-related vulnerability and adaptive capacity in Ethiopia's Borana and Somali Regions. IISD report. drought and projections for the 21st century with the Hadley Centre climate model. *Journal of Hydrometeorology* **7**(5): 1113-1125.

Bonatti M 2016. Land use policy climate vulnerability and contrasting climate perceptions as an element for the development of community adaptation strategies: Case studies in Southern Brazil. *Land Use Policy* **58**: 114-122.

Burnett D 2013. Final report: Stage 2 - Supporting climate resilient value chains. Evidence on Demand, UK (2013) xviii + 115 pp. [DOI: 10.12774/eod_cr.april2013.burnett].

Conway G 2009. *The science of climate change in Africa: impacts and adaptation*. In Grantham Institute for Climate Change, Imperial College London, London, United Kingdom. 1:1-21.

Chibinga C, Musimba N, Nyangito M, Simbaya J and Daura M. 2012. Climate variability; enhancing adaptive utilization of browse trees for improved livestock production among agro-pastoralist communities in Southern Zambia. *African Journal Environment Science Technology* **6**(7): 267-274

Eid H, Marsafawy S and Ouda S 2006. *Assessing the impacts of climate change on agriculture in Egypt: A Ricardian approach*. Centre for Environmental Economics and Policy in Africa (CEEPA). Special Series on Climate Change and Agriculture in Africa, University of Pretoria, Pretoria, 1-33.

Elum Z, David M and Ana M 2017. Climate risk management farmers' perception of climate change and responsive strategies in three selected provinces of South Africa*. Climate Risk Management* **16**: 246-257

Fratkin E 2014. Ethiopia's pastoralist policies: development, displacement, and resettlement. *Nomadic Peoples* **18**(1): 94-114

Galvin A, Boone R, Smith N and Lynn S 2001. Impacts of climate variability on East African pastoralists: linking social science and remote sensing. *Climate Research* **19**: 161-172.

Global Assessment Report (GAR) 2015. *Global Assessment Report on Disaster Risk Reduction, Geneva*. United Nations International Strategy for Disaster Risk Reduction (UNISDR), 1-3

Gregory P, Ingram J and Brklacich M 2005. Climate change and food security. *Philosophical Transactions of the Royal Society* **36**: 2139-2148.

Jones P and Thornton K 2009. Croppers to livestock keepers: Livelihood transition to 2050 in Africa due to climate change. *Environmental Science and Policy* **12**(4):427-437.

Khanal R 2009. Climate change and organic agriculture. *The Journal of Agriculture and Environment* **10**: 100-110.

Lemmen D, Warren F, Lacroix J and Bush E 2008. *From impacts to adaptation: Canada in a changing climate 2007,* 1-21. http://adaptation2007.nrcan.gc.ca. accessed on November 29, 2021.

McSweeney C, Lizcano G and New M 2010. The United Nations Development Programme (UNDP) climate change country profiles: improving the accessibility of observed and projected climate information for studies of climate change in developing countries. *Bulletin of the American Meteorological Society* **91**(2): 157-166.

Mendelsohn R, Dinar A and Dalfelt A 2000. Climate change impacts on African agriculture. *Climate Change Bulletin* **5**: 1- 25.

Mengistu D and Haji J 2015. Factors affecting the choices of coping strategies for climate extremes: The case of Yabello district,

Borana zone, Oromia national regional state, Ethiopia. *Science Research* **3**(4): 129-136.

Nega D, Mohammed C, Bridle K, Corkrey R and McNeil D 2015. Perception of climate change and its impact by smallholders in pastoral/agropastoral systems of Borana. South Ethiopia. *Springer Plus* **4**(1): 236.

Parry ML, Canziani OF, Palutikof JP, van der Linden PJ and Hanson CE 2007. *Intergovernmental Panel on Climate Change (IPCC) 2007*. Climate Change 2007: Impacts, adaptation, and vulnerability. contribution of working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, pp 976.

Shrotriya G and Daman P 2011. *Climate change and agricultural cooperatives*, Indian Farmers Fertiliser Cooperative Limited, New Delhi, India **1**: 1-6.

Thornton P, Herrero M, Freeman A, Mwai O, Rege E, Jones P and McDermott J 2007. Vulnerability, climate change, and livestock-research opportunities and challenges for poverty alleviation. *Journal of SAT Agriculture Research* **4**(1): 1-23.

Tadege A 2007. *Climate change national adaptation program of action (NAPA) of Ethiopia*. National Meteorological Agency, Addis Ababa: 1-96.

Tadese A and Alemayehu M 2017. Impacts of climate change on food security and its adaptation and mitigation options in Ethiopia: A review. *Agriculture, and Food Security* **8**: 63-75.

Tamiru L and Fekadu H 2019. Effects of climate change variability on agricultural productivity. *International Journal of Environmental Sciences & Natural Resources* **17**(1): 14-20.

United Nations Framework Convention on Climate Change (UNFCCC) Handbook 2007. *Climate change: the scientific basis*. Cambridge University Press, Cambridge, UK.: 1-220. secretariat@unfccc.int. accessed on November 29, 2021.

Urama K and Ozor N 2011. Agriculture innovations for climate change adaptation and food security in western and central Africa. *Agro-Science* **9**(1): 1-6.

World Bank 2010. *The social dimensions of adaptation to climate change in Ethiopia*. Development and climate change, Washington, DC USA. Pp 1-120. www.worldbank.org/eacc. accessed on November 29, 2021.

Yirga C 2007. *The dynamics of soil degradation and incentives for optimal Management in Central Highlands of Ethiopia.* Ph.D. thesis, Department of Agricultural Economics, extension and rural development. University of Pretoria, South Africa: 263.

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