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Farmers' perceptions of climate variability and its adverse impacts on crop and livestock production in Ethiopia

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ABSTRACT

This article explores farmers' perceptions of the manifestations of global change as a whole and of climate variability in particular, and its effects on the agricultural production in selected highland areas of Ethiopia. Primary data was collected using group and individual interviews, complemented by observations and a survey. The study shows that more that eighty percent of farmers felt the various manifestations and effects of climate variability. The study reveals that sex, age, income and educational level are determinant factors of farmers' perceptions on the manifestations and effects of climate variability on crop and livestock production. Farmers' perceptions of change in temperature are cognate with meteorological data analysis. However, their perceptions were found to be in disagreement with meteorological rainfall trends. This research concludes by suggesting realistic and achievable recommendations to enhance the adaptive capacity of farmers to climate extremes and the existing and future physical, biological and epidemiological challenges on crop and livestock production, so that shortfalls on farmers adaptive capacity can be addressed.

1. Introduction

1.1. Background and justification

The purpose of this research is to investigate the extent of farmers' perception about global change as a whole, and the various manifestations of climate variability in particular, and its effects on their livelihood. Climate variability and change are among the greatest developmental challenges of the 21st century (IPCC, 2007). Developing countries as a whole and especially African nations, are most the most vulnerable one, due to the sensitive nature of their livelihoods, and low adaptive capacity (Niang et al., 2014; Ayal and Muluneh, 2014). Van den and Hawkins (2000), defined "perception" as a process by which information or stimulus is received and transformed to create a psychological awareness. People perceive the same stimulus differently based on their previous experiences and cultural differences (RECOFTC, 2001). Likewise, Wolf et al. (2013) and Saarinen (1976) state that human perception of climate change is shaped by varying cognitive structures caused by socioeconomic and cultural differences that expose people to differing attitudes, values and interests. Therefore, farmers' perceptions of climate variability and its effects are influenced by psychological and socioeconomic differences and limit their response to climate change (Evans et al., 2016). Previous empirical and theoretical studies in different corners of Africa (e.g. Limantol et al., 2016; Shiferaw et al., 2014; Woldeamlak, 2012; Meze-Hausken, 2004) attested that the farming community perceived the changing of climate and are employing soft and hard adaptation strategies (Limantol et al., 2016; Ayal and Muluneh, 2014).

The observation of scientists to global change could vary from the perception of farmers due to the different lens or perspective underlying their observations (Nichols et al., 2004). The perception of farmers is formulated based on long experiences of multiple variables. Whereas scientists make highly general conclusions from analysis of a single or few variables taken from a particular place and extrapolate conclusions to other places, farmers perceive trends based on their assessment of the frequency and intensity of the highs and lows of climate data. However, scientists mostly depend on the mean value of climate data in generating arguments (Wolf et al., 2013; Weatherhead et al., 2010). Hence, scientific claims could coincide with the perception of farmers in some cases while differing in others (Ayal and Muluneh, 2014). For instance,

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both agree that the main effect of climate variability and extremes are negative but, unlike scientists, farmers do not think that climate variability and extremes has a clear trend to the extent of endangering their livelihood (Forbes and Stammler, 2009; Rees et al., 2008).

In Sub-Saharan Africa climate change and extremes such as drought is responsible for substantial economic, social, and environmental destruction. Managing the risk posed by climate change and extreme events through implementing effective technological, institutional, and policy options is crucial (Shiferaw et al., 2014). Understanding farmers' perceptions on manifestations and impacts of global change and climate variability, helps to explain why they respond to various stimuli in the way that they do. In addition, evaluating the merits and demerits of farmers' perception helps to design realistic and informed awareness creation programs. This is because, before educating respondents to learn better adaptation strategies, they should unlearn their misplaced perceptions. Similarly, identifying valuable farmers' perceptions is important in order to integrate them with scientific knowledge and design a better adaptation strategy rooted in indigenous skill and knowledge, making them more acceptable among the rural population. It is clear that the farmers' work enables them to experience firsthand the dynamic nature of climate.

Indeed, farmers' ability to cope and adaptation strategies, largely depend on the quality of perception. Farmers' perceptions about the nature of microclimate behavior and its impact are crucial to design appropriate and effective policy interventions (Juana et al., 2013). However, farmers' perception about climate variability and its effect on crop and livestock production is not studied in detailed. Therefore, farmers' perceptions of different aspects of climate variability and its impact in their locality were assessed against instrumental records. In case of manifest incongruence between their perception and instrumental records, an attempt is made to explain the source of the disparity. This is essential to determine the causes of misperceptions and articulate the implications to adaptation strategies in agricultural production.

2. Description of the study areas, research design and methodology

2.1. The study area

The study was conducted in Enemay and Gozamin, Northwest highland of Ethiopia. Gozamin and Enemay *woredas*[1] are found between 10° 18′- 10° 40′ and 38° 00′- 38° 22′ and 10° 20′- 10° 40′ and 37° 15′- 37° 45′ respectively. Total population in the study sites was 299,175 with an almost even male-female ratio. About 97% of the population lives in rural areas (CSA, 2008). The average population density is 168 people per square kilometer. High population pressure has limited the size of landholding, which, through expanding, seems to have reached the limits of further expansion (Tesfaye, 2004). More than 1% of the area is completely unproductive.

The topography of the study sites are characterized by rugged hills, mountains and gentle plain lands. According to FAO (1986), the major soil types in the area are Chromic Luvisols, Dystric Cambisols, Eutric Nitosols, Pellic Vertisols and Rendzinas. From these soil types, Eutric Nitosols is the dominant soil type in Gozamin while Vertisol is the major soil type in Enemay. Altitude varies from 800 to 4088 m above sea level which supports the presence of all agro-ecological zones but the dominant type (about 88%) falls under the category of *Woina dega* (subtropical) (Ayal and Muluneh, 2014). Vegetation cover is very low but in some inaccessible places natural forests have been preserved and indigenous trees such as *Wanza* (*Cordia africana* Lam), *warka* (*Ficus vasta Forssk*), *shoal* (*Ficus sur* Forssk), *tid* (*Juniperus procera Hochst*), *girar* (*Acacia abyssinica Benth*), and *Bisana* (*Croton macrostachyus* Hochst.ex Delile) etc are found.

The area receives an annual rainfall amount ranging from 800 mm to 1500 mm. It is drained by the *Abay* (Blue Nile), *Muga, Yegudfin, Chemoga, Kulich* and *Degell* rivers. Mixed farming, including poultry and beekeeping, is practiced but since crop production is the main economic activity, land use pattern allocates most of the area to cultivated land (45.7%), followed by human settlement (41.41%) and grazing land (12.9%) (CSA, 2008). The major crops cultivated in the area are teff, maize, wheat, barley, millet, vetch, lentil, sorghum, oil seeds field bean, field pea, haricot and soybean. The commonly reared domestic livestock in the descending order of their population size are cattle, sheep, goat, pack animals and chicken (CSA, 2008). However, the performance of agriculture is poor due to, among other things, the low use of modern agricultural inputs and poor veterinary services (Tesfaye, 2004).

Given the encouraging development trends in recent years, the expansion of basic infrastructure is high. Education, especially primary education, is expanding through formal and informal programs. As a result, the coverage of primary education has reached 80.64%, although there are only five schools for secondary and preparatory education. The coverage of healthcare has reached 70%. However, such health institutions are reported to lack basic equipment such as laboratories and surgical gloves, to render adequate service.

2.2. Research methodology

2.2.1. Study site selection and sampling techniques

To address the issues, the researcher adopted a concurrent multistage sample design for the quantitative and qualitative components of the study. A concurrent multistage sampling allowed the researcher to include different sets of sample participants such as farmers and key informants (development agents, experts and knowledgeable community members). Gozamin and Enemay *woredas* and then 3 *kebeles*[2] in each *woredas* were selected using the purposive sampling method. Therefore, the research was conducted in Libanos, Denba and Enerata *kebeles* in Gozamin and Yeser Eysus, Mahibre Birhan and Dema *kebeles* in Enemay.

Accordingly, 6 zone and *woreda* experts, 12 crop and livestock development agents, 1 female and 5 male community key informants, 36 heterogeneous (i.e. female household heads, aged and young household heads) participants were selected purposefully. In addition, stratified random sampling techniques based on age, sex and wealth status, were used to select 250 sample households. Site and key informant selection processes were conducted in consultation with the zonal and *woredas* experts.

2.2.2. Sources and data collection methods

In this research, a mixed research approach was used. Combinations of participatory, qualitative and quantitative methods were used for primary and secondary data collection. Accordingly, the study was conducted using the information obtained from different sets of stakeholders. Zonal and *woreda* experts, development agents, community key informants, farmers and relevant institutions such as NMSA, CSA and respective woreda annual reports

[1] Woreda is administrative unit equivalent to district.

[2] Kebele is the smallest administrative unit in the woreda.