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Smallholder Farmers' Perception of Climate Change: The Case of Jamma District of South Wollo Zone, Ethiopia

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ABSTRACT

Climate change is causing the greatest environmental, social and economic threats across the globe. Its impact has been increasing especially on agricultural activities in developing countries. It depresses crop yields through temperature increase and reductions of precipitation. Climate change mainly affected low-income countries where their adaptive capacities are perceived to be low, due to weak institutional capacity, limited engagement in environmental and adaptation issues and lack of validation of local knowledge. A better understanding of the perceptions of farmers about climate change is essential to develop appropriate adaptation measures that can alleviate the adverse effects of climate change. Therefore, the main aim of the study was to examine perceptions of smallholder farmers in the Jamma district of South Wollo Zone, Ethiopia. The study was used in both primary and secondary data sources to collect both qualitative and quantitative data. Primary data were collected from a randomly selected 156 sample households interviewed through a structured questionnaire. Focus group discussion also used to collect the qualitative data about the perception and attitudes of smallholder farmers about climate change. Descriptive statistics were used to provide insights into farmers' perceptions about change in temperature and precipitation patterns comparing with the metrological data. Among the sample respondents, 92.3 percent perceived as an increase in temperature. Similarly, 98.2 and 90.4 percent of the sampled households perceived that decreased the Belg rain and in the overall average rainfall in the main rain season (kiremt) respectively.

Keywords: Climate Change, Jamma District Zone, Perception.

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1. Introduction

Climate change is the most complex global challenge in the 21st century posing the greatest threat to businesses and governments. The human contribution to changes in climate is due to the emission of greenhouse gasses (IPCC, 2014). During a climate change discussion, agriculture is primarily concerned because climate is a primary determinant of agricultural production.

The challenges of climate change are manifested through shortening of maturity period and then decreasing crop yield, affecting animal health, growth and reproduction and expansion of desertification, etc. (Kide, 2014). On the other hand, rural farmers are largely unable to access information about climate change due to information flow complexities, lack of localized risk management advisories, limited translation of scientific information into easily comprehensible messages and limited information centers (Leslie, 2013). In many African countries, agricultural production and food security could be affected by climate change and variability. Relatively large changes in the sea's temperature create unusual weather patterns, such as drought, flood and storms (Temesgen *et al*., 2014).

Agriculture is the main sector in Ethiopia which is dominated by smallholder farming and livestock husbandry. It accounts for about 36.3 percent of GDP, generates 70 percent of foreign exchange earnings and more than 73 percent of employment (UNDP, 2018). However, the sector productivity and competitiveness are increasingly constrained by climate change. A better understanding of farmers' perceptions of climate change and the decision-making process at the grass-root level is important to inform policies aimed at promoting successful adaptation strategies for the agricultural sector at the macro level.

Smallholders in Ethiopia generally face widespread problems related to inappropriate cultivation, overgrazing and deforestation, resulting in soil erosion and soil fertility decline, water scarcity, lack of pasture and livestock feed, and fuel wood crisis. This vicious cycle of "poverty, food insecurity and natural resources degradation" is driven by population growth but is being exacerbated by increasing weather variability and climate change, requiring urgent action and different approaches in the dry lands and highland areas (Dawit, 2014). Therefore, this study examined the perception of the farmers towards climate change and variability.

An increase in temperatures and a decrease in precipitation resulted in increased number of more projected hot days, fewer number of projected cold days and decreased number of projected days with precipitation; these events may lead to increased occurrences of drought in South Wollo Zone (Legesse *et al*., 2012).Therefore, detail investigation at micro level is an important means to determine the characteristics of smallholder farmers and thus help to design appropriate economic policies and strategies in that local context. Jamma is mainly affected by climate change events and no earlier study about climate change perceptions and adaptation strategies of smallholder farmers. In this regard, this study contributes to bridge these gaps and attempts to reveal the perception of farmers about the past, current and future climate change.

2. EMPIRICAL STUDIES ON PERCEPTIONS OF CLIMATE CHANGE

Perception is one of the first most important steps in the process of designing some form of change in farmers' livelihood system to respond to the negative impacts of climate change. Perception about changes in temperature and rainfall pattern is a crucial prerequisite for applying any kind of climate change adaptation options (Bewket, 2010; Apata, 2012).

Empirical studies conducted in African countries such as Nyanga *et al*. (2011) in Zambia, Temesgen *et al*. (2008) in Nile-basin of Ethiopia and Slegers (2008) in Semi-arid central Tanzania show that more than 80 percent of farmers perceived that change in climate components over the last three decades (increasing temperature, reducing rainfall). When the farmers perceived the change in climate they prepare to adjust their farms in order to reduce the negative impact of climate change. Similarly, the study conducted by Babatolu and Akinnubi (2016) in the Upper and Lower Niger River Basin Development Authority Areas, Nigeria showed a majority of the smallholder farmers perceived the change in climate and adopt different response mechanisms.

Teka *et al*., 2012 described that rural farmers actually perceived that the reduction of their crop and livestock production and their land productivity in the past two decades. One of the primary climate hazards in Ethiopia was drought and it occurred recurrently. For instance, the farm households who perceived the change in climate used improved crop varieties, adjusting planting dates, soil water conservation, crop diversification and irrigation practice to reduce the impact of climate change (Gebre *et al.,* 2015). Belaineh *et al.* (2013) reported that more than 95 percent of the sample households perceived that increased temperature and reduce the amount of rainfall in the Eastern part of Ethiopia. (Belachew and Zuberi, 2015) revealed that about 91.59 percent of the sample household perceived that an increase in temperature and reduction in rainfall by using five-point Likert Scale.

3. METHODOLOGY

3.1. Sampling Techniques and Sample Size

Jamma district is purposively selected for this study because it is highly vulnerable to climate change. Then two stage sampling technique employed to draw the sample. At the first stage, by using a stratified random sampling technique 22 rural kebeles were stratified into two agro-ecological zones. There are 17 kebeles located in the highland and the remaining 5 kebeles located in the midland. Accordingly, 5 Kebele were selected, 4 kebeles from the highland and 1 from the midland agro-ecologies using probability proportional to size in the district. In the second stage, a total of 156 household heads were selected by using simple random sampling (SRS) with probability proportional to size technique.

The study was used in both primary and secondary data sources to collect both qualitative and quantitative data. It used questionnaires as the major source of data collection tool to collect data from households by using the interview method. The rainfall and temperature data were collected from Kombolcha National Meteorological Agency (NMA) branch office.

3.2. Data Analysis

The descriptive statistical tools such as, mean, percentages, graphs, frequencies and standard deviations, as well as the Likert rating scale, were used to characterize farmer's perceptions of climate change.

4. RESULTS AND DISCUSSION

4.1. Smallholder Farmers' Perception of Climate Change

Climate change is not an outcome of a single time phenomenon; it has taken thousands of years for its beginning. Therefore, smallholder farmers' perception about climate change specifically, (temperature and rainfall pattern changes), is a necessary prerequisite for the implementation of any kind of climate change adaptation strategies (Ikheloa, 2013). Thus, smallholder farmers were asked whether they have perceived changes in the temperature and rainfall pattern in their locality area to examine the existing situation. It is also necessary to look at the trend of climate element from long term data recorded at

4.1.1. Smallholder Farmers' Perception of Temperature Change

The perception of farmers about the overall trend of average temperature in the study area was examined. Among the sampled respondents, 94.2 percent perceived long-term changes in temperature in the study area over the years. Out of which, 92.3 percent perceived as an increase in temperature and only 1.9 percent of sampled households perceived a decrease in temperature whereas, 5.8 percent of sample households perceived as constant. Similarly, 91.7 percent of sampled households perceived an increase in a number of hot days while 3.2 percent of respondents perceived as it is decreasing and only 5.1 percent of respondents were perceived as constant over the past two decades (Table 1).

The trend analysis of Meteorological data record of temperature from the period between 1992 -2016 showed that increasing trend in both minimum and maximum annual average temperature over the past twenty five years. Therefore, farmers' perception appears to be in agreement with the statistical record of temperature from the Meteorological station in the study area.

4.1.2. Smallholder Farmers' Perception of Rainfall

The main rainy season, *Kiremt* in the study area includes months of June, July and August. Sometimes there is a short rainy season in March and April. Therefore, the perception of the smallholder farmers about change in the rainfall pattern of the main rainy season (*Kiremt*) and a short rainy season (*Belg*) over the past twenty years was examined. The result showed that 98.2 percent of the sampled households perceived that the *Belg* rain was decreased. Correspondingly, 90.4 percent of the sampled households have perceived that there was a decrease in the overall average rainfall in the main rain season (*kiremt*) (Table 2). The result of this study indicated that farmers' perception was in accordance with the meteorological record.

The trend analysis of the Meteorological data of rainfall over the past 25 years showed a decreasing trend in annual rainfall amount in the study area. It indicated that annual rainfall in the study area decreases by about 10.92 mm each year. It also indicates high variability of rainfall in the study area. The variability of rainfall is very high in the *Belg* rainy season.

The sample households were also asked about their general level of perceptions of climate change with some indicators/ parameters of temperature and precipitation by using five points Likert scale. The survey result showed that 92.3 percent of the sample household perceived temperature has increased and 88.5 percent perceived a decrease in the amount of rainfall. Likewise, 91.7 percent of the sampled households perceive an increase in a number of hot days per year while 99.4 percent and 96.1 percent of sampled households perceived late start of rainfall and early cessation respectively over the past two decades (Table 3).

The survey result also showed 49.4 percent and 20.5 percent of the sample households perceived a high increase in temperature and a high decrease in the amount of rainfall over the past two decades respectively. Moreover, only 1.9 percent of the sample households indicated that temperature has been decreasing and 1.3 percent of households perceive the rainfall has been increasing. Similarly, about 5.8 percent and 8.3 percent of the sample households perceived no change in temperature and rainfall, respectively (Table 3).

About 91.7 percent and 92.3 percent of the sample respondents indicated that late start of precipitation and early cessation of precipitation with the highest level respectively. Similarly, the amount of rainfall in the Belg season decreased by 91.7 percent. The mean value of the Likert score for the above climate change parameters is 4.4, 4.1, 4.91 and 4.85 for temperature increased, precipitation decreased, late start of precipitation and early cessation of rainfall, respectively. These results indicated that rainfall had changed with the highest variability in starting late and early cessation over the past two decades followed by temperature (Table 3).

4.2. Climate Change Induced Hazards and Their Perceived Effects

The sample respondents were asked about their perception of climate induced hazards occurred in the study area over the past two decades. All of the respondents well recognize the climate induced shocks especially the aged

farmers remember the severe drought year in Ethiopia. Moreover, the young farmers also remember the recent drought year 2015/16. Therefore, the main climate related hazards and their level of severity in the study area is summarized in the following table (Table 4).

The surveyed households were asked about their perceived impact of the above environmental shocks. The sample respondents observed many consequences of climate induced shocks which affect their livelihood. However, the effects of these shocks are different in different agro-ecological location. Majority of them are a shortage of water, decline in crop yield of the farmer, death of livestock and human health problem (Table 5).

The respondents indicated that there is frequent occurrence of drought in the study area. This climate induced shocks severely affect both their crop and animal production. They also indicated an increase in crop pest and animal disease in the study area over the past two decades. They also suggest a new crop pest and disease occurred in the study area. It affects mainly teff, sorgum and beans. During focus group discussion, farmers said that their number of animals are gradually decreasing due to poor feeding and animal disease. The grazing land is reduced from time to time due to expansion in agricultural land and house construction. Therefore, they reduce their number of animals, as well as animal productivity becomes very low. There is also a high prevalence of frost and the wind in the area and farmers indicated that they lost their crop as well as home particularly in the highland area. Another climate induced shock encountered by the farmers in the study area is a shortage of water. They travel far away from their home to fetch drinking water as well as for their livestock.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

Climate change will adversely affect the rain-fed agriculture in Ethiopia. To overcome these adverse effects of climate change farmers use different adaptation measures in different area. To adopt climate change adaptation options assessment of the smallholder farmer's perception about climate change is a critical concern. Therefore, the paper mainly focuses on the level of perception of smallholder farmers about the change in climate elements (temperature and precipitation) and climate change induced hazards and their perceived effects. Majorities of the farmers actually perceived increasing temperature and decreasing precipitation especially the Belg rain. Similarly, almost all of the sampled households perceive an increase in a number of hot days per year, late start of rainfall and early cessation respectively over the past two decades. The major climate change induced hazards occurred in the area include drought, flood, crop pest and animal diseases and high wind. This climate induced shocks severely affect both their crop and animal production. An increase in crop pests and animal disease and occurrence of a new crop pest and disease occurred in the study area which mainly affects teff, sorgum and beans.

5.2. RECOMMENDATIONS

Based on the finding of the study the following policy implications

Both the government and non-governmental organizations invest in climate-resilient projects to improve on climate monitoring and reporting stations. The development agents should provide clear and timely information about the climatic conditions to the smallholder farmers. To improve on the existing knowledge of farmers about climate change and weather variability there is the need to conduct further research at local level.

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Table 1. Farmers' perception of change in temperature

Temperature change over Years	Perceived patterns of change N= 156					
	Increased		Decreased		No change	
	N	%	N	%	N	%
Average annual temperature	144	92.3	3	1.9	9	5.8
Number of hot days	143	91.7	5	3.2	8	5.1

Source: Own survey result, 2017

Table 2. Perception of sample respondents on rainfall patterns over years

	Increase		Decrease		No change	
	N	%	N	%	N	%
Main rain season (*Kiremt*)	2	1.3	141	90.4	13	8.3
Short rain (*Belg*)	0	0	153	98.2	3	1.8
Annual precipitation	4	2.6	138	88.5	14	8.9

Source: Own survey result, 2017

Table 3. Sample households' climate change perception index over years

Climate change signals and pattern of changes	Level of perception (N=156)										Mean
	1		2		3		4		5		
	N	%	N	%	N	%	N	%	N	%	
Increase in temperature	0		3	1.9	9	5.8	67	42.9	77	49.4	4.4
Increase in umber of hot days	1	0.6	4	2.6	2	1.3	35	22.4	114	73.1	4.1
Decrease in precipitation	0		2	1.3	13	8.3	109	69.9	32	20.5	4.1
Early cessation of precipitation	1	0.6	3	1.9	2	1.3	6	3.8	144	92.3	4.85
Late start of precipitation	0		0		1	0.6	12	7.7	143	91.7	4.91
Decrease belg rain	0		0		2	1.7	11	7.1	143	91.7	4.9

Note: 1=strongly disagree, 2=disagree, 3=neutral, 4= agree and 5= strongly agree

Source: Own survey result, 2017

Table 4. Climate change induced hazards

Climate change induced hazard of HH	**Level of severity**					
	Low		Medium		High	
	N	%	N	%	N	%
Drought	6	3.9	25	16	125	80.1
Floods	14	9	108	69.2	34	21.8
Crop pest and animals diseases	28	18	66	42	62	40
High wind	39	25	56	35.9	61	39.1

Note. Multiple answers were observed

Source: Own survey result, 2017

Table 5**.** Effects of major climate change induced shocks on surveyed farmers.

Consequences of climate induced shocks	Number of HH who perceived	%
Decline in crop yield	99	63.5
Shortage of water	67	42.9
Death of livestock	53	34
Human health problem	41	26.3

Source: Own survey result, 2017