INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 21, No. 3, p. 56-62, 2022
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Smallholder farmers' perception and coping mechanisms towards climate change on mixed farming systems at selected Districts of Hadiya Zone, Southern Ethiopia

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Article published on September 20, 2022

Key words: Climate change, Coping mechanisms, Impact, Mixed farming systems, Perception

Abstract

Agriculture is the foundation of the Ethiopian economy, but the productivity and competitiveness of this sector are increasingly constrained by the temporal and spatial variability of climate change. Thus, this study was carried out to assess smallholder farmers' perceptions and coping mechanisms toward climate change in mixed farming systems in selected districts of Hadiya Zone, Southern Ethiopia. Data were collected from 150 sample smallholder farmers through a questionnaire, key informant interviews, and focus group discussions. The survey results showed that households differ in terms of perceiving and coping capability with climate change. In this regard, about 21.4% noticed climate change, 62.3% felt a decline in the amount of rainfall, 56.2% stated late onset of rain, and 17.5% showed early cessation of rainfall. Subsequently, to cope with the impacts of climate change some farmers use crop diversification, planting early maturing varieties, livestock sales, and changing planting dates. In general, there is a perceptive gap between farmers about climate change, and the coping mechanisms were not effectively implemented in the study area. Therefore, farmers and other stakeholders should contain the adverse effects of climate change, and enable the community to exercise effective coping practices.

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Introduction

Climate change is one of the most urgent and complex challenges for all countries in the world that directly influences the food supply and livelihoods of billions of people (Giddens, 2009). It is one of the biggest environmental challenges that bring changes in weather patterns that can have serious repercussions for all of us, modifying seasonal cycles, harming ecosystems and water supply, affecting agricultural farming systems and food production, causing sea levels to rise (Hassan, 2010; Corner *et al.*, 2012).

Even though climate change is a global challenge, the poor developing African countries are generally recognized to be the most vulnerable to climate change due to their low level of adaptive capabilities (Niang *et al.*, 2014). The livelihoods of millions of people who are poor and susceptible are presently threatened by Climate change which alters the natural and physical resources they depend on (Mesfin and Bekele, 2018). It threatens various sectors of economic development including natural resources, agriculture, food security, tourism, manufacturing, and health (Clifton, 2017). For these countries, agriculture is the most important sector which contributes more than 60% of employees and covers an average of 40% of the GDPs of the region (NASAC, 2015). Even though agriculture is an essential component of their social well-being, especially for smallholder farmers' (holders of <2 ha of farm plots), climate change has complicated the overall well-being of the societies which results in poverty, food insecurity, low productivity, loss of biodiversity, ecosystem disturbance, poor health status and sever death (Below *et al.*, 2010; Zerga *et al.*, 2016).

Like in the other African countries, agriculture is the foundation of the Ethiopian economy, accounting for about 43% of national GDP, generating 90% of foreign exchange earnings, and employing more than 80% of the population (IMF, 2012). It is also the major source of food for the population and the prime contributing sector to food security. However, the sector is mostly dominated by small-scale mixed crop-livestock production with very low productivity due to several factors. The major factors responsible for low productivity include reliance on traditional farming techniques, soil degradation caused by overgrazing and deforestation, poor complimentary services such as extension, credit, marketing, infrastructure, and climatic factors such as drought and flood (Deressa *et al.*, 2011). Among other factors, climate change is one of the most serious environmental threats that adversely affect agricultural production and productivity in most parts of Ethiopia (Temesgen *et al.*, 2014) including the study area. Even though agriculture is the foundation of the Ethiopian economy, the productivity, and competitiveness of this sector are increasingly constrained by the temporal and spatial variability of climate change (Mahoo *et al.*, 2013). The country's agriculture is one of the most vulnerable sectors to current climatic variability and projected climate change, potentially exposing millions of people to recurrent food shortages and episodic famines (NMA, 2007). Climate change imposes constraints on development, especially among smallholder farmers whose livelihoods mostly depend on rain-fed agriculture (IPCC, 2007; Saguye, 2017). This is due to their dependence on rain-fed small-scale mixed crop and livestock production with low economic development, limited disaster management skills, weak institutional capacity, and low adaptive capacity (Boko *et al.*, 2007; Gebreegziabher *et al.*, 2011). It affects agriculture in several ways; including through changes in average temperatures; rainfall and climate extremes with an important impact on soil erosion (i.e. floods, drought, etc): changes in pests and diseases, change in the productivity of crops and livestock, changes in atmospheric carbon dioxide, changes in the nutritional quality of some foods, changes in the growing season, and changes in sea level (NMA, 2007).

For countries like Ethiopia, whose livelihood occupation of the nation is mainly based on subsistence agriculture that is highly relied on rainfall, it is important to understand climate change challenges, especially amongst smallholder farmers' since agriculture is an essential component of their social well-being. For these agricultural-dependent vulnerable groups, even minor climate changes can have disastrous impacts on their lives and livelihoods. In addition to this, currently, smallholder farmers in rural areas have been facing low agricultural productivity, crop failure, human disease outbreak, pest and diseases, lack of water, shortages of agricultural-based food items at a household level, and food insecurities in many parts of the country including the study area.

Since climate change variability negatively affects crop yield and livestock productivity that threatens food security for smallholder farmers, there is an urgent need to identify approaches that strengthen the adaptive capacity of smallholders and enhance their ability to respond to climate change in a sustainable way. Hence, understanding smallholder farmers' perceptions and coping mechanisms for extreme climate change and its significant impacts on crop and livestock production are crucial to designing and implementing appropriate adaptation strategies to climate change and variability to improve sustainable agricultural productivity (Muller, 2013; Thornton and Herrero, 014).

Moreover, the efforts made by the farmers to cope with the changing climate at the local level are mostly unorganized and influenced by a set of factors that needs a well-integrated and holistic approach to the entire system of the agriculture sector to make it less sensitive to climate change impact. To narrow this gap, there are no appropriate research works conducted on farmers' perceptions and coping mechanisms towards climate change in the study area. Hence, this study was designed to assess smallholder farmers' perceptions and coping mechanisms towards climate changes in the mixed farming system in selected Woreda of Hadiya Zone.

Materials and methods

Description of the study area

This study was conducted in Ameka, Misha, and Gibe districts of the Hadiya Zone in Southern Ethiopia (7°.22" to 7° .45' 00''N and 37°.40" to 38°.00'E).

In terms of agroecology, the Hadya area is mainly characterized by three climatic variations. These are midland (Woyna-Degga), arable highland (Degga), and lowland (Qolla). According to DoANR (2018), nearly 60 percent of the land lies in the midland, nine percent in the arable highland, and 35 percent in the lowland climate zones. Moreover, Dessalegn (2007) notes that more than a 75 percent of the human and livestock population are to be found in the midland and arable highland climatic zones that also account for some 80 percent of the food crops produced in the Hadiya Zone.

Sampling Technique

Multistage sampling techniques were applied for this particular study. In the first stage, three districts were selected purposively due to their different agro-climatic conditions. In the second stage, the study area was stratified into three different strata based on agroecological, based on agro-ecological classification. This encompassed one peasant association (PA) from highland (Dega), one PA from midland (Woina-Dega), and one PA from lowland (Kolla) PA which was selected randomly by lottery method. From each district, three representatives of PA were selected. In the third stage, lists of households in each selected PA were obtained from the PA offices in the study areas. Then, sample households were taken proportionally from each PA from the total population. A sample size (n) in each PA was picked based on its proportion to a sampling frame (N). To select sample households a simple random sampling method was applied.

To determine sample size, the following Kothari (2004) mathematical formula was used.

$$n = \frac{Z^2 * P * q * N}{e^2(N-1)Z^2 * P * q}$$

Where n = the sample size; N = total number of households; p = 0.5 the sample proportion reliability and q = 1- p; e = 5% the margin of error/acceptable error considered; Z = 1.96 is the critical value for a 95% confidence interval.By using the sample size formula, 150 respondents were determined from the selected PA to fill the survey questionnaire. In the selection of key informants and FGD participants, long experience in farming, voluntary participation in the discussion, and knowledge about the impact of climate variability and extremes on their agricultural activities and productions were considered.

Data collection

The research method for data collection of this study involved both qualitative and quantitative methods in combination with using a sequential explanatory strategy because it is more appropriate to triangulate the reliability of information and describe the existing situation of climate change in the area. To get reliable data, surveys were conducted on sampled households, Key informants were selected and interviewed and focus group discussions (FGD) were conducted with farmers.

Primary data was collected from participants through surveys. Structured questionnaires were developed for household surveys, semi-structured for in-depth face-to-face interviews of key informants, and unstructured questions for FGDs. In addition to primary data, secondary data was collected from journal articles, statistical abstracts, books, policy briefs, study reports, theses, and dissertations. These sources of secondary information were from the internet, college libraries, institutions, and organizations.

Data analysis

Descriptive statistical tools such as mean, percentages, frequencies, and standard deviations were used to summarize and categorize the information gathered. Crosstabs, F-test, and chi-square tests were employed.

Results and discussion

Smallholder Farmers' Perception of Climate Change

The survey compares current and the past three decades' weather conditions, the analysis revealed that (54.3%) of farmers had not perceived drastic differences over the years. But, the majority (62.3%) of the respondents indicated that the rainfall amount had decreased whereas a few farmers felt that the rainfall amount had increased (13.4%) (Table 1). On the other hand, a significant number of households confirmed that late onset of rainfall, early cessation (termination) of rainfall, poor distribution of rainfall, high temperature, frequent and high volume floods, and strong wind have been seen in the study area. This result indicates the rainfall pattern has become irregular, the temperature increased these might be an evident feature of climate change and which was affecting crop and livestock production in the study area. Similar findings were documented in the study conducted in the Amhara region of Ethiopia by Bewket (2010).

Table 1. Farmer's perception of climate change during the past 30 years.

Climate change indicators in the study districts	Response (%)
Rainfall amount has increased	13.4
Rainfall amount has decreased	62.3
Rainfall amount is the same	00.00
Late-onset of rainfall	56.2
Early cessation of rainfall	17.5
No change onset of rainfall	00.00
The temperature has increased	72.7
Temperature has decreased	3
No change in temperature	00.00

Local climate change indicators were assessed in the households. Accordingly, loss of some crop varieties (4.5%), increased drought conditions (25.2%), irregularity of rainfall patterns (8%), a decline in product yields (10%), and a decrease in available water (intermittent flow of rivers and streams, drying up of ponds and wetlands) (16%) (Table 2) were perceived by few respondents of households and the Chi-Square (X^2) test showed that no significant difference (p values far 0.1) between the local indictors. Similarly, in most of the focus group and key informants' discussions, it was confirmed that the climatic variability, particularly irregularity of rainfall and rising temperatures were perceived by a few of them as the affecting factors of agricultural activities, including livestock production. This result implies relatively, the majority of the smallholder farmers did not perceive local climate change indicators. Therefore, it needs the strong effort of natural resources development works and any other stakeholders to scale up the understanding of these farmers because climate change in the form of higher temperature, reduced and increased rainfall variability negatively affects crop yield and livestock productivity that threatens food security in smallholder farmers (Aemro *et al.*, 2012).

Table 2. Perception of respondents on the local indicators of climate change.

Local Indicators of Perceived Climate Change	Percent of farmers' response	
	Yes	No
Loss of some plant and animal species	4.5	71.2
Increased drought and flood frequency	25.2	52.8
Irregular rainfall pattern	8	67.7
The decline of soil productivity/fertility	9.9	65.8
The decline in Agriculture yield	11	64.7
Water availability reduced	16	59.7
Growing period shortened	3	72.7

Smallholder Farmers Coping Mechanisms towards Climate Change

Analysis of responses of smallholder farmers' experience for coping mechanisms practiced to cope with climate change vulnerability showed that many have tried to use a change in crop variety (42.5%), change planting date (31.37%), Crop diversification (42.1%), planting of short-season varieties (31.37%), and selling livestock (30.60%) (Table 3). While the key informants and focus group discussions confirmed the above-listed practices are commonly employed to cope with minor climate shocks. Moreover, the most common coping strategies for severe climatic shocks preferred by the respondents' were afforestation (32.9%), migrated (32.9%), integrated watershed management (32.1%), borrowed cash (37.4%), selling livestock (35.35%) and Work for food (26.8%) (Table 4). This shows, that understanding the impacts of minor and severe climate shock on smallholder farmers and developing appropriate coping mechanisms are critical issues in the areas where small-scale agriculture is central to economic development, food security, and local livelihoods. Similarly, Deressa *et al.* (2010) reported equivalent results in their finding such as growing of drought, heat resistant and early maturing crop varieties, crop and livestock diversification, use of small-scale irrigation, water harvesting and storage, improved water exploitation methods, labor migration, strengthening of agroforestry practices, improved food storage, controlled grazing, changing planting dates, and engaging in off-farm activities were used by farmers to reduce climate change shock.

Table 3. Smallholder farmers' coping mechanisms for minor climatic shocks.

	Coping mechanisms for small climatic shocks	Frequency	Percent
1.	Change in crops Variety	64	42.5%
2.	Crop diversification	63	42.1%
3.	Change in planting date	53	35.2%
4.	Planting of short-season variety	47	31.37%
5.	Selling livestock	46	30.60%

Table 4. Smallholder farmers' coping mechanisms for severe climatic shocks.

	Coping mechanisms for severe climatic shocks	Frequency	Percent
1	Afforestation	49	32.9%
2	Migrated	49	32.9%
3	Integrated watershed management	48	32.1%
4	Borrowed cash	56	37.4%
5	Selling livestock	40	26.8%
6	Work for food	29	19.3%

Conclusion

The temporal and spatial variability of climate change hinders the productivity and competitiveness of agricultural activity. Similarly, this survey showed in the selected districts of the Hadiya zone, few farmers lack adequate perceptions of climate change primarily on temperature and rainfall patterns. On contrary, the majority of them perceived the rainfall onset; cessation, and distribution had become erratic, and that affected their farming practices and livestock husbandry. As a result of these, many smallholder farmers practiced coping options such as having a keen interest to use crop diversification; changing planting dates and some farmers sold their livestock.

However, many of the coping options were not fully implemented in a well-coordinated and organized manner in all smallholder farmers' fields in the study area. Therefore, efforts should be done through the farmers and stakeholders to contain the adverse effects of climate change, and enable the affected community to exercise effective coping practices.

Acknowledgement

The authors gratefully acknowledge the district agriculture officers for supporting the survey.

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